Prevalence and nature of medication errors in children and older patients in primary care

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Abstract

AIM: To conduct a systematic literature review on the existing literature on the prevalence of medication errors across the medicines management system in primary care; To explore the systems of error management in primary care; to investigate the prevalence and nature of medication errors in children, 0-12 years, and in older patients, ≥65 years, in primary care; and to explore community pharmacists' interventions on medicines-related problems.

METHODS: 1) Systematic literature review; 2) Questionnaire survey of Primary Care Trusts (PCTs), Clinical Commissioning Groups (CCGs) and NHS Area Teams; 3) Retrospective review of the electronic medical records of a random sample of older patients, ≥65 years old, and children 0-12 years old, from 2 general practices in Luton and Bedford CCGs, England; 4) Prospective observation of community pharmacists' interventions on medicines-related problems and prescribing errors from 3 community pharmacies in Luton and Bedford CCGs in England.

DATA ANALYSIS: Quantitative data from records review were analysed using Microsoft Excel on data extracted from an Access database. Statistical tests of significance were performed as necessary. Descriptive statistics were conducted on quantitative data from the studies and inductive qualitative analyses were conducted on aspects of the questionnaire survey.

RESULTS:

- The systematic literature review demonstrated that medication errors are common, and occur at every stage of the medication management system in primary care, with error rates between ≤1% and ≥90%, depending on the part of the system studied and the definitions and methods used. There is some evidence that the prescribing stage is the most susceptible, and that the elderly (over 65 years) and children (under 18 years) are more likely to experience significant errors, although very little research has focussed on these age groups.
- The questionnaire survey of PCTS, CCGs and NHSE demonstrated that national and local systems for managing medication errors appeared chaotic, and need to be better integrated to improve error learning and prevention in general practice
- The retrospective review of patients' medical records in general practices demonstrated that prescribing and monitoring errors are common in older patients and in children. 2739 unique prescription items for 364 older patients ≥65 years old were reviewed, with prescribing and monitoring errors detected for 1 in 3 patients involving about 1 in

12 prescriptions. The factors associated with increased risk of errors were: number of unique medications prescribed, being ≥75 years old, being prescribed medications requiring monitoring, and medications from these therapeutic areas: corticosteroid, NSAID, diuretic, thyroid and antithyroid hormones, statins and ACE-I/ARB. 755 unique prescription items for 524 younger patients 0-12 years old were examined, with approximately 1 in 10 prescriptions and 1 in 5 patients being exposed to a prescribing error. Factors associated with increased risk of prescribing errors in younger patients were: being aged ≤10 years old, being prescribed three or more medications, and from similar therapeutic areas as above. Majority of the errors were of mild to moderate severity.

- Community pharmacists performed critical interventions as the last healthcare professional defense within the medicines management system in primary care. However, this role is challenged by other dispensary duties including the physical aspects of dispensing and other administrative roles.

CONCLUSION Prescribing and monitoring errors in general practice, and older patients and children may be more at risk compared to the rest of the population, though most errors detected were less severe. Factors associated with increased risk for errors in these age groups were multifaceted. The systems for periodic laboratory monitoring for routinely prescribed drugs, particularly in older patients, need to be reviewed and strengthened to reduce preventable hospital admissions. Antibiotic dosing in children in general practice needs to be regularly reviewed through continued professional developments and other avenues. As guidance on local arrangements for error reporting and learning systems are less standardised across primary care organisations, pertinent data from adverse prescribing events and near misses may be lost. Interventions for reducing errors should therefore explore how to strengthen local arrangements for error learning and clinical governance. Community pharmacists and/or primary care pharmacists provide an important defence within the medicines management system in primary care. Policy discussions and review around the role of the pharmacist in primary care are necessary to strengthen this defence, and harness the potential thereof.

Glossary

Monitoring error	A monitoring error occurs when a prescribed medicine is not monitored in the way, which would be considered acceptable in routine general practice. In this study, it is the absence of relevant laboratory tests, for specific drugs, being carried out at the frequency listed in the criteria, with tolerance of +50%. If a patient refused to give consent for a test, then this would not constitute an error.
Prescribing error	A prescribing error occurs when, as a result of a prescribing decision or prescription-writing process, there is an unintentional, significant: reduction in the probability of treatment being timely and effective, *or* increase in the risk of harm when compared to generally accepted practice.
ScriptSwitch®	Prescribing decision support software (with specific features to help general practices control their prescribing costs).
SystmOne®	A type of GP clinical computer system supplied by the company, TPP.
TPP	Type of GP computer system supplier.

List of abbreviations

ACEI	Angiotensin Converting Enzyme Inhibitor
ADR	Adverse Drug Reaction
BD	Twice Daily
BNF	British National Formulary
CHD	Coronary Heart Disease
CI	Confidence Interval
CNS	Central Nervous System
Comm. Pharm	Community Pharmacist
CP	Community Pharmacy
CPCF	Community Pharmacy Contractual Framework
CVD	Cardiovascular Disease
DH	Department of Health
DRP	Drug Related Problem
GIT	Gastro-Intestinal Tract
GMC	General Medical Council
GPhC	General Pharmaceutical Council
ENT	Ear, Nose and Throat
GP	General Practitioner
HCP	Healthcare Professional
ID	Identification Code
INR	International Normalized Ratio
IHD	Ischaemic Heart Disease
IHI	Institute for Healthcare Improvement
IMD	Indices of Multiple Deprivation
IoM	Institute of Medicine
MPharm	Master of Pharmacy Programme
IQR	Inter Quartile Range
MR	Modified Release
MRP	Medicine Related Problems
MUR	Medicines Use Review
NHS	National Health Service
NICE	National Institute for Health and Clinical Excellence

NMS	New Medicine Service
NPSA	National Patient Safety Agency
NSF	National Service Framework
NRLS	National Reporting and Learning System
NSAID	Non-Steroidal Anti-Inflammatory Drug
OTC	Over-The-Counter
P	P-value
PCNE	Pharmaceutical Care Network Europe
PCT	Primary Care Trust
PSNC	Pharmaceutical Services Negotiating Committee
PRACtISE	Prevalence And Causes of Prescribing errors in general practice study
QOF	Quality of Outcomes Framework
REC	Research Ethics Committee
Rx	Prescription
RPS	Royal Pharmaceutical Society
TDS	Three times daily

Thesis structure

This thesis is structured as outlined below.

- Chapter 1 of this thesis sets out the context of the background to research in patient safety. This introduction discusses the nature of the problem of medical and medication errors, history of medical and medication errors, the relationship between medication errors and adverse drug reactions, the medicines use process, medication errors in secondary and primary care, and in older and younger patient populations, identification of medication errors, and reporting medication errors.
- Chapter 2 outlines the theoretical and philosophical framework underpinning this research with respect to quantitative approaches to the evaluations of prescribing and monitoring errors.
- Chapter 3 outlines the overall methods applied in this research and comments on the feasibility study.
- Chapter 4 – Phase 1, Study 1 – outlines the systematic search and review of the existing literature on medication errors in primary care.
- Chapter 5 – Phase 1, Study 2 – describes the research process for characterization of the systems used by Primary Care Trusts (PCT) and Clinical Commissioning Groups (CCG) for the identification, recording and reporting of medication errors in a before-and-after study.
- Chapter 6 to Chapter 8 – Phase 2, Study 3 – reports on the retrospective review of medical records of older patients and children in general practice to identify potential prescribing and monitoring errors. Chapter six provides background information on the study's aim and objectives and describes the study setting. Chapter seven provides information on the characteristics of older patients ≥65 years old reviewed and the results of the investigations. Chapter eight provides information on the characteristics of younger patients 0-12 years old and the results of the investigations. Chapter 9 provides discussions on chapters 6 to 8
- Chapter 10 – Phase 2, Study 4 – reports on the prospective observation of community pharmacists' interventions on prescribing errors and medicines-related problems in primary care.
- Chapter 11 – Phase 3 – provides a general discussion on the implications of the research findings and recommendations and pulls together the results and conclusions from the entire research process, with the limitations of the research.

Chapter 1. **Introduction/background to the study**

1.0 Introduction on Patient Safety

Within the last decade, medical error and patient safety have been the subjects of discussions for government bodies, healthcare organizations, and researchers, the media, and patients. The American Institute of Medicine (IOM) report, '*To Err is Human'*, highlighted the harmful, common, expensive, and more importantly, the preventable nature of medical errors (Kohn et al., 1999). A United Kingdom (UK) Department of Health, DH report '*An Organization with a Memory: Learning from Adverse Events in the NHS,'* emphasised the importance of reporting and learning from errors across the UK National Health Service, NHS (Department of Health, 2000). These government reports established the need for a paradigm shift in safety culture within healthcare organisations and their teams, teamwork, active reporting and learning from adverse events. The reports further emphasised the role of active reporting and error learning between the various departments of healthcare systems based on the preventable and reoccurring nature of medical errors. Therefore, much emphasis has been placed on the need to adopt a non-punitive attitude towards healthcare professionals who make errors, as although they are direct results of human failures (Reason, 2000), errors are products of the systems that produce them (Leape et al., 1995).

The increased awareness on errors in medical practice has sparked much research into the health service dimensions of patient safety. Albeit, studies and interventions to prevent error occurrence presently lack standardization and uniformity, making the whole system appear chaotic (Vincent, 2010). Comparing results or outcomes of interventions has been difficult to achieve. Nevertheless, in spite of the large variations in data seen in different settings, there is enough evidence of the high rates of medical error, and its burdensome harm to patients (Vincent, 2010), and ironically, the increasingly-pressured healthcare service.

1.1 A historical perspective on medical harm and the evolution of patient safety

Although medicine is increasingly moving towards acknowledging and understanding medical harm and prevention, medical harm and attempts to prevent them date back to Hippocrates classic maxim to "*abstain from harming or wronging any man*" (Vincent, 2010). Modern medicine still has the potential for substantial harm, possibly greater now than the past, due to so much advances and complexities in practice and therapy. Charles Vincent's account on the history of medical harm and the evolution of patient safety provides an interesting perspective provided below (Vincent, 2010).

Heroic medicine dominated the early 19th century when medical interventions were more focussed on saving lives, irrespective of the costs of doing so, leading to much suffering by patients. Treatments were very dramatic and crude e.g. treatment of 'morbid excitement' such as yellow fever may have involved draining over half the total blood volume of the patient by heroic physicians, who in turn demonstrated heroism. On the other end of the spectrum were practitioners who believed absolutely in natural healing, and therefore viewed heroic medicine as lethal. A more practical position developed over time however, and physicians moved to a rational view where the risk-benefit ratio of medical interventions was assessed prior to treatment. This risk-benefit ratio clearly underpins orthodox medical practice today – patient health outcomes have taken centre-stage with a subsequent increase in the healthcare professional's responsibility to them, including the avoidance of discomfort and pain from both the disease and its treatment.

Defining what constitutes harm was not any greyer then than today, however. For the heroic healers, the most important outcome was to avoid death, and any measure taken to achieve these would have been justified. On the other hand, the proprietors of natural healing avoided any form of human suffering in medical intervention. The middle or rational position attempts to maintain a balance between beneficial interventions and undue suffering. As such, a complete state of medical safety may be non-existent even in the face of a very rational and balanced healthcare system today. Therefore, safety in healthcare needs to be understood, viewed, and promoted by stakeholders in the light of other specific treatment outcomes and objectives.

Irrational medical interventions were one category of harm. Hospital-acquired infections were another source of harm that dominated the earlier practice of medicine. Sepsis was common, and gangrene readily encountered that "*those entering hospital for surgery were 'exposed to more chance of death than the English soldier on the field of Waterloo*'" (Porter, 1999 in Vincent 2010). Not all physicians at the time agreed with the school of thought. However, following empirical research and publication, by the end of the 19th century, disease transfer was eased by infection control, sterilisation, and the use of gloves, masks etc. Today, hospital-acquired (nosocomial) infection is still a problem due to the interplay of many factors including insufficient hand washing among healthcare professionals, comparable to what was seen over a century ago.

The pioneering work of Ernest Codman, a Boston surgeon of the early 20th century in analysing surgical outcomes and reviewing them is partly relevant for the history of error classification or categorisation. Codman acknowledged his errors in surgery, made them public, and challenged his colleagues to show the effectiveness of their procedures (Vincent, 2010). Through his actions, Codman received opposition from his colleagues. However, part his proposals were eventually adopted by the American Surgical Society. His principles and views led to the formation of the Joint Commission on Accreditation of Healthcare Organizations (JCAHO), which is the largest accrediting body in the US (Sharpe and Faden, 1998 as cited in Vincent, 2010).

Earlier on, harm from medical intervention was not a subject for discussion when medical practice achieved relatively small outcomes. During the 1920's however, terminologies such as 'iatrogenic disease' meant that medical harm was increasingly being recognised, although the term initially referred to a nervous problem experienced by a patient that was associated with diagnosis. There was a clear divide between practitioners who viewed medical harm an inevitable by-product of advancements in medical practice and those who thought more stringent practices could avoid some forms of patient harm, following increase in medical interventions in the mid 1950's.

Systematic evaluations of adverse events resulting from hospitalisation mishaps commenced in the 1960s, when reports started to be collated and reviewed, although initial reports suggested that harm due to staff errors were left out. Drug treatment was identified as a major factor leading to adverse events following further investigation by researchers; the most hazardous drugs being nitrates, digoxin, Lidocaine, aminophylline and heparin (Vincent,

2010). Procedures, which became associated with the most problems, included intravenous interventions and catheterisation; falls were also implicated. Some of these processes, for instance, fall in the elderly due to therapeutic interventions, are challenging sources of harm even today.

Illich's controversial identification and documentation of 'social iatrogenesis' and 'cultural iatrogenesis,' described excessive reliance on medicine to solve normal problems of living, and people's inability to manage ill health respectively, further contributing to the growing literature of medical harm in the 1970's (Vincent, 2010). Illich's emphasis was on the need for people to take responsibility for their health, avoid too much dependence on medical interventions, based on his belief that medical harm was not going to be avoided by technological and pharmacological innovations. Government papers towards the end of the 20th century reiterated his claims.

Although the concept of medical error and harm has been around for a very long time, more than ever before, healthcare professionals are increasingly acknowledging and evaluating patient harm from medical error. Pioneering research and researchers, and other factors, including a mission to improve the quality of healthcare, evaluations of the characteristics of error, high profile cases, learning from psychology and high risk industries, litigation and compensation, and government and public influences, have greatly influenced the evolution of patient safety (Vincent, 2010)

Patient safety came forward on the back of the understanding and practice of quality improvement. The birth of quality improvement programs in the early 20th century, such as maternal morbidity and mortality reviews by the British Ministry of Health in 1928, exposed the complexities of issues around patient safety. Quality of care issues were inferred from geographical variations in medical interventions and outcomes, and efforts were made to improve healthcare processes and administration by following quality assurance procedures in manufacturing industries, such as continuous quality improvement, total quality management, business process re-engineering and quality circles. These quality management approaches relied on both evaluation of systematic data and optimisation of personnel contributions to improve outcomes. By the 1990's, healthcare stakeholders became increasingly aware of the place of systematic quality improvement programmes.

Another concept, which evolved in the 20th century, is learning from error, following a call for clinicians to deliberately identify and learn from them, based Sir Karl Popper's

philosophy of Science, which surmises that scientific knowledge is never final, but that advancement in science relies on identifying limitations in exiting theories. The concept of the fallibility of medical practice and professionals, and what to do with inevitable system and personnel failures was introduced.

High-profile cases of medical errors, for example, the death of Betsy Lehman from a drug overdose during chemotherapy, wrong leg amputation of Willie King, and the death of Ben Kolb during a minor injury from a drug error, the UK Bristol Royal Infirmary infant morbidity and mortality following cardiac surgeries, etc. showed that the healthcare system was not fail-safe (Vincent, 2010). The Bristol Inquiry, published following the events of infant morbidity and mortality from cardiac surgery, adopted a systems approach to error analysis, and brought about change from tragedy. Bristol demonstrated that interplay between system and personnel factors were ultimately responsible for widespread quality issues throughout the NHS, and its recommendations were relevant to the entire health system.

High-risk industries such as aviation, chemical and nuclear industries, with high stakes on safety, have influenced patient safety researchers tremendously, and studies of major mishaps in these industries have shaped the theory of medical error. Subsequently, research and practice evaluations, first in anaesthesia and obstetrics resulted in broader systematic evaluations of healthcare and interventions to reduce harm. The work and publication of Leape in 1994 challenged the then prevalent blame-culture in medicine, and promoted the place of the discipline of psychology and human factors, and learning from other industries, to solve the problem of medical error (Leape, 1994; Vincent, 2010)

Litigation, although a direct deterrent to reporting, has also influenced patient safety by leading to the evolution of clinical risk management to reduce patient harm (Vincent, 2010).

1.1.1 Professional and government reports

Professional and government reports also influenced patient safety. The US Institute of Medicine report ‘To Err is Human’ pleaded for action on improving patient safety across the healthcare strata following the review of many studies of error and harm (Kohn et al., 1999) as cited in (Vincent, 2010). It became a very important milestone in the development of patient safety, by establishing it as a fundamental requirement of medical practice. It achieved what could be described as a professional and political awakening to the deep issues

of patient safety and quality in healthcare, and recommended actions on patient safety across US healthcare strata: establishment of a Centre for Patient Safety, and robust systems for reporting of adverse events and errors, and promotion of the development of safety initiatives by healthcare organisations, their regulatory and professional bodies.

The IoM report spurred many other government and professional reports on patient safety, including the UK's 'An Organisation with a Memory: Learning from Adverse Events in the NHS', which placed much emphasis on error learning (Department of Health, 2000; Vincent, 2010). The report reviewed the systems of learning, and similar to the work of Leape and Cooper, drew parallel to learning from high-risk industries, and the need for culture change and teamwork within the NHS (Department of Health, 2000; Vincent, 2010).

The psychology of error has underpinned analysis of errors. According to Reason, errors are divided into two broad categories namely slips and lapses, which are associated with actions, and mistakes, which are associated with knowledge. Slips and lapses are associated with using the wrong action to achieve the right plan: slips are external actions while lapses are internal events. Mistakes are associated with using the wrong plan in the first place to achieve the right action. Mistakes may be rule-based or knowledge-based. Violations, on the other hand are intentional deviations from standards or rules. These concepts describe the active failures by those people at the 'sharp end' of the system who are working the system, in healthcare, the providers and users of the system. It is the interaction between the 'active and latent failures,' which lead to errors as shown in the below.

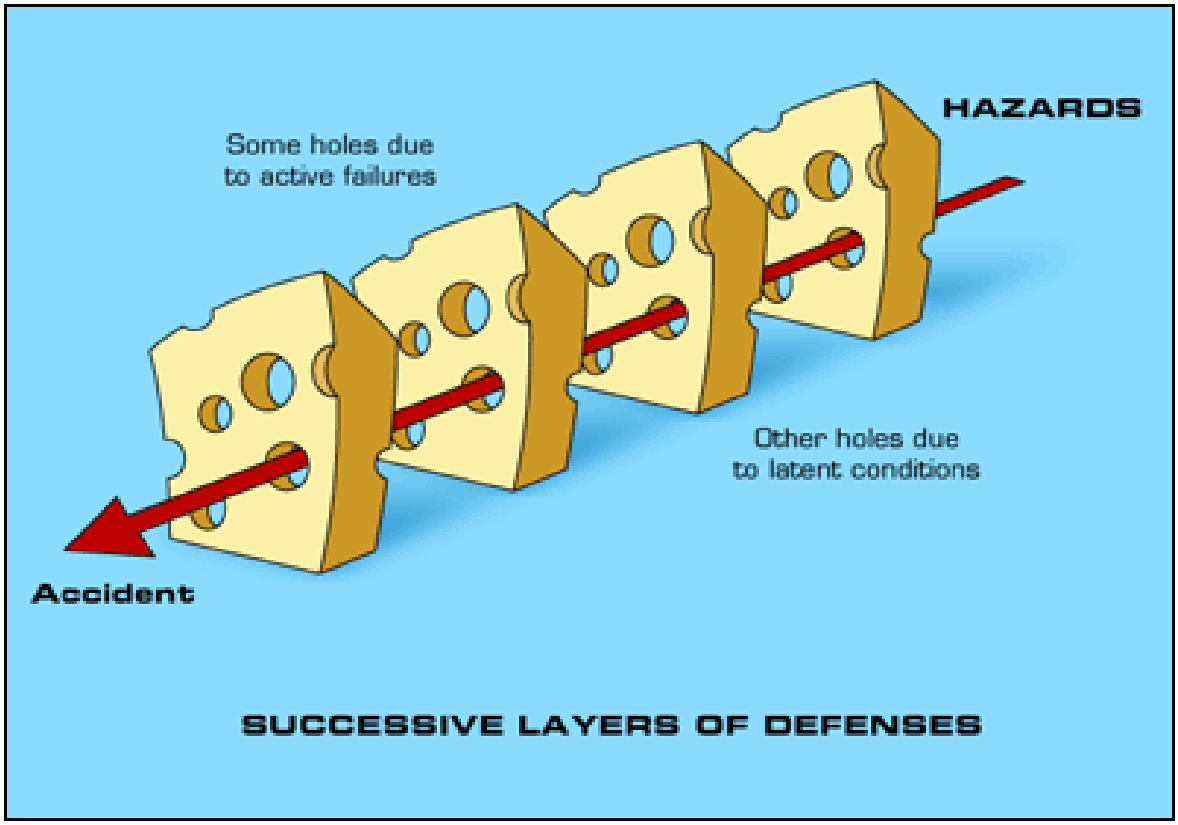


Figure 1: Reason's "Swiss Cheese" Model (image with permission from www.patientsafety.duhs.duke.edu

1.2 Incorporating safety with quality

The section above has provided a synopsis on the history of medical harm and the emergence of patient safety. This section will discuss the relationship between the quality of care and safety, drawing on Donabedian's framework for quality and Vincent's definition of safety in healthcare (Donabedian, 1986; Vincent, 2010). As Vincent surmised, it is important to understand that safety is not the principal priority in healthcare, as often mentioned by government ministers, hospital and care executives, conference speakers and even the front staff delivering healthcare. The priority of healthcare is to make people feel better, by providing good quality healthcare. Safety really becomes a priority where it comes into conflict with other 'legitimate' objectives of healthcare.

Patient safety should be one of many objectives of healthcare – a chief executive for example, has to balance costs, safety, effectiveness, patient access to care and satisfaction with service, amongst others; a general practitioner attempts to prescribe in a cost-effective manner; patients also have to balance safety against other objectives. However, because safety is a concept, and is less tangible and less readily measurable than other quality indicators, it is quite easily ignored and forgotten in the press of events. Within the past decade, there have been many initiatives with a call to actively pursue and promote safety, as opposed to ordinarily avoiding damage; the need to actively reduce errors and promote the evolvement of a reliable and high quality healthcare has been underscored.

Patient safety has been defined as 'the avoidance, prevention and amelioration of adverse outcomes or injuries stemming from the process of healthcare (Vincent, 2006). This definition acknowledges the inherent harm in healthcare, and the need to support the recipients of harm when it becomes unavoidable (Vincent, 2010). The focus of this definition of patient safety is very instructive – to avoid, prevent and ameliorate adverse outcomes or harm. Harm reduction is thus pivotal to a system such as healthcare with safety as one of its objectives. Harm reduction is not synonymous with error reduction as patient harm is not always due to errors. For instance, patient harm from the use of medicines may not necessarily be caused by an error in the medication-handling system. Although many errors do not lead to harm, identification of errors and their prevention is an important step in learning, in maintaining safety, and overall, improving the quality of care.

Donabedian has described the quality of care as being related to its capacity to achieve desired improvements in health and well being, in conditions acceptable to both the recipient

of care and the wider society (Donabedian, 1986). Quality, in this definition, will comprise of four aspects namely the technical management of health and illness, management of the relationship between healthcare providers and their clients, facilities of care and the principles that rule the affairs in general and the healthcare system in particular. Quality of care therefore defines the gap between what is achievable and what actually exists – when this gap is minimal, quality is good; the converse is true (Vincent, 2010) . Donabedian has also described the difference between the structure, process and outcome of healthcare to promote the understanding that quality relies on the interactions between difference components of care, which are all amenable to evaluation both by providers and their clients. (Donabedian, 1986). Other renowned expert identified six measures of quality, which map well onto Donabedian's four aspects mentioned above – technical excellence, social acceptability, humanity, cost, equity and relevance to need (Donabedian, 1986; Maxwell, 1984). As Vincent noted, safety was not expressed as one these dimensions of quality then, even though the concept of safety in healthcare is already interlaced between other measures, such as Maxwell's technical excellence and acceptability and Donabedian's principles that govern the affairs of healthcare and the healthcare system (Vincent, 2010). The US Institute of Medicine (IoM) report, "To Err is Human," initially, and subsequently, the British Department of Health (DH) report, "An Organisation with a Memory," have put safety in healthcare in the lead (Department of Health, 2000; Kohn et al., 1999; Vincent, 2010). More recently, the US IoM have highlighted six aims for healthcare improvement: safety, effectiveness, patient-centred, timely, efficiency and equitable (Institute of Medicine (U.S.). Committee on Quality of Health Care in America., 2001).

Summarily, Safety is established as one of the indicators of quality. When harm is caused due to lapses in the process of care, then a safety issue exists. The concept of patient safety had updated the quality of care: it shows that healthcare could be harmful to patients; brings important attention to the impact and results of error and harm; enables medicine to face-up to errors in healthcare, and address the nature and causes of error; helps healthcare to learn from other high risk industries; generates new systems and tools to healthcare improvement etc. Therefore, true quality assurance in healthcare will access the safety dimension of the quality of care.

1.3 Medication error

1.3.1 Background/introduction

A medical error may occur at any stage in a patient's interaction with healthcare, which could include investigation, diagnosis, laboratory testing, surgery, therapeutic and non-therapeutic management, patient education, compliance and concordance. Each of these stages is associated with different types of errors. Of these, medication errors have been shown to be one of the most common, resulting in unprecedented levels of patient morbidity and mortality (Aronson, 2009b; Department of Health, 2008; Garfield et al., 2009; Vincent, 2010). The USA, UK, World Health Organization and many developed countries have identified that priority needs to be given to improving patient outcomes and medication safety in healthcare (Britt et al., 1997; Department of Health, 2000, 2004; Thomsen et al., 2007; World Health Organisation, 2002).

Medication errors (and the Adverse Drug Reactions, ADRs, which result from them) form part of a much global problem known as medicines-related problems (MRPs). An MRP is an event that involves drug treatment or therapy, which potentially or actually interferes with the patient experiencing an optimum outcome of care (Hepler & Strand, 1990). MRPs are a growing source of concern, especially with an ageing population and an increase in chronic diseases, co-morbidities and polypharmacy.

One way of reviewing the processes of care and determining if specified standards are being met is to study the errors associated with these processes (Vincent, 2010). The use of medication or therapeutic management is the most common form of intervention in medical practice. As such, medication error is the most extensively studied area of medical errors, and could occur at any point within the medicines management or handling system, which includes prescribing, preparation or dispensing, and patient administration. A medication error may be described broadly as any mistake in drug use or therapeutic management. Types of medication errors include wrong decision in the choice of drug, omitting to give the drug, incorrect or suboptimal dose, overdose, formulation error, wrong route, etc. (Dean et al., 2000; Vincent, 2010). Studies on medication errors vary in scope – some evaluate the whole system of medication handling, while others focus on a specific point within the system, and have a different objective to studies on adverse drug events (ADE), which are directed towards the outcome of care (Vincent, 2010).

Research and practice have varying interpretations of what should be classed as a medication error; this has implications for data collection and interpretation (Ferner, 2014). The issues around definition and classification of errors will be discussed further on. Firstly, an understanding of the concept of medication error is imperative, and a methodological approach as described by Morimoto et al is useful. An incident is an umbrella term to describe any misdeed in the medication use process, which may be an adverse drug event or reaction (ADE or ADR), potential ADE, medication error, or even none of these. Some ADEs are due to medication errors, and all potential ADEs are medication errors, as their identification often indicates error interception. Minor errors, which have small or no potential for harm are not grouped as potential ADEs but are also classed as medication errors. Should the incident however have the potential to harm a patient, it is considered both a medication error and a potential ADE i.e. a potential ADE is a medication error with the potential to cause injury but which does not actually result in an injury due to circumstances, chance or because it was intercepted and corrected. A preventable ADE is an injury that is the result of an error occurring at any stage in medication use. A non-preventable ADE is an injury due to a medication but which is not due to an error. Therefore, studies of errors differ from studies of non-preventable ADE. An ameliorable ADE is an injury of which the severity or duration may have been significantly reduced if different actions had been taken. A non-ameliorable ADE is an injury in which there is no existing way to reduce its severity or duration. (Morimoto et al., 2004). These concepts overlap and are not mutually exclusive as shown in Figure 2 below.

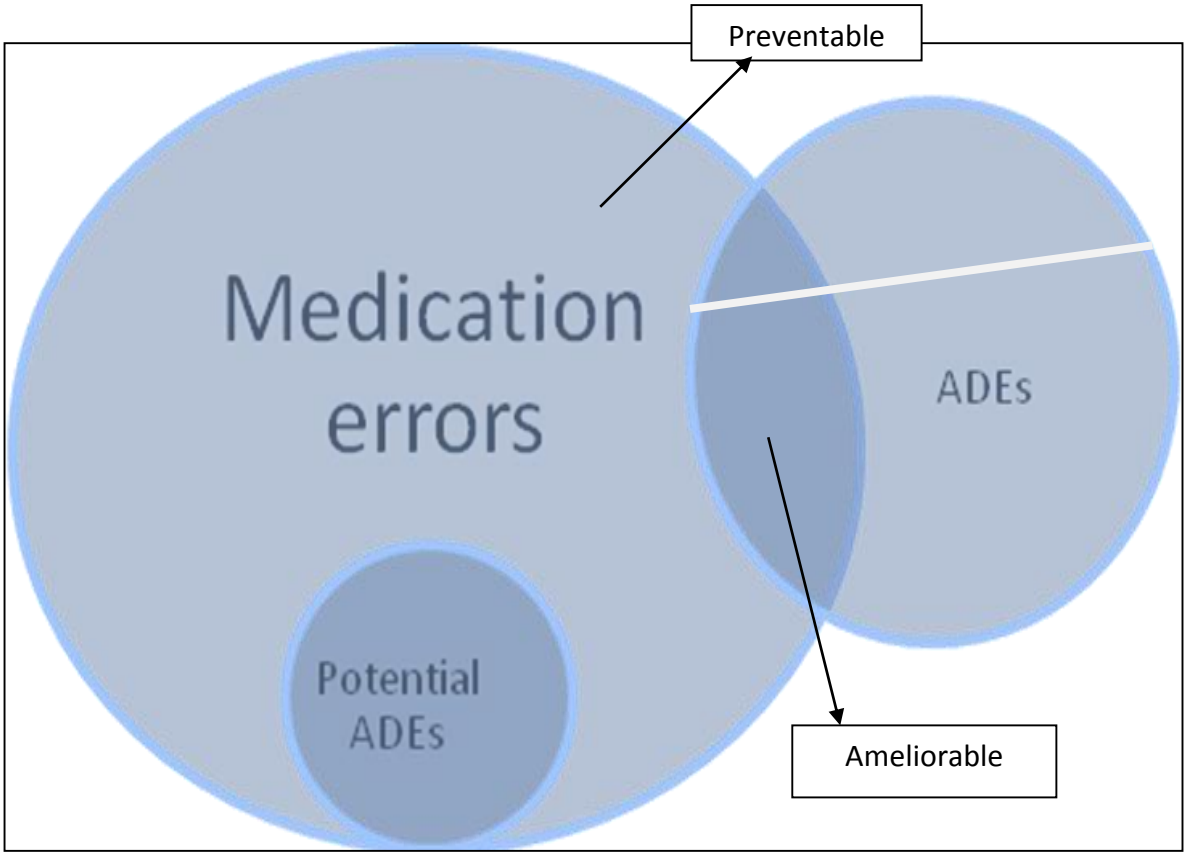


Figure 2: Relationship between adverse drug events (ADEs), potential ADEs, and medication errors (Morimoto et al., 2004)

1.3.2 Prevalence and harm from medication errors

Although the specific rates and frequencies of medication errors are not known (Ferner, 2014), most errors in medication go unnoticed. Of those that are identified, very few culminate in ADEs or ADRs (Campbell & Cantrill, 2001). For instance, in a UK hospital study, about 1.5% of prescribing errors was detected in 36,200 medication orders, with just over half (54%) being associated with the choice of dose, and 0.4% of orders were potentially serious (Dean et al., 2002). In the recently-published PRACtiSE Study, 4.9% prescriptions contained a prescribing or monitoring error from a retrospective review of 1,200 patient electronic medical records in 15 general practices in the UK; of these, 1 in 550 (0.18%) were judged to contain a 'severe' error (Avery, Barber, et al., 2012). In a UK study of 55 care homes, although 69.5% of all residents had one or more errors the mean potential harm for prescribing, monitoring, administration and dispensing errors was 2.6, 3.7, 2.1, and 2.0 (0=harm; 10=death) respectively (Barber et al., 2009). In the USA, a study demonstrated about 1.7% errors in prescriptions dispensed from community pharmacies (Flynn et al., 2003) as cited in (Campbell & Cantrill, 2001). Another study in Hull in the UK found 0.48% near misses and 0.08% dispensing errors in 51, 357 items (Edmondson et al., 2003) as cited in (Dean Franklin & O'Grady, 2007). Other researchers found 0.04% dispensing errors in 125,395 dispensed items (Ashcroft, Quinlan, et al., 2005). Franklin and O'Grady found an overall dispensing error rate of 3% in 2859 dispensed items at the final check stage of the dispensing process prior to patient collection (Dean Franklin & O'Grady, 2007). However, the impact of these relatively low level of harm from medication errors is better understood when interpreted in terms of the high volumes of medication items used daily – in England, the number of prescription items dispensed in the community per year went over one billion for the first time in 2012 - equating to 2.7million a day, or over 1,900 a minute (Prescribing and Primary Care Services, 2013). Furthermore, the emotional, physical, financial and healthcare costs of patient morbidity and mortality are simply unquantifiable (Vincent, 2010).

The place of medication error research cannot be overemphasised. There are many opportunities for errors, considering the many small but individual steps from prescribing a drug to receipt and use by the patient. Medication error studies have evaluated the whole system of drug handling or focussed on a specific point within the system, the latter being more commonplace (Vincent, 2010). A few studies have indicated that patient safety incidents in hospitals take their roots from primary care management. In the UK for instance, 6.5% hospital admissions were related to ADRs in a study of 18,820 inpatients (Pirmohamed

et al., 2004). In the US, researchers reviewed 661 patients in ambulatory care through the use of record reviews and telephone interviews, and found that approximately 25% had an ADE, with 11% of events being preventable (Gandhi et al., 2003). Winterstein et al (2002) found that 4.3% of all hospital admissions were drug-related, many of which were preventable (Winterstein et al., 2002). Furthermore, healthcare systems must evaluate medication errors because, like other medical errors, they are products of the systems that produce them, and a system susceptible to a 'minor' error can produce a 'severe' error if system failures and error-producing conditions are not reviewed and addressed (Leape, 1994). Medication error research is also important for identifying and implementing system changes that improve patient safety and population health outcomes. In a study evaluating the impact of computerised prescribing on outpatient prescribing errors, although a small number of prescriptions were found to lead to actual harm, a large number had even greater potential to cause serious harm (Gandhi et al., 2005). Paediatric patients or the elderly may be the most vulnerable in these situations (Vincent, 2010). Developing interventions in both primary and secondary care, implementing and evaluating their impacts on measurable outcomes to ensure safer medicines management is therefore a key priority. Another reason to study medication errors is the evidence that the annual number of deaths resulting from medication errors had increased, from 20 in 1990 to below 200 in 2000 (Department of Health, 2000). In addition, the high cost of litigation arising from medication errors against a limited healthcare budget cannot be overlooked.

Interventions to reduce medication error occurrence have been researched, implemented and evaluated in secondary and primary care. In the United States, and a few other countries, computerized provider order entry (CPOE) systems have greatly reduced some error categories because they provide important warnings and flags on contraindications and potential allergies to prescribers while using them (Abramson, Barrón, et al., 2011). In the UK, concepts like robotic dispensing, and the use of patients' own medication while on admission have also reduced the incidence of medication errors in secondary care (Dean Franklin et al., 2008). In UK community practice, government healthcare initiatives like the National Reporting and Learning System (NRLS), medicines management, Quality of Outcomes Framework (QOF), Older Patients Framework, and other Clinical Commissioning Group (CCG) and NHS initiatives have influenced medication safety recently. However, the problem of medication error is not over because any one intervention is insufficient to

prevent all error types and new types or categories of errors are increasingly uncovered as errors are often the products of the system that produces them.

1.3.3 Where, why and how medication errors occur

Medication error studies evaluate whether a medication was correctly handled within the medicines management process (prescribing, transcribing, dispensing, administration and monitoring), usually without actual or potential harm to the patient (Vincent, 2010). Other researchers have included repeat dispensing, and the education and training of patients and healthcare professionals in the medicines management process (Avery et al., 2002). Adverse drug events (ADEs) on the other hand, focus on the harm, which may or may not have been caused by a medication error (Vincent, 2010). Examples of ADE include excessive doses of antihypertensives, which results in bradycardia or hypotension, prescribing drugs to patients who have known allergies to those drugs, inadequate monitoring of warfarin etc. (Vincent, 2010). Other consequences of error may be social, which also pose as sources of unnecessary sufferings to patients, and result in waste of healthcare resources.

Researchers in psychology and patient safety have provided important insights into why and how human error occurs as discussed below.

1.3.4 Accident causation model

Preventable ADEs result from one or more failures in the medicines management process. Researchers used an illustrated case to demonstrate how a series of staged failures eventually lead to an ADE (Avery et al., 2002). In the model, the patient suffered the adverse event following underlying sources of systems failure such as problems with computerised warning systems, inter-service communication, and dissemination of therapeutic knowledge, staff training, organisation and workload distribution (Avery et al., 2002). These failures in the systems lead to other problems (e.g. slips and memory lapses, lack of standardised protocol for prescribing for patients discharged from hospital, lack of patient information, lack of drug knowledge etc.) that directly contribute to the event. These systems failures and the problems they create, if not intercepted at stages within the medicines management process (prescribing, dispensing, patient education and medication monitoring) where errors should otherwise be prevented, eventually lead to an adverse event. The researchers compared their model with that of Leape, concluding that a better understanding of system failures would provide suggestions on how the system could be made better and safer (Leape et al., 1995).

The work of Reason has also been widely used to understand why human error occur and highlight management strategies (Reason, 1990, 2000). The Swiss cheese model identifies

that errors occur as a result of a series of breakdown of safety guards. An error may be intercepted at many points within a system (for example, in medicines management, an error may be intercepted at the final check stage of a prescription before handing out to the patient (in which case it is classed as a 'near-miss'), or may actually miss detection through many safety gates within the medicines management system to reach the patient (when it is then classed as an ADE due to a medication error). These models provide an insight into how errors may be prevented by improvements at the stages of the medicines management process. While these models provide important insight into why errors occur, they may be difficult to apply in all clinical and real scenarios, and could be time-consuming. Furthermore, parts of systems' visible failures are a direct result of an ever-increasing squeeze on limited healthcare budgets across economies as more people are now living longer with increasing co-morbidities.

1.3.5 Secondary and primary care

As the medication handling process differs between secondary and primary care, potential for medication errors also varies. For instance, in secondary care, there is close co-working amongst healthcare professionals, and trained healthcare professionals often do medication administration with supervision. In primary care however, patients are in touch with various health care professionals (physicians, pharmacists, dentists, nurses, others) at various sites and mostly self-administer their own medicines. In addition, monitoring may be more organised in secondary care because patients are usually resident within an institution and are in regular contact with healthcare professionals without the added responsibility of having to organise and book their own appointments unlike in primary care. The nature of medication errors observed at the different stages of medication handling would therefore vary widely between secondary and primary care. The most dangerous points in the medicines management process within primary care relate to the prescribing decision, administration and monitoring, emphasising the differences between secondary and primary care here outlined (Avery et al., 2002).

1.3.6 Geriatrics vs. Paediatrics

Older people use healthcare more. Patients over 65 years old, usually with multiple co-morbidities account for approximately 60% of admissions, and 70% of bed days (Vincent,

2010). However, little research has focussed on patient safety in older people, even though they are more susceptible to healthcare error and harm. The evidence that older people experience more adverse events than their younger counterparts, most of which are typical of their age groups, such as falls, nosocomial infections, and drug errors, is non-debatable. The care of older people with multiple conditions is not adequately provided for by limited healthcare services and budget, while ironically, an interplay between physiological and social factors in the elderly makes therapeutic interventions complex (Vincent, 2010). Older people have contributory and risk factors, which lead to undesirable outcomes; however, if healthcare intervention is proactive and effective at managing these risks at an early stage, quick and desirable outcomes would be achievable (Long, 2010) in (Vincent, 2010). Vincent describes a range of 'geriatric giants,' or syndromes, which older people experience in concert when on hospital admission most of which complicate their therapeutic management and conditions leading to undesirable patient outcomes. With effective management within the hospital, a host of those syndromes could be readily overcome. In the community, the prognosis is more complex. Delirium, depression, incontinence, dehydration and malnutrition, which Vincent (2010) describes as geriatric syndromes, are much less noticeable when they set in. Adverse drug events due to medication errors including drug-drug interaction, side effects leading to non-compliance, confusion, etc. can also interfere with therapeutic management of the elderly, which can lead to hospital admissions. The irony is that so much less research has focussed on medication safety in the elderly (Olaniyan et al., 2014).

Studies also suggest that paediatric patient safety needs more attention (Avery, Barber, et al., 2012; Olaniyan et al., 2014; Vincent, 2010). Vincent (2010) surmises that factors contributing to this in hospital may include failure to be looked after by a paediatrician, failure of sufficient supervision of senior staff, and failure of staff to administer fluids adequately and correctly (Vincent, 2010). In community practice, these factors are mirrored to a large extent – lack of readily recognisable symptoms of worsening illness, incorrect dose determinations and administrations, etc. The young may be as frail as the elderly, and particular attention needs to be paid to these age groups who use healthcare more and are therefore more susceptible to harm (Ghaleb et al., 2010; Rees et al., 2015).

1.4 Defining a medication error

With varying definitions used by different groups, the issue of defining a medication error has been debatable for some time. Clinicians, healthcare practitioners and researchers may define errors differently. Many terms have been used perhaps, incorrectly and interchangeably to describe medication errors (Ferner, 2014). Some of these include: medication error, failure, near miss, rule violation, deviation, preventable adverse drug event (ADE), potential ADE, ADRs, to name a few. Definitions and classifications of errors are however crucial to medication error research to estimate the rates of errors. Some studies seem to provide higher rates than others purely because of what was included in the definition and subsequently data collection. The first step to tackling the bigger problem of chaotic measurements and interpretations is to clearly define what constitutes a medication error.

Lisby and colleagues sought to describe the extent and characteristics of medication error definitions in hospitals, their consequences for measuring the prevalence of medication errors, and to determine whether there were associations between definitions and prevalence. Their systematic review found that the reported prevalence was 2-75% from 45 studies (Lisby et al., 2010). They also found 26 different wordings for a generic definition of a medication error and concluded that definitions and methods of detection of medication errors were not reproducible but subject to researchers' preferences. The study by Lisby et al (2010) was carried out on studies performed in Europe, the USA, Canada and Australia. Differences in healthcare systems across countries, and evolution of clinical knowledge over time may account for some of the reported variation in prevalence.

Ashcroft et al (2005) found "lower" rates of dispensing errors in a study of dispensing errors in UK community pharmacies when compared to other similar small-scale studies but reiterated that the studies could not be directly compared and interpreted due to differences in study design and operational definitions (Ashcroft, Quinlan, et al., 2005). Interpretation of quantitative prescribing error studies was also problematic due to lack of clear definitions in the literature (Dean et al., 2000). The researchers described a lack of a generally accepted definition that would make quantification more meaningful and universal allowing for comparison of studies and use of error rates as a meaningful element of clinical governance. Some studies have included only errors that result in harm (adverse drug events), whereas others have added errors that have not reached the patient (near misses) giving a wide range of rates being described in the literature (Garfield et al., 2009; Lisby et al., 2010). Dean and

colleagues identified this problem of multiplicity of definitions over a decade ago, and proceeded to develop and validate an operational definition of a prescribing error for research use when they evaluated prescribing errors in a UK hospital which is now widely used (Dean et al, 2000),

The problem of definition is also extended to error classification and severity grading. Where error classification is achieved by agreement between a doctor and a pharmacist, these are often largely based on the knowledge and views of individual practitioners, and may not be in agreement with other healthcare professionals or (Dean et al., 2000), or a different sector of healthcare.

The National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) and the National Patient Safety Agency (NPSA)'s definition and severity grading of medication error is now increasingly being adopted in many error studies and practice. This is a positive step towards standardisation of error management. The NCC MERP defines a medication error as *"any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of health professional, patient or consumer"*. This definition therefore covers the whole of the medicines management process, from prescribing through to medication monitoring (Department of Health, 2004). The NCC MERP index for categorising errors describes the categories in increasing severity from ordinary exposure to circumstances/events with capacity to cause error, *A*, to patient death, *I*.

Any research into the prevalence or incidence of medication error types will require operational definitions to clarify what should be counted as an error or otherwise.

1.4.1 Challenges of defining and classifying errors

The discourse of definitions of errors is an important background for any medication error study as presented in this section. For example, defining the term 'prescribing error' may appear relatively simple. However, practitioners and researchers may disagree about what constitutes an error. As Charles Vincent noted, achieving agreement on a working definition of a prescribing error once required a full primary study and an outline of scenarios that should be included or excluded as prescribing errors, even with room for disagreement (Dean et al., 2000; Vincent, 2010). In the Investigating the prevalence and causes of prescribing

errors in general practice (PRACtISE) study, Avery and colleagues provided a detailed analysis of the issues around defining an error as examined below (Avery, Barber, et al., 2012).

Classifying an act as an error is a value judgement; it is subjective in that the training and experience of the person(s) making such judgement cannot be ignored and will always influence their decision. If an error judgement is based solely on scientific facts, such as drug-receptor interactions, it is expected to fail because, "as Aristotle pointed out, the worlds of facts and values are different" (Avery, Barber, et al., 2012). The researchers noted that the use of expressions, which suggest value judgments such as "'failure', 'inappropriate', 'should', etc." should therefore be explained to reduce inconsistencies in their interpretation i.e. an error definition should not be so broad to give rise to different interpretations, nevertheless not so specific that it becomes useless or impractical. An error definition should be fairly widely applicable within and across healthcare systems if sufficient information is provided to extrapolate its rules to different situations.

The researchers highlighted three important points in relation to error definitions:

- The suitability of a definition for the purpose for which it is intended (differences between an error definition in practice for incident reporting versus the extent and detail of a definition used in quantitative research);
- The need to separate definition, which comes first, from classification (which may include types of errors or potential outcome for example); and
- The confusion generated by researchers when they use different words for similar purposes and/or similar words for different purposes in their publication.

Senders and Moray suggested that an error should be interpreted as something done, which

- A set of rules or external observer did not desire
- Moved an outcome beyond acceptable limits; and
- Was not intended by the actor (Senders et al., 1991) as cited in Vincent, 2010).

These two schools of thought, and probably others, suggest that a set of criteria is required for defining an error. The requirements for an error to be workable therefore are the need for a

set of standards against which there must be some sort of failure, albeit without the intention of the actor to do so. What these criteria do not point out readily is that the divide between these principles in practice is very blurred as exemplified in the succeeding paragraphs (Vincent, 2010).

Dean and colleagues used the Delphi technique to develop and validate an operational definition of a prescribing error for research use when they studied prescribing errors in a UK hospital:

"A clinically meaningful prescribing error occurs when, as a result of a prescribing decision or prescription-writing process, there is an unintentional significant

- Reduction in the probability of treatment being timely and effective, or
- Increase in the risk of harm when compared with generally accepted practice."

This definition was developed following a Delphi process, which involved 34 judges: physicians, surgeons, pharmacists, nurses and risk managers. Lists of 27 scenarios, which should be included as prescribing errors, 8, which should not, and 7, for which judgement will depend on the individual situation, accompanied this definition. The scenarios included in the list were not meant to be comprehensive, but rather to explain a sample of potentially equivocal cases to facilitate decision on whether those scenarios should be classed as errors or not (Dean et al., 2000).

The authors pointed out three important aspects of this definition:

- "Unintentional" – this definition is based on theories of human error and would exclude any risk of harm due to deliberate acts
- "Compared with generally accepted practice" – From the work of Bates et al (1995), a medication error is classified as a preventable adverse drug event (ADE) (Bates et al., 1995). The reference to "generally accepted practice" is based upon the preventability of errors i.e. errors are not acceptable practices. Avery et al (2013) noted that some authors set very high standards for practice, which leads to incredibly high error rates with no acceptability to healthcare professionals (HCP) or policy makers. Using their example, all cases of penicillin allergy could be avoided by never using drugs with a penicillin structure in patients who have never used penicillin. However, the use of penicillin is acceptable, and as such, prescribing penicillin to a patient without a history of allergy

would not lead to an error as long as it was suitable for them (Avery, Barber, et al., 2012; Avery et al., 2013).

- "Significant" – the Delphi panel felt this word should be included for two reasons:
    - It was thought important to clarify between clinically-meaningful prescribing errors and those scenarios where it could not be judged that an error has occurred but where treatment optimization was possible
    - It was included to allow for rational errors in the prescribing process, which would not lead to adverse events for the patient. The word "significant" was therefore included to clarify that the definition is of a "clinically meaningful" prescribing error.

Although this definition is now widely used, a small number of critiques of this definition have been published. Avery and colleagues (2012) have responded to critiques of their definition by Ferner and Aronson, who have suggested that developing definitions using consensus-based methods such as the Delphi technique is defective in that it is a definition by committee (Aronson, 2009a; Ferner, 2009; Ferner & Aronson, 2006). The authors of the definition have argued that credibility of research findings is important to practitioners if they are to consider them seriously and use findings meaningfully. They reason that consensus of healthcare professionals provide a validity element to the definition, and that the Delphi technique overcomes the problem of dominance by one or more individuals and eliminates peer pressure – issues commonly associated with committee-based decision-making.

Furthermore, some authors have criticised the inclusion of only "clinically meaningful" prescribing errors based on the argument that when an error occurs, it may be a pointer to a weakness in the system, and that and that the risk of harm cannot be extrapolated from a single patient to the population(Ferner, 2009; Ferner & Aronson, 2006). However, the term "clinically meaningful" indicates that there is s category of "clinically insignificant" errors, or errors with minimal risk of harm to the patient, as such this definition does not appear to completely ignore clinically insignificant errors. Perhaps this may be an indication that reported error rates should include an element of severity assessment to increase their clinical relevance (Garfield et al., 2013).

Ferner and Aronson have also suggested that an "attainable standard" should be used in place of "generally accepted practice" because "generally accepted practice" may be poor (Ferner & Aronson, 2006). Avery and colleagues (2012) have questioned what that attainable standard should be, and by who should such standards are set.

Attainable *standards* or generally *accepted practice* however both have something in common – the need to be measured against some form of "good" practice. Patients' confidence in healthcare and use of medicines, especially at the healthcare professional end of the system, is directly related to how safe clinical practice is. Users of healthcare would expect that any principle and/or policy, which would contribute to the safety and integrity of healthcare and medication use would be *attainable* and *acceptable*.

1.4.1.1 Classifying errors

Error classification can be done in many ways. An error can be understood with respect to the behaviour involved, the underlying psychological processes, and in relation to the factors, which contributed to it: a classification such as 'wrong drug' describes behaviour of issuing the wrong drug. Such an error will be psychologically classed as a slip (Vincent, 2010). Classification schemes have been proposed in high-risk industries to aid the preparation of a safety case that outlines what errors might occur. The Predictive Human Error Analysis (PHEA) technique has been generally developed for use in high-risk industries where the actions of single person can be fairly outlined (Vincent, 2010). PHEA uses six main categories or errors: planning, operation, checking, retrieval, communication, and selection errors. Classifications of errors in healthcare can readily draw from schemes like PHEA. To be useful in practice, error classifications, like definitions should be clear. Clarifying classifications used is important to facilitate interpretation and usefulness of error data. Error data, which are intended to provide feedback to healthcare providers, need to be relevant to daily practice and facilitate or provide a basis for behaviour or cultural change. It is therefore not surprising that many UK studies sensibly classify errors using the behaviours involved (Avery, Barber, et al., 2012; Barber et al., 2009; Dean et al., 2000; Ghaleb et al., 2010). Though it may be useful to map such behavioural classifications onto other schemes, such as psychological processes or even a system like PHEA for comparison, this classification appear to communicate more relevantly with healthcare stakeholders.

1.4.2 Error definition in practice

Furthermore, Avery and colleagues surmised that the boundary of the system of detecting errors has to be considered and defined (Avery, Barber, et al., 2012). They gave the following example; would a community pharmacist who interprets a GP's Latin abbreviations for the

patient be a part of the system, or have they received a prescribing error? This has implications for the interpretation and usefulness of study results by healthcare professionals across various healthcare systems – prescription-only-medicines, POMs can vary across healthcare systems, and in developing countries, a community pharmacist does not necessarily perform prescription transcription and dispensing. This is also relevant in other sectors within primary care such as residential or nursing homes where a pharmacist may not always undertake prescription transcription or dispensing. The researchers noted that as assumptions and expectations are unavoidable, these should be made as clear and standard as possible within a particular study. Such assumptions could also be clarified with case law.

Specifically, in primary healthcare, the role of the community pharmacist (or dispenser in a dispensing practice) who assumedly would always be an intermediary to translate the instructions of a prescriber to a patient, has to be considered (Avery, Barber, et al., 2012). For example, a prescriber may issue a prescription for Levothyroxine with a daily dose of 75micrograms daily, which requires three tablets of Levothyroxine 25micrograms or one each of Levothyroxine 25- and 50-micrograms each. Although a prescription of this nature may not be clear to a patient, it is fair to assume that the dispensing pharmacist will translate this as necessary. This rule applies to Latin abbreviations such as "OD" or "BD." Avery and colleagues therefore decided not to include the prescription of brief or abbreviated instructions as errors in the PRACtISE study. In situations where the directions are produced directly on prescription labels such as with the Electronic Prescription Service Release, EPSR 2, this parallel may not always be however. One of the complexities of community practice or primary care is that it is assumed a patient will always go to the same pharmacy to fill their prescription. In practice, this is not the case. As such prescriptions of both co-dydramol and Paracetamol for example, without a clear statement by the prescriber that they should not be taken together is recorded as a potential duplication error (Avery, Barber, et al., 2012).

Also, a potential error could be date-specific as a result of developments in clinical knowledge. The researchers gave examples of prescribing a Cyclooxygenase II inhibitor (COX II) in a patient with a cardiovascular disease, which may not have been judged as an error a few years ago; and the *out-dated* need for an additional contraception if a broad-spectrum antibiotic is prescribed while taking a combined oral contraceptive pill. The time-dependent information relating to an error in what was initiated in the past is therefore relevant.

Avery and colleagues also noted that "a reduction in the probability of treatment being timely and effective" might be difficult to identify. Under-dosing of antimicrobial agents were included as an error in their study – the researchers argued that under-dosing may lead to a "treatment being less effective," and an increase in the risk of antimicrobial resistance.

In error studies, review of patient medical records has been found to be a more thorough approach than analysis of incident reports (Tam et al, 2008, Aronson, 2009, Avery et al, 2012, Olaniyan et al, 2014). Successful retrospective review of prescriptions and medical records directly relates to documentation. For example, prescribing Phenoxymethylpenicillin to a penicillin-sensitive patient would only be picked up as an error if information on patients' allergies were documented. If the lack of information makes it impossible to make a valid judgement on whether or not an error has occurred, no errors should be recorded (Avery, Barber, et al., 2012).

1.4.3 Primary care-specific issues

Avery and colleagues further considered how to handle prescription items left on a repeat prescription but not actually requested by the patient. The researchers decided not to include these cases as errors as they explained they were only looking at issued prescriptions. In practice however, items left on repeat can directly result in the "reduction in the probability of treatment being timely and effective," if the 'wrong item' is issued. This may be relevant in a study of older patient groups who generally take more medication and who experience more changes in their dosage regimen. As such, if an item, which is recorded in the medical notes as being discontinued is left on a patient's repeat, this would be recorded as an error based on the researcher's experience of the chaos and waste observed in community pharmacy practice with issuing discontinued items.

The present study also considered a patient's most probably behaviour when specific information about dosage instructions and/or route of administration was missing (Avery, Barber, et al., 2012)– Avery et al gave this example – if an eye drop did not specify the eye being treated for a symptomatic condition, this was not recorded as an error as the patient was likely to know which was being treated; for asymptomatic conditions such as glaucoma however, this was recorded as an error. The risks associated with the drug were also taken into consideration with this judgement – potent topical corticosteroids, which did not have specific instructions about where to be applied, and how often were counted as errors. The

researchers did not record errors for medications that have detailed Patient Information Leaflets (PIF) or those with only one main indication or dosage schedule, or those available over-the-counter (OTC) for the relevant indication such as paediatric Paracetamol suspension since the information provided on the packaging may be sufficient to inform this patient. A patient may not however always be in receipt of an original container of a medication. For example, paediatric Paracetamol suspension may be dispensed from a stock of 2000Litres into dispensing bottles of the volume ordered by the doctor. For the present study therefore, each case was individually judged – for example, a prescriber's instruction may become a potential source of confusion to a patient even if the medication is available OTC. Furthermore, a patient may decide not to fill a prescription if is cheaper to obtain it as an OTC. High-risk drugs, and medications with a wide range of potential doses, such as oral steroids, were also judged as errors if dosage regimes were ambiguous (Avery, Barber, et al., 2012).

1.5 Assessing the potential for harm: potential and actual errors

Research has suggested that the severity of errors should be assessed in addition to the frequency of errors when measuring error rates (Garfield et al., 2013). The clinical relevance of study results may be increased when compared with studies presenting prevalence alone (Garfield et al., 2013). However, in their systematic review, Garfield and colleagues observed that a total of 40 different tools (including adaptations of other tools) were used in 60 publications. The methods used in assessing severity of errors were disparate; however, most of the tools identified had some features in common. In addition, the researchers found that little information was available on development of the majority of the tools with respect to their validity, reliability, and whether they were developed to assess potential or actual harm.

Tools based on actual patient outcomes may have limited use in practice if a researcher becomes aware of an error and are expected to intervene (Barber et al., 2009; Garfield et al., 2013). In retrospective studies like the present study, it may be difficult to recognize clinical effects because of the time delay between the occurrence and identification of errors (Dean & Barber, 1999) and incomplete documentation of drug effects in patients' medical records. These provide some advantage with using potential outcomes to assess severity because even when actual patient harm is unknown, judgements could be made about severity. However, assessing potential severity based on potential outcomes is likely to be a subjective judgement (Garfield et al., 2013).

1.6 Reporting and learning from error

The importance of error reporting appears to have been underscored. However, Vincent, in his book, Patient Safety (second edition, chapter five), has provided a synopsis on the issue of error reporting while emphasising its most important relevance, learning (Vincent, 2010). Sadly, tragedies and accounts of failures in healthcare seem to have a very notorious way for re-occurrences considering more recent high-profile cases like Mid Staffordshire NHS Trusts failure. Medicine and science bear similarities from Popper's philosophy of science, which states that scientific knowledge is anything but permanent, and that science progresses on the recognition of imperfections in accepted theories (Vincent, 2010). Popper's position argues that the recognition of faults, or errors, or imperfections in existing theories actually grows knowledge in a process involving a case of throwing out the old for the new and 'better;' this view turns error from its very negative undertones to a theme of value, very resourceful, and clue to progress, both scientifically and clinically. However, healthcare has yet to embrace this position whole-heartedly. Healthcare professionals possess some idealised position of authority, which has been assumed by individual professionals or rather imposed upon them by their colleagues or patients, that is almost not questionable in spite of a decade-long campaign to learn from errors from their professional colleagues. Such a high view or position of authority can be misguided and hazardous where such authorities are not expected to make mistakes leading to further opportunities to hide errors.

The quality of paediatric cardiac surgery by two surgeons began to raise concerns among clinical staff at the Bristol Royal Infirmary in the late 1980's. There were suggestions that when compared with other specialist units, the results of paediatric cardiac surgery were not as good, and that mortality rates were significantly higher. The death of a child who was scheduled for surgery against the advice of anaesthetists, some surgeons, and the DH led to the launch of an external enquiry, and ultimately extensive local and national media coverage. The Secretary of State for Health subsequently launched an Inquiry into Bristol. The report made many recommendations to the Health Service (Teasdale & Council of the Society of British Neurological, 2002). The inquiry underscored the fact that healthcare could be dangerous when the standards slip, and established the need for openness in medical performance and health outcomes, and further emphasis was laid on the subject of medical error, system and human failure in the delivery of healthcare (Treasure, 1998).

Many recommendations were made on the back of 'Bristol,' some of which included the vital role of teamwork, the monitoring of care, and role of regulation, among others. One of the

elements of the monitoring of care, and role of regulation is learning from error, which is often facilitated through error reporting, collating local and national information received and sharing best practices. Error reporting in healthcare is still however not yet standardised and may appear chaotic at the best of times; there may be lack of clear pathways for healthcare professionals on what, where and how they should be reporting, which can lead to duplication of efforts, increase in error-reporting systems within institutions and healthcare systems, and other related activities, which may be grouped together under the broad area reporting .

Healthcare organisations use various kinds of reporting systems. In the UK, the yellow card system and the National Reporting and Learning System (NRLS) are used to capture adverse drug reactions and medical errors respectively. The UK's yellow card system, which provides a system for early detection of trends in adverse drug reactions, was set up in 1964 following thalidomide poisoning. NRLS established by the National Patient Safety Agency, NPSA is one of the offshoots of increasing focus on patient safety following the DH call for a paradigm in safety culture within the NHS. As well as serving a learning function, local health authority systems also serve as information sources for impending complaints and litigation. However, as would be discussed in later, the risk management systems used by local authorities in the NHS are not properly developed and standardised.

Aviation and the nuclear industry have provided a reference for healthcare with respect to safety and reporting systems. The Aviation Safety System comprise of interacting components, which are designed to detect, analyse, and act on real incidents and 'near-misses,' while identifying other possible risks (Vincent, 2010). Although this has not always been, NASA's safety system firmly establishes the principles, behaviours, and attitudes towards reporting, which need to be cultivated within healthcare for a functional system.

Safety reporting systems may be voluntary or mandatory, the latter being more common with regulatory bodies, and may serve additional functions to error learning. However, effectiveness of the system requires peoples' commitment to make it work. Healthcare is very far from the ideal, as reporting is still linked with 'punishment.' Ideally, reporting should not lead to punitive measures, but this uncertainty amongst healthcare professionals is one of the barriers to the potential usefulness of reporting. The usefulness and relevance of incident reports in healthcare depends on how complete enquiries made thereof are.

1.6.1 Healthcare Reporting Systems

Reporting systems within healthcare are as varied and stratified as healthcare – systems could be generic, department- or speciality-specific, even nationally, regionally or locally functional – with their value and effectiveness being strongly related to their types and/or purposes (Vincent, 2010). Local incident reporting systems in hospitals, which serve as safety and quality improvement tools as well as resources for claims management, were developed following increase in awareness of risk management. Similar systems are used in primary care organisations in developed healthcare systems. The British NPSA Reporting and Learning System (RLS), launched in 2004, is potentially more practical as a national reporting and learning system when compared with USA, where the healthcare system comprise a diverse range of public and private sectors. The Australian Incident Monitoring System (AIMS) is a large scale reporting system, which is based on a standard form. It allows multiple sources of information and important analysis (Runciman et al., 2003). The British NPSA RLS like AIMS, can pull together rare events on its system to inform learning and action. However, the sheer volume of reports to those national systems may not support important local learning. Furthermore, Incident reporting systems, though very useful, are limited at detecting adverse events (Franklin et al., 2009; Tam et al., 2008). As such, local mechanisms for error learning should complement such large-scale error-reporting systems.

1.7 Medication error reporting

Medication error reporting is a very important process in managing errors (Sarvadikar et al., 2010). Incident reporting improves prevention of future occurrences of medication incidents in a healthcare system: provision of valuable feedback to reporters and their colleagues, identification of system failures within the medication handling procedure, development of local and national risk management standards, identification of developing trends relating to patient and medication safety, and the impact of these on patient outcomes.

The National Patient Safety Agency (NPSA) in the UK has set up the National Reporting and Learning System (NRLS) to make sure that lessons being learnt from ADEs due to medication errors in one area are learnt similarly across the whole healthcare system. As such, all healthcare providers are expected to report serious ADEs and ‘near misses’ in accordance with this national incident reporting scheme. A DOH report (2000) sought to

improve safety and patient outcomes through reporting, analysing and learning form Adverse Incidents in the National Health Service, NHS (Department of Health, 2000).

In spite of all these benefits of incident reporting, routine reporting procedures have been estimated to report as low as 5% of adverse events that may be detected by case note reviews in secondary care (Sari et al, 2007 as cited in Sarvadikar *et al.*, 2010). There are no reported figures for primary care where over 80% of prescriptions are written (Department of Health, 2008).

There have been a number of identified barriers to reporting medication errors, and efforts to improve these should be geared at overcoming these barriers rather than a blind call to report incidents occurring within healthcare system. These barriers may include shame (Davidoff, 2002 as cited in Sarvadikar *et al.*, 2010), fear of punitive measures against healthcare professionals who make errors (Evans et al, 2006 as cited in Sarvadikar *et al.*, 2010), lack of simplified reporting systems (Maidment and Thorn, 2005 as cited in Sarvadikar *et al.*, 2010), fear of litigation (Ashcroft et al., 2006), lack of support within healthcare organisations (Maidment and Thorn, 2005 as cited in Sarvadikar *et al.*, 2010), or even lack of the necessary level of awareness of the importance of error reporting amongst different healthcare professionals or the systems available for error reporting.

Sarvadikar and colleagues surveyed the attitudes of different healthcare professionals to error reporting. While nurses and pharmacists were more inclined to report incidents of all levels of severity despite their fear of being blamed or even punished for them, doctors were rather more inclined to report more serious errors than 'less severe' ones. However, the same level of responsibility to error reporting should be shared by all healthcare professionals if lessons are to be learned since "minor" errors always have potential to become more severe incidents, as they are more often a result of system failures.

Although studying errors by reviewing routine error reports have been observed to grossly underestimate the true levels of error rates, it remains a practical approach to obtaining error data in secondary and primary care in the long term as it brings minimal interruptions to the healthcare system. Researchers surmised that reporting systems help in the identification of latent errors such as skill mix and staffing levels in community pharmacies which otherwise may not be evidently visible by observational methods (Ashcroft et al., 2006).

The attitude of healthcare professionals to reporting error incidents may be an indication of the safety culture and climate within the organisations.

As medication errors are generally caused by multiple factors (Department of Health, 2000), understanding these factors and the interactions between them is crucial to preventing their occurrences. According to Reason, the interactions of active failures of individuals and latent conditions within an organization are responsible for medication errors (Reason, 1990). Many studies have focussed on assessing error rates and types but understanding practitioners' perceptions of issues affecting error occurrence and prevention is indeed valuable in creating and maintaining a safety culture in the outpatient setting (Teinilä et al., 2011). There is therefore a need to survey organizational and cultural items relating to medication safety in primary care – to explore the primary outpatient care practitioners' perceptions of medication errors and error prevention.

1.8 Medication errors in primary care

Attention to patient safety and medication error issues have been mostly directed at secondary care as this clearly indicates high-risk procedures such as surgery and blood transfusions, and an environment full of potential for risks such as nosocomial infections (Gaal et al., 2010; Harmsen et al., 2010). However, secondary care represents only a small percentage of a patient's use of the healthcare services.

In many countries, most patients receive most of their healthcare needs in primary (1°) care (Harmsen *et al.*, 2010). In the UK, the DOH report, *Building on strengths-delivering the future* (2008) estimated that greater than 80% of prescriptions for medication are written in primary care, and about 71% of the medication budget is currently spent in primary care (Department of Health, 2008). Furthermore, over 600 million prescription items are dispensed in community pharmacies in England and Wales (Ashcroft, Quinlan, et al., 2005). In addition, a wide variety of drugs are prescribed and monitored in primary care (including the monitoring of some medications which are routinely initiated from secondary care), and primary care practitioners are progressively taking on more and more complex medication regimen and patient health responsibilities (Avery et al., 2002).

A few studies have also showed that patient safety incidents in hospitals take their roots from primary care management. In the UK, 6.5% admissions to hospital were related to adverse drug reactions in a study of 18,820 patients that were admitted to hospital (Pirmohamed et al., 2004). Similar studies have been conducted in the Netherlands, France, Germany and the USA (Harmsen et al., 2010). Kohn et al (1999) in the IOM report, '*To err is human'*, estimated that 1 in every 131 outpatient deaths is attributable to medication errors. Over a decade ago, Winterstein et al (2000) as cited in Avery et al, 2002, in a systematic review and meta-analysis of 15 studies found that about 7% of hospital admissions were drug-related and over half of them were preventable in the first instance. About 60% of the groups of medication that were found to lead to increases in ADEs then have now only being given due attention when first prescribed to a patient by the recently initiated New Medicines Service (NMS) in England and Wales.

The dearth of information on medication errors in primary care may be attributable to many factors. Unlike secondary care, different health care professionals come in contact with patients at various locations; therefore, there is a requirement for multidisciplinary co-working with great implications for transfer of information and communication (Harmsen et

al., 2010). A World Health Organization (WHO) body, World Alliance for Patient Safety, concluded that inadequate or inappropriate communication and coordination are major priorities for patient safety research in the developed countries (Kennedy et al., 2011). Prescribing errors in the primary care setting are sometimes due to a breakdown in communication between prescribers and community pharmacists e.g. ordering commercially unavailable medicines, omission of parts of prescriptions, or even writing the wrong aspects of a prescription such as patient's name, address, age, medication, dosage or directions.

Lack of ready availability of copies of prescriptions for review, coupled with the scenario that patients get their prescriptions dispensed at multiple pharmacies are some of the factors that contribute to inadequate data describing the frequency and impact of outpatient medication errors (Gandhi et al., 2005). Self-administration by patients further has great implications for monitoring (Gandhi et al., 2003). Administration errors themselves are however indicative of defects in the medicines management process.

As contact with general practitioners occurs sparsely, communication about patient health problems is not (Gandhi et al., 2003). The researchers reiterated that lack of comprehensive documentation of patient care in the community might reduce the benefits of chart review, which is extensively employed in inpatient studies.

There is increasing research into methods for improving medication safety in primary care. Changing prescribing behaviour through educational outreaches, increasing use of computerised prompts (although some problems exists with physicians overriding these), increased focus on medicines mostly implicated and pharmacists' interventions are on the increase in many countries (Avery et al., 2009; Avery et al., 2002; Teinilä et al., 2011). In primary care, medication reviews and monitoring, repeat prescribing and the evolution of the expert patient are further ways in which the use of medication in primary care is increasingly made safer (Avery et al., 2002).

Nevertheless, with an increase in the methods for improving medication management systems, the problems are far from being over because none of them are self-sufficient, and may only improve individual aspects of the system as discussed above. Improvements in the medication management process are therefore a continuum especially as newer trends of problems are increasingly uncovered.

1.9 Research questions

The research questions that arise from the background above include the following:

- What are the current issues on medication errors in primary care – error rates and prevalence and interventions implemented to prevent medication errors? Are specific patient categories more susceptible to errors?
- What are the current systems for managing medication errors in UK primary care? How do these systems compare locally? What does primary healthcare safety culture look like?
- What is prevalence of medication errors in primary healthcare? What types of medication errors occur the most in UK primary care organizations, especially within vulnerable patient groups identified?
- What types of errors frequently occur in the primary healthcare setting?
- What roles do community pharmacists play in intercepting medication errors in primary care?

1.10 Aim and objectives

The aim of the study was therefore to determine the prevalence and nature of prescribing errors in general practice in older patients ≥65 years old and children 0-12 years old, and to identify defences against error occurrence in primary care.

The objectives were

- To undertake a systematic review of medication errors across the entire medication management process in primary care
- To describe the current systems and processes of medication error identification, recording and reporting in primary care organizations as pointers to their current culture of safety using postal questionnaires to Primary Care Trusts (PCTs), Clinical Commissioning Groups (CCGs) and NHS Area Teams
- To investigate the prevalence and nature of prescribing errors in older patients ≥65 years old and in children in primary care through the retrospective review of patient medication records in participating general practices

- To investigate the prevalence and nature of monitoring errors in older patients ≥65 years old and in children in primary care through the retrospective review of patient medication records
- To explore whether the prevalence and nature of errors vary with patient and prescription characteristics through analyses of data collected from the retrospective review of patient medication record
- To explore error-producing conditions in general practice, particularly amongst vulnerable patient groups through interrogation of data collected from the retrospective record reviews
- To explore community pharmacists' roles and interventions on medicines related problems in primary care through direct observations in participating community pharmacies
- To make recommendations for practice to reduce prescribing and monitoring errors in general practice from the findings of the systematic review, results from the retrospective review of patient medical records in participating general practices and observations in community pharmacies.

Chapter 2. Research context and theoretical framework

2.0 Introduction

Research is the systematic and rigorous method of enquiry, which aims to describe phenomena and to develop and test descriptive concepts and theories; overall, the main aim of research is to contribute to a scientific body of knowledge, and in healthcare, to improve health systems, health services, and health outcomes (Bowling, 2014). Ann Bowling has provided a detailed synopsis on the principles of Health Service Research in her book, "Research Methods in Health: Investigating health and health services," fourth edition. This has provided important insight for the current research as discussed in the following paragraphs.

This chapter provides an outline of the range of research methods used in health and health services enquiries. These guided the researcher to choose suitable research methods and designs to address particular research questions. As Ann Bowling pointed out, it is not feasible to place research methods in order of superiority, as various methods are suitable for various research questions: a cross-sectional survey, for example, can be used to enquire about the health status of a population, an experimental method may be more suitable for investigating cause-and-effect, and qualitative methods including observations, in-depth interviews and focus groups may be more suited to an area of enquiry of which little is known. Triangulated research methods, which consist of complimentary, combined methodological approaches to enquire about the different aspects of a research question, is increasingly recommended as a way of ensuring the external validity of the research. This is even highly relevant in health research, as health is multi-dimensional and health research is multi-disciplinary in nature. There is close working relationship between healthcare professionals and the different disciplines investigating health and health services. This means a variety of valid research methods including quantitative and qualitative, descriptive and analytical research methods is available.

2.1 Health research, health services and health systems research

Health research is described as:

"The process for obtaining systematic knowledge and technology, which can be used for the improvement of the health of individual groups. It provides the basic information on the state of health and disease of the population; it aims to develop tools to prevent and cure illness

and mitigate its effects and it attempts to devise better approaches to health care for the individual and the community," (Davies, 1991 as cited in Bowling, 2014). Health research has a pivot role in providing the information required for the planning of services to achieve health.

Health systems research is more broadly defined as "ultimately concerned with improving the health of a community, by enhancing the efficiency and effectiveness of the health system as an integrated part of the overall process of socio-economic development," (Varkevisser et al, 1991 as cited in (Bowling, 2014). In advanced healthcare systems like the UK and the USA, the focus is more on health services research rather than on health systems research, which is more narrowly explained in terms of the relationship between health service delivery and population health needs. The Medical Research Council provides an example of this relationship as the "identification of the health care needs of the population and the study of the provision, effectiveness and use of health services" (Clarke and Kurinczuk 1992 as cited in Bowling, 2014). Health services research is concerned with assessment of health services with respect to their appropriateness, effectiveness, and costs while health research refers to descriptive enquiries of the experience of illness and the population's views of health and ill health. Importantly, these concepts overlap. However, to be useful, the findings of health services need to be converted into actions or interventions.

Although they share the same concepts with respect to the evaluation of structure, process and outcome, health services research differs from audit and quality assurance in that it has evaluation at its heart, not monitoring. Evaluation describes assessment of the effectiveness of organisations, services and initiatives using scientific methods, and the rigorous and systematic research data collection (Shaw 1980 as cited in (Bowling, 2014)). Evaluation of health service, under which the present project falls under, comes under health services research.

Furthermore, while clinical research focuses on biochemical indicators of health outcomes and more recently albeit limited, on the quality of life of patients, health services research evaluates the results of clinical interventions on social, psychological, physical and economic perspectives, and the health sector (Hunter and Long 1993 as cited in (Bowling, 2014).

Health services research has three emphases: interaction between population health requirements and demand for health services, and the provision, use and appropriateness of health services; the processes and infrastructures, their efficiency and quality; and the

suitability and appropriateness of health service interventions with respect to their effectiveness and cost-effectiveness in addition to patients' expected health outcomes

The current research sits mostly within the second theme – the processes and infrastructures and their efficiency and quality, and to a lesser extent within the third theme or focus – suitability and appropriateness of interventions. Investigating the incidence and nature of medication errors in vulnerable patient populations including older and younger patients ultimately reviews the processes of medicines use – prescribing, transcribing, dispensing and administration, this time, the focus being on prescribing (and monitoring) errors. An example of "the suitability and appropriateness of interventions" will be a clinical pharmacist's retrospective review of medical records to identify whether the current systems within general practices are preventing the most common errors in older patients and in children.

2.1.1 Evaluation of the quality of care

In a research on medication errors, it is imperative to define the evaluation of the quality of care. In evaluating healthcare, quality of care is defined in respect of its effectiveness with enhancing the population's health status, and a measure of how professional and public standards about care are met (Donabedian, 1980 as cited in Bowling, 2014). In Donabedian's model, systematic assessment of quality evaluate the structure of healthcare (including staffing and building); the process (including service delivery, organisation and use; for example, consultation rates and referrals, admission and discharge protocols, prescribing practices such as prescribing safety); output (including productivity, access, effectiveness); and outcome (health outcomes including disability, discomfort, dissatisfaction). There are other related definitions of quality of care. Higginson (1994) as cited in (Bowling, 2014), defined quality of care in relation to effectiveness, acceptability and humanity, equity and accessibility and efficiency.

The aspect of health services research, which assesses the quality of care, involves the evaluation of structure, process and outcome of healthcare interventions such as prescribing in the current study.

2.2 The theoretical framework of assessment

Theories about the conduct of research (the philosophy of science) are important because they have influenced the progression of the systematic and rigorous research practices and methods, and the selection of methods. Scientific research methods entail the methodical or systematic enquiry of the phenomena of interest through thorough investigation using the senses, usually sight and hearing, complimented by technical instruments, correct measurement, and finally, experimentation through the careful manipulation of an intervention in controlled conditions and investigation and determination of the outcome**.** An important characteristic of scientific research methods is that the practice systematic. This means that an established set of guidelines and methods, which are rigorously complied with, and against which the research may be assessed, form its basis. Overall, the goal of scientific research is that the influence of other factors – including the inquirer's influence – on research findings is significantly reduced.

In addition to being systematic, it is imperative for scientific research to be rigorously conducted to reduce contamination and improve the precision of research findings through the following processes: comprehensive documentation of the research processes, objective data collection or observation, systematic collection, analysis and interpretation of the data, thorough maintenance of comprehensive research records, validity checks using additional research methods, repeated measures of the phenomena of interest, and reliability – testing by a different trained investigator using the same methods, measurement and analyses tools, to generate the same outputs or results.

The method of enquiry chosen depends on the investigator's position or their perception of how society works. An investigation, which starts with an idea, followed by development of theories and hypotheses, which are in turn tested by data is termed deduction. If research however starts with data collection followed by constructing hypotheses for testing from them, this method is described as induction. Deductive and inductive analyses form a huge aspect of scientific research and knowledge.

In the current study, both deductive and inductive analyses were relevant: the current literature suggests that medication errors are common in older patients and in children due to factors, which may include polypharmacy, diminishing pharmacokinetics and pharmacodynamics, co-morbidities, system failures, etc. in older patients, and the need for age- or weight-appropriate dose, etc. in children. From these findings, theories and

hypotheses are established, and data is collected to test these hypotheses. On the other hand, the systems of identifying, recording and reporting medication errors at Clinical Commissioning Groups, CCG (and formerly Primary Care Trusts, PCTs) level have not been previously characterised by primary research. The analyses of data generated from PCT/CCG surveys will guide the construction of hypotheses for testing in an inductive process.

Theoretical perspectives or paradigms govern every aspect of a scientific research. Research questions are therefore based on collection of assumptions, called paradigms. Paradigms are essential because they guide the focus and provide frameworks for interpreting findings. The reformulation of theories or perspectives where existing paradigms are altered is in turn provided by research observations. Although an enquirer's theoretical perspectives cannot be completely ignored throughout a research process, sources of bias, which undermine validity and reliability, should be consciously reduced through the rigorous and objective process of research.

The philosophical framework of deductive logic formed the basis of scientific research previously. Francis Bacon and John Locke established empiricism or inductive methods based on the need for making observations as opposed to just theoretical statements. Following Karl Popper's proposal that knowledge is gained by falsification of hypotheses, the hypothetico-deductive method was birthed, and forms the basis of modern scientific methods.

In theory, scientific research methods consist of rules and systems, based on the hypothetico-deductive method against which research can be evaluated. Practically however, scientific research is based on a less formal and somewhat haphazard mix of the rules of deductive and inductive or probabilistic paradigms – 'a mixture of empirical conception and the certainties of deductive reasoning.

The different types of paradigms, which can be used to inform and guide an investigator's research, include the following:

- **Grounded theory:** This is commonly employed in social science. The process of identifying theory from data that has been systematically collected and analyzed is referred to as grounded theory. Most of the hypotheses and concepts are worked out systematically from the data during the course of research to generate a theory from the data. It is a theory, which occurs inductively from the study of the interests it

represents. There is therefore a reciprocal relationship between data collection, analyses and theories.

- **Constructivist grounded theory:** The Constructivist grounded theory underlines multiple individual realities (Charmaz, 2000 as cited in Bowling, 2014). It involves concurrent data collection and analyses, where analytic codes and categories are developed from the data as opposed to a priori hypotheses, establishing middle-range theories, not grand theories to describe processes, applies theoretical sampling as opposed to representative sampling to verify conceptual categories, and undertaking literature review after the analyses. There is controversy that this theory leads to artificial manipulation of data, which is contradictory to the original theory (Piddephatt, 2006 as cited in Bowling, 2014).
- **Positivism:** The enquirer's perception about society governs this method of investigation. It assumes an external reality, which guides the determination of facts
- **Functionalism:** This is a positivist approach, which focuses on the social system. Illness is viewed in relation to its impact on the immediate social system, and the consequences thereof. Anything, which interferes with the social system and its values are described as dysfunctional, and those, which contribute to its functioning as functional. It is a system of holistic science.
- **Phenomenology:** The phenomenological philosophy proposes that research observation should come before theory because 'it initiates, reformulates, deflects and clarifies theory,' (Merton 1968 as cited in (Bowling, 2014)). Phenomenology is based on the paradigm that knowledge is socially built through the interaction of individuals, and that this understanding is undermined with the tools of positivism. Phenomenology is based on individuals' interaction between individuals in their natural existence. The tools are open-ended, unstructured, in-depth interview or participant observation.

As Ann Bowling surmises, the question should not be about choosing between quantitative methods or positivism and phenomenology or qualitative methods, but about the identification of novel ways to combine both in studies as they can compliment each other and produce rich research outputs (Bowling, 2014). Qualitative techniques are useful in producing rich data, particularly in new research topics and complex phenomena. On the other hand, quantitative methods are useful when the research area is relatively

straightforward, responsive to valid and reliable investigation. The use of triangulated or multiple methods of enquiry, if anything increase accuracy, validity and provide usefulness of the quantitative data that has been collected. The current research uses a mixed method approach to investigate the prevalence and nature of prescribing and monitoring error in primary care.

The deliberation in this thesis was to acknowledge and understand which paradigm was most appropriate to answer the research questions raised from the literature on medication errors in primary care. Methodological consideration was given to

1. The nature and source of information
2. Access to information and data collection
3. Analyses and interpretation of research findings
4. Implications of conclusions and contribution to existing scientific knowledge

2.3 Positivism

The principles of biomedicine are based on positivism. Positivism accentuates positive facts and aims to identify laws using quantitative methods. It describes a systematic observation and measurement of matter, which are believed to be free from the value judgement of the scientist due to the availability of objective systems of measurement. It is based on the premise that theories are examinable using the deductive principles of the scientific method, and is the central philosophy underlying quantitative scientific methods. In social sciences, Positivism assumes that external stimuli are necessary to alter human behaviour, and that it is possible to investigate social phenomena using the principles of the natural scientist. Surveys and experimental methods, and statistical techniques of analyses are the most popular positivism tools. Many of the methods used in health and healthcare research are based on the positivist belief. For example, structured interviews reduce the influence of the instrument and the enquirer on the respondent. Positivism is somewhat over dependent of experimental method and does not combine adequately, qualitative methods, which are believed to be able to provide understanding of human behaviour and social processes.

In the current study, the rational principles of the hypothetico-deductive method of positivism was recognised as a theoretical framework for the production of knowledge on medication

errors in primary care based on the investigator's assumption. The hypothetico-deductive method underlies modern scientific research. In this method, a hypothesis is developed from existing theory, and consequences deduced from that theory are tested against empirical data. If the hypothesis is false, the enquirer can develop a new one. If not, other tests or enquiries are used to attempt falsification. This means removing falsehood, rather than verifying theories brings about scientific progress. Operationalism, which states that the principles used in empirical research must be measured in terms of the indicators used to determine them influenced the challenge of accuracy inherent in the scientific hypothetico-deductive method. With respect to the current research, an operational definition of what constitutes a prescribing error in primary care is central to achieving objective measurements. A system of rules and procedures, which forms the basis of the research and following the principles of the hypothetico-deductive method, and against which the study can be evaluated constitutes the theory of the modern and rational scientific method. Research needs to be conducted systematically and rigorously while eliminating or reducing sources of bias. In practice however, the distinction between empiricism and deductive reasoning is less marked.

A scientific objective approach to identifying medication errors through the retrospective review of medical records in older patients and in children, using operational definitions, forms and objective assessment of prescriptions, and the use of quantitative and statistical analyses to interrogate the data from these studies, are based on the principles of the scientific hypothetico-deductive or positivist theory based on hypotheses and estimates of predictions that prescribing errors affect these vulnerable patient groups more than the rest of the population.

Although the multidisciplinary group of experts who judged the severity of errors followed established principles and rules of determination of prescribing error severity judging, their judgements were not completely value free as demonstrated by Williams and Ashcroft (Williams & Ashcroft, 2009).

The current study did not seek to explore the meaning of prescribing errors from the patients' or practitioners' perspectives in a qualitative or phenomenological enquiry as this was recently studied through focus groups and interviews and published by Slight and colleagues (Slight et al., 2013). However, the findings of Slight and colleagues, and the hypotheses developed thereof, on the causes of prescribing and monitoring errors in primary care have influenced the current study.

The aspect of the study, which sought to characterise the PCT/CCG systems of managing medication errors in primary care combines a quantitative deductive and qualitative inductive methods of enquiry. The section below discusses previous studies, which have investigated medication errors and those that employed this strategy.

2.4 Development of methodology

Medication errors, notably prescribing errors have been investigated in previous studies using quantitative methods and, in a limited number of cases, a mixed method approach, which usually involves case note reviews and interviews of patients and healthcare professionals has been used (Avery, Barber, et al., 2012; Barber et al., 2009; Gandhi et al., 2003; Gandhi et al., 2005; Kaushal et al., 2010). The purpose of the interviews conducted in most of these studies was mainly to verify descriptive information retrieved from medical records from patients, and in few cases, to conduct in-depth qualitative interviews on prescribers' perception of the concept of prescribing errors, and observation (Avery, Barber, et al., 2012; Barber et al., 2009). The quantitative methods approach used in these studies focused on deductive, scientific measurements or estimations of the prevalence and nature of medication errors, and identification of risk factors for medication errors, with the main goal of building up theories to compare groups and make extrapolations. Due to the fairly large sample sizes used, the results may be generalizable. Slight and colleagues (2013) used qualitative in-depth interviews to seek understanding of how prescribers 'perceive the world' in relation to prescribing errors. Barber and colleagues (2009) used direct observation and theoretically framed interviews. Although the research included a quantitative estimation of the prevalence and nature of prescribing errors in primary care, they also sought to understand what prescribing errors meant to practitioners. In the background of conducting research on prescribing errors, quantitative methods have therefore been used to investigate prevalence rates, nature and factors associated with prescribing errors. Qualitative research methods have been used to understand the social meaning of prescribing errors to individuals based on the paradigm of phenomenology that 'reality' is multi-faceted, and collectively interrogated through the interaction of individuals who "use symbols to interpret each other and assign meaning to perceptions and experience" (Bowling, 2014). The main purpose of the current research in this thesis is to quantitatively investigate the prevalence and nature of prescribing errors in older patients and in children using the hypothetico-deductive principles of positivism, though aspects of the study have some qualitative elements to it.

The mixed methodology research paradigm could be simultaneously or consecutively used during development of instruments of measurement, data collection, analyses and deductions. Both methods complement each other. In this study, qualitative methods were essential in the initial stages of developing the PCT/CCG survey questionnaire design, scale construction and analyses. Quantitative techniques are appropriate for unambiguous, valid and reliable estimates of the prevalence of prescribing and monitoring errors.

2.5 Identification of potential prescribing errors

The identification of a potential prescribing error in an older patient population may be challenging due to the prevalent need for co-prescribing effective medications for co-morbidities. Understanding patient characteristics and care pathways during investigative enquiries can however aid detection. The literature on medication errors suggest that identifying potential prescribing errors is based on the set of rules or definitions applied to the enquiry (Dean et al., 2000). Previous studies have therefore acknowledged that the definition and method used when identifying potential prescribing errors can affect the error rate reported (Avery, Barber, et al., 2012; Lisby et al., 2010; Olaniyan et al., 2014).

Methods used to capture error information have included retrospective and prospective medical records reviews, retrospective and prospective audit of electronic and paper prescriptions in general practices or those presented to community pharmacies, pharmacist-led identifications, patient interviews, direct observations, review of discharge summaries, incident report reviews, retrospective review of national data archives, and practitioner interviews. Study objectives, study setting (country), study population, researcher's preference and access to relevant information are some of the factors, which may determine the choice of method in investigating the rates of prescribing errors. Higher error rates were consistently reported in studies that retrospectively reviewed prescriptions and patients' medical records when compared to reviews of incident reports and community pharmacist interventions. This is largely due to the limited information available without access to patients' records.

One of the challenges of retrospectively reviewing patients' medical records is a potential for incomplete information. This is a major challenge where hand-written records or prescriptions are reviewed but is significantly reduced in healthcare systems where electronic medical records are in place, such as in the British NHS. It could however be argued that it

may be difficult to judge a prescriber's intention by what they have written down without interviewing them. Although interviews can produce relevant information on potential errors, there is the possibility that interviewees may not recall the circumstances around incidents by the time of the interview takes place. Avery and colleagues mitigated against the problem of incomplete information by recording no error if lack of information made it impossible to make a valid judgement on whether or not an error had taken place (Avery, Barber, et al., 2012).

What constitutes a prescribing error in each study has been mainly influenced by researchers' objectives and preferences. Some studies have included all rule violations including omission, commission, and integration errors leading to high error rates (Al Khaja et al., 2007), whereas some have focused on specific subtypes of prescribing errors, such as drug interaction errors, leading to low rates (Chen, Avery, et al., 2005). The multiplicity of error definition has been identified, and researchers have attempted to develop definitions, which could be operationalized in research and practice (Alldred et al., 2008; Dean et al., 2000; Dean Franklin & O'Grady, 2007). While it may be useful to have a universally accepted definition, researchers need to state explicitly the definition they have used. An ideal definition should bridge the gap between research and practice to enable research to lead development.

Consideration also needs to be given to how errors are expressed. In the systematic review underpinning this study, many denominators were used to express error rates (Olaniyan et al., 2014). Barber and colleagues (2009) expressed error rates as a percentage of opportunities for errors; the rational was that to judge that an error has occurred, a chance for occurrence had to first of all be established. In the literature, error rates are mostly expressed as a percentage of items (prescriptions) or patient. Importantly, error rates need to be expressed in simple to interpret forms for busy healthcare professionals to make sense of the information.

Potential prescribing errors have also been classified differently in studies depending on the objectives of the investigators. Most studies have classified prescribing errors by type such as drug interactions, wrong dose, wrong strength, etc., while a few have classified errors based on their characteristics such as being preventable, ameliorable, etc. (Gandhi et al., 2003). Some UK studies and elsewhere have also classified errors by the British National

Formulary, BNF chapters of the drugs affected, mainly to inform interventions or recommendations to stakeholders.

Most studies on prescribing errors in primary care are usually multidisciplinary collaborations – physicians, nurses, pharmacists, psychologists, social scientists, and statisticians, among others. When specified, pharmacists have mostly been involved in the act of identifying potential prescribing errors (Al Khaja et al., 2005; Avery, Barber, et al., 2012; Barber et al., 2009; Chen, Avery, et al., 2005), though physicians and nurses have also been involved. (Avery, Barber, et al., 2012) and Barber et al (2009) justified the use of CCG (formerly PCT) pharmacists as their job roles already involved the review of medical records and patient medications. The higher involvement of pharmacists in this process may be justified owing to their training and skills in drug use, pharmaceutical care plans, medicines optimisation and medicines management.

2.6 Classification of severity assessment of prescribing errors

It has been established that prescribing errors are common in secondary care, and studies are increasingly suggesting that error rates may even be higher in primary care. A systematic review found a median medication error rate of 7% or 52 errors per 100 admissions when 65 eligible studies were reviewed (Lewis et al., 2009). In primary care, the error rate ranged from ≤1% to ≥90 % when Olaniyan et al, 2014, reviewed 34 studies. Medication errors however range from those with severe consequences to those that result in little or no harm to the patient. It is argued that since errors are a result of the systems that produce them, it should not matter if they do result in severe consequences or not, as errors have a potential for reoccurrence, and similar shortfalls in them medication system produce both harmful and non-harmful errors, provide additional work pressures for already squeezed healthcare systems, and can impact negatively on patients' confidence in their healthcare (Garfield et al., 2013). Therefore, there is suggestion that to be truly useful, potential errors should not just be identified but should be assessed for severity to provide clinically relevant information and ensure adequate evaluation of interventions to reduce errors (Uzych, 1996).

The methods used for assessing the severity of errors vary widely though many features in common. Although Garfield and colleagues' systematic review (2013) identified 40 different tools used by 60 studies for assessing error severity, most used single-item classification systems for assessing error severity with associated definitions, and were mostly presented as

ordinal Likert scales (Garfield et al., 2013). One tool, Dean and Barber's tool, was based on a visual analogue scale. Some of the tools were for assessing severity error as well as other types of assessment e.g. National Coordinating Council for Medication Error Reporting (NNC MERP) tool included a 'not an error' category.

Most of the tools reviewed by Garfield and colleagues were developed for medication errors in general, while some were developed for studies of prescribing error. Some of the tools identified by the researchers to assess potential errors were based on other tools, which were originally designed to assess actual harm such as the NCC MERP index. The researchers noted that using tools based on actual outcome might be impractical in a research situation from an ethical point of view where the research is expected to intervene. Although using potential outcome is then beneficial in that judgements could still be made without knowledge of the actual outcome, judgements are more subjective.

Garfield and colleagues found that most tools ranged from potentially or actually lethal, to minor/mild error, or no harm. Some tools included the highest level of severity as 'severe,' or 'harmful,' and others adapted existing tools by expanding the levels to suit their studies. The researchers found that a measure of reliability was established for 17 of the 40 tools and validity was reported for only 5 tools. Two of the 40 tools were identified with acceptable validity and reliability – the NCC MERP index tool as adapted by Forrey et al who collapsed the nine levels into six, and Dean and Barber's tool. Garfield et al surmised that Dean and Barber's tool might be relevant for research purposes because it has been tested on larger sample sizes and its continuous scale can improve statistical analyses (Garfield et al., 2013).

Dean and Barber's tool (Dean & Barber, 1999), which has been successfully used in UK primary- care studies such as those of (Avery, Barber, et al., 2012; Barber et al., 2009; Dean Franklin & O'Grady, 2007), used generalizability theory to establish reliability – to obtain an acceptable generalizability coefficient, four reviewers or expert panel were needed to assess error severity. Their mean scores were subsequently used as the index of severity. Although this tool may be potentially time-consuming, a multi-disciplinary panel may be best suited to evaluating data on errors.

2.7 Framework for thesis

The research process reported in this thesis was guided by a mixed methods approach as outlined below.

The positivist approach described above was used to guide the experimental aspects of the research process. Positivism aims to discover laws using hypothetico-deductive or quantitative methods of enquiry. In this approach, the researcher systematically observes and measures phenomena, and the results of these investigations are to a large extent undistorted by the value judgement of the enquirer due to the availability of objective systems of measurements. The most popular tools, which are used in positivism, are surveys and experimental methods and statistical techniques of analyses.

Experimental methods are applied in this study to the retrospective review of medical records and the prospective observation of pharmacists' intervention on prescription errors, to investigate the prevalence and nature of prescribing errors in primary care. The data obtained is subjected to statistical analyses to describe phenomena. Although the aspect of the study, which sought to characterise the systems used by PCTs/CCGs to manage medication errors was studied using structured questionnaires, inductive analysis was applied to relevant aspects to produce a rich and insightful result.

The severity assessment of the prescribing errors identified in this study was based on potential outcome as opposed to actual outcome and as such, may be subjected to the value judgment of the assessors – different people may produce different judgements. To reduce this, 'case laws' compiled by Avery et al (2012) were applied to the current study.

The hypothetico-deductive method is not free from criticism. As Brown (1977), as cited in Bowling (2014) argued, refutation of hypothesis is not a sure process as it relies on observations, which may not necessarily be correct due to the challenges of measurement. As Bowling pointed out, investigators are always faced with the issue of accuracy of measurement when using experimental methods. The approach used by positivists to deal with the question of accuracy of the experimental method, based on the positivist belief that laws govern phenomena, and that these can be measured by following the principles of the scientific method, is known as Operationalism. Operationalism argues that the principles used in empirical research must be defined relative to the indicators used to measure them e.g. identifying prescribing errors based on a working or operational definition. Some scientists however argue that operationalization may be inadequate and somewhat misleading, leading

to problem of validity (Blalock and Blalock 1977) as cited in Bowling (2014). Validity asks the question "is the measure measuring what it purports to?" e.g. is the definition of prescribing error actually identifying prescribing errors? As such, Operationalism only provides flexible guidance to the research process and does not claim that the concepts are synonymous with the indicators of measurement although the researcher is faced with the problem of relating empirical concepts to theoretical concepts.

Bowling (2014) outlined the important steps, which should guide quantitative research: issues of sampling and sampling methods and the principles, which guide quantitative surveys and the experimental analytic method. Bowling described the place of internal and external validity to judge the quality of experimental enquiries. Where appropriate, the appropriate steps were taken to ensure internal validity.

2.7.1 Reliability and validity

The reproducibility and consistency of the instrument of measurement is referred to as reliability. It measures the extent to which the instrument of measurement is standardised and free from random error and produce internal consistency and repeatability. Bowling identifies parameters, which need to be reviewed before an instrument could be judged as reliable. These included test-retest, inter-rater reliability and internal consistency. Repeatability is measured by test-retest procedures, which involves the administration of the instrument at different time periods, where the test conditions have not changed; inter-rater reliability can be used to determine the extent to which the results obtained by two or more observers agree when observing the same phenomenon.

2.7.1.1 Validity

After it has been satisfactorily subjected to repeated tests in the populations for which it was designed, an instrument is assigned validity. This is known as internal validity. External validity refers to the extent of generalizability of the research findings to the wider population of interest. External validity recognises that generalising a study's results to a wider population of interest depends on the context of the study. It has an implication for applying the research findings in practice. Content validity refers to judgements (usually made by a panel) about the length to which the content of the instrument appears logically to observe the characteristic or phenomenon it is intended for.

Data collection tools used in this current study were previously validated and used in a previous UK study, the PRACtISE Study by Avery and colleagues (Avery, Barber, et al., 2012). In a validation process, one of the supervisors retrospectively reviewed a 5% and 10% random sample each of the records of older patients ≥65 years and younger patients 0-12 years respectively, which had been reviewed by the principal investigator. No disparities were recorded between the supervisor and investigator's observations; therefore a 100% agreement was achieved.

2.7.1.2 Threats to reliability and validity

Various sources of threats to the reliability and validity of an investigation have been documented. These threats, known as biases and errors in the conceptualisation of the research idea, the design, sampling and process of the study, have the potential to result in systematic deviations from the true value (Last, 1988 as cited in Bowling, 2014). Biases and error can affect the experimental or quantitative research as well as social research. As such, all forms of research constantly attempt to reduce sources of bias and errors. The sources of bias identified in this research include the following: design bias, interviewer bias, non-response bias, random measurement error, sampling bias, and systematic bias. Steps were taken to reduce the influence of these sources of errors, and others, on the current research process, analyses and conclusions.

This thesis has drawn from previous studies examining prescribing and monitoring errors in primary care to explore the various methods available, and to address the research questions outlined at the end of the introduction chapter above. This section has discussed the context, theoretical framework, and methods to establish the investigator's assumptions or philosophical reasoning in relation to the gaps in the literature and how they could be answered.

A summary of the research questions and methodology used are outlined below in Table 1.

Table 1: Summary of study research questions and methodology used

Research questions	Methodology	Rationalisation/	Method	Outcome measures
• What are the reported rates of different types of medication errors across the entire medication use process in primary care – in the UK and elsewhere • What are the interventions, which have been adopted in primary care to prevent prescribing errors. What interventions may be suitable to preventing some of the prescribing errors identified in the present study	• Quantitative • Literature review of interventions to prevent prescribing errors in primary care and recommendation of pragmatic interventions to be used to prevent the errors identified in the current study	• Identification of published research findings on medication errors in primary care • Identification of previously effective interventions and recommendations based on these	• Systematic literature review • Reflection on the types and nature of errors identified in the current study and how interventions may prevent them	• Definitions and methods used in studies/comparisons • Countries and settings • Prevalence and rates of errors reported; comparison of error rates • Critical appraisal of the methods reported • Interventions implemented in general practices and community pharmacies to identify and prevent prescribing errors
What are the current systems and processes of managing (identification, recording and reporting) medication errors locally in the UK primary care	Mixed method: quantitative method using structured surveys with qualitative, inductive	Characterisation of the systems of error management in primary care at PCT/CCG levels pre/post-CCG creation	Semi-structured postal survey	Description existing protocols for identification, recording and reporting of medication errors at local authority level

	analyses of data			
What are the characteristics of older patients and children with prescribing errors in general practice: patient demographics and drug use in these patient groups	Quantitative	Description of the patient population studied with respect to their demographics and patterns of drug use	Review of patient medical notes in general practice using standardized and validated methods and forms	Age distribution of study sample, patterns of drug use, therapeutic and BNF chapter categorisation of drugs used
What is the prevalence and nature of prescribing errors identified in • Older patients • And children, in general practice	Quantitative	• Identification of potential prescribing errors • Description of error categories and type; severity assessment of potential errors	• Review of patient medical records in general practice • Assessment of potential errors by expert panel	• Nature and types of potential prescribing errors • Prevalence of prescribing errors per item and per patient • Severity ratings or scores
What is the prevalence of prescription and medicines-related problems identified from community pharmacists' intervention on prescription errors	Quantitative	Identification of pharmacists' intervention on prescription error: rates and nature	Prospective review of prescriptions presented to community pharmacies	• Prevalence and nature of prescription problems and medicines related problems in community pharmacies • Severity classification of problems identified

The table above provided a summary of the research questions in the study. The overall framework for the PhD is shown below in Figure 3.

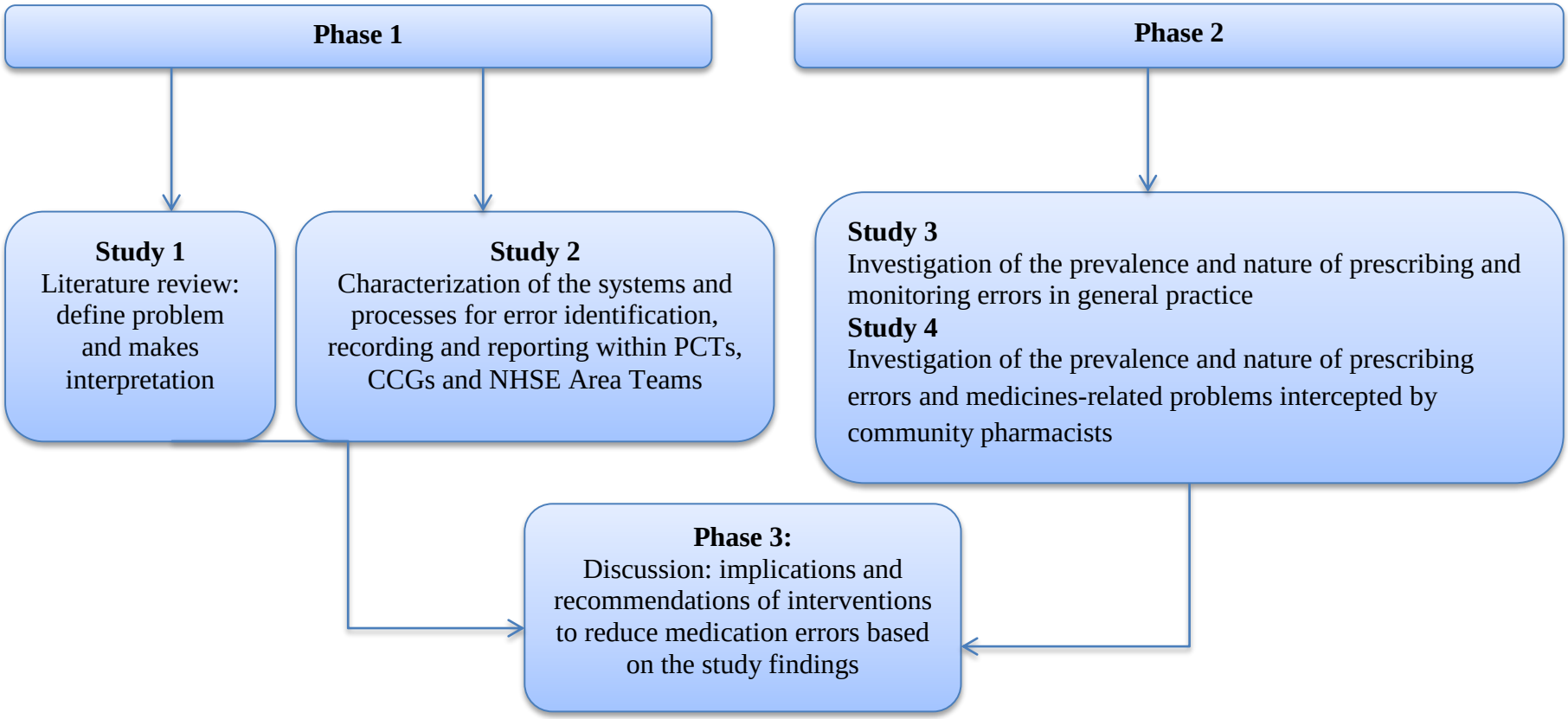


Figure 3: Overall framework for the research

This chapter has reviewed the theoretical framework underpinning this thesis and provided a description of the philosophical paradigm adopted. The structure of the thesis has been outlined.

Chapter 3. **Methodology**

3.0 Methodology

This chapter provides an overview of the general methods used in each phase and study of this research as outlined in Figure 3 above. Each study chapter further provides a detailed methods section.

3.1 General method

This study was an in-depth, multi-phase, and multicentre study to explore the safety of medication use in primary care. The study used a mixed methodology and was conducted in three phases. Phase one comprised a systematic literature review, and characterisation of the existing systems of and processes for medication error identification, recording and reporting by primary care organisations, formerly Primary Care Trusts, PCTs and Clinical Commissioning Groups, CCGs. Phase Two comprised a review of the definitions of prescribing errors in primary care leading to the adoption of a pragmatic and widely-accepted definition of a prescribing error for the purposes of this study. Phase Two also comprised the retrospective review of the clinical records of older patients and children in general practices (GP) surgeries to identify potential prescribing errors. Phase Two also comprised the prospective observation of community pharmacists' interventions on medicines-related problems and an audit of their daily activities. Based on the findings from Phases one and two, practical recommendations were made to prevent the occurrence of medication errors in primary care organisations.

3.2 Support and ethics application and approval

The study was conducted following ethical approval from relevant healthcare organisations and support from associated healthcare professionals mainly general practitioners, practice managers and community pharmacists. Written support were obtained from

- Luton CCG
- Bedfordshire CCG
- Harrow PCT
- NHS South West London Primary Care (comprising of Croydon, Kingston, Richmond, Sutton & Merton and Wandsworth CCGs)
- Kingfisher Practice in Crawley Green, Luton CCG

- Salisbury House Surgery in Leighton Buzzard, Bedford CCG
- Lloyds Pharmacy, Hitchin Road, Stopsley, Luton CCG
- Lloyds Pharmacy, Leighton Buzzard, Bedford CCG
- Royal Pharmacy, Luton CCG (see appendices)

Application for ethical approval was sought and obtained from the Health Research Authority's (HRA) National Research Ethics (NRES) Committee East of England – Cambridge Central following a review meeting attended by the research degree student and supervisors on 11th May 2012. Provisional approval was obtained on the 29th of May 2012 (Appendix 10) and a favourable opinion obtained on the 27th of September 2012 (see appendices for protocol approved by ethics).

At the point of seeking approval from the individual Research and Development (R and D) departments of the then PCTs, the R and D departments of Luton CCG and NHS South London raised concerns on the intention of the study to access medical records without patient consent. They then suggested to the study to either seek patient consent or apply to the then National Information Governance Board (NIGB) now the HRA Confidentiality Advisory Committee (HRA CAG), for section 251 support.

Section 251 of the NHS Act 2006 re-enacted Section 60 of the Health and Social Care Act 2001. The terms Section 60 and Section 251, when used in relation to use of patient information therefore refers to the same powers. These powers allow the Secretary of State for Health to make regulations to set aside the common law duty of confidentiality for medical purposes where it is not possible to use anonymized information and where seeking individual consent is not practicable. Under the Health and Social Care Act 2008, responsibility for administering these powers was transferred from the Patient Information Advisory Group to the HRA. Section 251 came about because it was recognised that there were essential activities of the NHS, and important medical research, that required use of identifiable patient information but because patient consent had not been obtained to use people's personal and confidential information for these other purposes, there was no secure basis in law for these uses.

Due to the intended number of medical records that were going to be reviewed, it was impractical to seek patient consent. Moreover, the concept of medication error research may

be unnecessarily unnerving for patients and practitioners. Therefore, an application was made on the IRAS to the NIGB for 'section 251 support,' for exemption from seeking patient consent. Completing the IRAS forms for the NIGB application however, meant that sections of the REC form would be amended. As such, the REC, who had initially granted full approval to the study, changed the approval from final to provisional in December 2012 pending the results of the NIGB application.

Application was made to the NIGB in February 2013. Similar to the REC, NIGB meets about once in two months, and this schedule translated into delays. Approval was finally obtained on the 11th of June 2013 (Appendix 11).

The normal time scale for ethics approvals was usually within three to five months. However, due to the extensive changes in the NHS primary care structure through the abolition of PCTs and formation of CCGs, full ethical approval from the HRA NRES, HRA CAG, PCTs/CCGs, and their respective R and D departments took over ten months. The HRA NRES does not support any data collection prior to full ethical approval.

The research team had on-going communication and engagement meetings with the participating CCGs to establish links with the leads in the face of the transition of PCTs to CCGs. Discussions and presentations on study administration and strategies for recruitment of practices and pharmacies dominated those meetings. While waiting for the HRA CAG's response, an audit protocol was developed as a back up plan and tested with Luton CCG.

3.3 Study design

3.3.1 Phase 1 Study 1: Systematic literature Review

A systematic literature review and critical appraisal of studies on medication errors and interventions implemented in primary care to prevent errors was undertaken. The following databases were searched: PubMed, ISI Web of Knowledge (Web of Science), Scopus, Science Direct, Google Scholar, Medline, CINAHL (Cumulative Index to Nursing and Allied Health Database), International Pharmaceutical Abstracts, Embase, PsycINFO, PASCAL, COCHRANE. There was a preference for peer-reviewed journals. Relevant unpublished works, such as doctoral thesis were also searched for. The search terms comprised two themes namely medication errors and primary care, while secondary care was excluded. Inclusion and exclusion criteria are outlined below:

a) Search was limited to studies published in English Language
b) Search was not be restricted to the UK to gain an international perspective
c) "Medication error" was used as Medical Search Heading (MeSH) term and keyword
d) Articles covered broad topics including definition of ME, incidence and prevalence, types, intervention and outcome measures
e) The reference lists of relevant papers were reviewed to identify other articles
f) The search identified publications of established authors in the field of medication safety
g) Studies focusing on just a specific disease conditions or specific drugs were excluded
h) Any study that mentioned the following were reviewed – definition, prevalence and incidence, interventions, safety climate and culture.

Analysis:

Summary of findings were presented in a table with headings including study aim and objectives, study population, definitions and methods used, and the findings. A discussion of the critical appraisal of the studies was produced.

3.3.2 Phase 1 Study 2: Characterisation of PCTs, CCGs and NHS England systems for identification and learning from medication errors in primary care.

The Heads of Medicine Management (HOMM) and Chief Pharmacists (CP) in each of 146 PCTs, 108 CCG and 28 NHS England Areas were contacted by the research student to complete a postal questionnaire. A covering letter and a data collection pro-forma in the form of a questionnaire was sent out directly to the respondents with a pre-paid reply envelop to the research office. The covering letter provided a brief description of the study's objectives, procedures, contact details of the researcher. The questionnaire contained the questions outlined in Appendix 12.

Analysis: Quantitative data was entered onto the computer and analysed using Microsoft Excel. Qualitative data on the processes and protocols for error identification, reporting and interventions implemented to prevent errors were grouped and coded for inductive analysis.

3.3.3 Phase 2

Study setting and recruitment of participants for Phase Two of the study are described below.

3.3.3.1 Study Setting

The study setting was purposively selected general practice surgeries and community pharmacies located within the geographical zones of conveniently sampled CCGs (formerly PCTS) namely Bedfordshire and Luton PCTs. When PCTs were abolished and CCGs created, further consent was sought from the new CCG structure. The study set out initially to recruit two general practices, one each of rural and urban settings with varying levels of deprivation, from three purposively selected CCGs (formerly PCTs) to represent general practices nationally. To achieve this, five Primary Care Trusts (PCTs) were approached. These included City and Hackney, Luton, Bedfordshire, Harrow PCTs, and NHS South West London.

The CCGs were purposively selected based on the presence of a diversity of patient ethnicity and age groups within the communities. They represented a patient population diverse in socio-economic status (according to the National Statistics Socio-Economic Classification, NS-SEC, which provides an indication of socio economic indices based on occupation). The CCGs were selected because they include areas classified as most- and least-deprived Small Areas according to the English Indices of Multiple Deprivation (IMD), 2010. The sample size was selected within our available resources, and the presence of contacts known to the supervisory team. General practices and community pharmacies were recruited as outlined below. City and Hackney PCT declined participation citing conflicting on-going projects as the reason. NHS South West London, Bedfordshire and Luton CCGs gave their consents to participate, and the study was eventually conducted in Bedfordshire and Luton CCGs due to time constraints

3.3.3.2 Recruitment of general practice (surgeries)

Luton and Bedford CCG were approached to provide the research student with a full list of the general practices and community pharmacies within their wards. From the list obtained from Luton, all general practices in their geographical zones were invited to express their interest to participate in the study by sending out an invitation letter to each of them. As response was very low (only two general practices responded), the research team decided to recruit a convenient sample of general practices and community pharmacies in both CCGs. Invitation letters and practice information sheets provided a brief description of the aim and

objectives of the research, and how the study would contribute to their practices. Additionally, the information sheet gave a summary of how the study would affect the practices. Practices were selected based on the following inclusion and exclusion criteria:

a) Up to two practices per PCT will be selected – one of a more "rural" location, and the other "urban" based on NS-SEC classification and IMD 2010.
b) Practices who hold electronic patient medical records will be recruited
c) Practices will be easy to access by public transport.
d) Practices who do not keep electronic records of prescriptions will be excluded.
e) Practices that do not have the space to enable the research student to review patient records for the purposes of the study will be excluded.

3.3.3.3 Recruitment of community pharmacies

Community pharmacies within a 2-mile radius of the recruited surgeries were conveniently sampled by direct approach to invite them to participate in the study. The 2-mile radius was set to allow the study to focus on small "cohorts" of surgeries and pharmacies who were very likely to work closely together to meet patients' needs. In the UK, patients are more likely to fill their prescriptions at pharmacies within this distance of their surgeries, which are usually located close to their dwellings. Of six pharmacies, three each within Luton and Bedford CCGs, three gave their consent to participate. The invitation letter and Pharmacy Information sheets provided relevant information similar to those used to recruit general practices. Inclusion and exclusion criteria were similar to those of the general practices as outlined above.

3.3.3.4 Definitions of prescribing and monitoring errors used in study

3.3.3.4.1 Prescribing error

One of the preliminary objectives of the present study was to develop a general practitioner and primary healthcare professional-led definition of a prescribing error, which would hopefully form a foundation for both research and practice. Due to limited funds, and time pressures placed on the project by the abolition of Primary Care Trusts, PCTs and creation of CCGs, this objective was reviewed. A secondary deterrent was the potential of increasing the plethora of definitions in the literature. Following a systematic review of medication safety in

primary care with an element that reviewed the error definitions used, the present study adopted the definition of a prescribing error developed and validated by (Dean et al., 2000), and of a monitoring error by (Alldred et al., 2008). Although the definition of Dean et al was developed with UK secondary care in mind, it is widely applicable in primary care in the UK. This definition has been used in the Department of Health, DH report "Building a safer NHS for patients – improving medication safety (Department of Health, 2004), and has been successfully adopted in other studies (Dean et al, 2000; Sagripanti et al, 2002; Donyai et al, 2007 and Franklin et al, 2007 in (Alldred et al., 2008). Researchers have successfully used this definition when they investigated the prevalence and nature of prescribing errors in primary care (Avery, Barber, et al., 2012). Furthermore, this definition was used by 11 of 65 studies (Kane-Gill & Devlin, 2006) as cited in (Avery, Barber, et al., 2012). The definitions used are stated below:

"A clinically meaningful prescribing error occurs when, as a result of a prescribing decision or prescription-writing process, there is an unintentional significant

- Reduction in the probability of treatment being timely and effective, or
- Increase in the risk of harm when compared with generally accepted practice" (Dean et al., 2000).

3.3.3.4.2 Monitoring errors

Alldred et al (2008) had observed that the evidence regarding how often a particular medicine should be monitored was sparse and information from various sources were often conflicting. A definition of monitoring errors was therefore developed and validated by Alldred et al, when they conducted a UK study on Care Home Use of Medicines (CHUMS). Along with their definition, researchers, general practitioners and clinical pharmacists collated a set of criteria, which were meant to be both practical and easy to use. The list was not intended to be exhaustive but focussed on drugs, which were most likely to be prescribed and had the potential for harm. The drugs or groups of drugs, which were included in the list, were judged to require monitoring in the primary care setting (Appendix 16).

The core definition of a monitoring error as agreed by the study is:

"A monitoring error occurs when a prescribed medicine is not monitored in the way which

would be considered acceptable in routine general practice. It includes the absence of tests being carried out at the frequency listed in the criteria, with tolerance of +50%. This means, for example, that if a drug requires liver function tests at 3 monthly intervals, we would class as an error if a test has not been conducted within 18 weeks. If a patient refused to give consent for a test, then this would not constitute an error" (Barber et al., 2009). The researchers chose to allow at 50% tolerance in the timing of tests because they felt it is a pragmatic and generous limit. These definitions were adopted in the current study.

In their study of the prevalence and nature of prescribing errors in UK general practice, Avery and colleagues reflected on defining errors in practice: they described an evolving list of what is termed "case law" as required in addition to definitions. This case law is founded on the published list of examples of scenarios or cases of what should, and should not, be included as an error. The researchers noted that additional case law is likely to be needed as a study moves on. In previous studies, an adjudication panel has been used to draw up case law (Alldred et al., 2008; Dean et al., 2000). Appendix 18 contains examples of judgements made by the error-judging panel on scenarios identified as part of their study. This has guided by the present study.

3.3.3.5 Assessment of severity of potential prescribing and monitoring errors

Dean and Barber developed a visual analogue tool to predict the harm that would result from errors when the real-life outcome is unknown as in the present study (see Chapter 6 below). They used generalizability theory to predict the harm that would result from medication administration errors, and validated it by the blind assessment of errors with known outcomes. The method involves assessment of the potential clinical significance of identified errors by a panel of five judges using a visual analogue scale, which is numbered from 0 to 10, with 0 representing an error with no clinical effects on the patient, and 10 an incident that would result in death. Errors with an average score less than 3 are classed as minor, 3-7 inclusive as moderate, and errors with an average score of greater than 7 are severe. The present study has adopted the use of Dean and Barber's visual analogue scale (see below) to assess the potential harm or severity of the prescribing and monitoring errors identified in this study (Dean & Barber, 1999).

The NPSA patient safety incident severity rating scale is conventionally used to assess the severity of errors reported to the NPSA. This scale has also been adapted for severity

assessment of the potential errors identified in the current study as shown below, mainly to facilitate provision of feedback to participating organizations.

Table 2: NRLS patient safety incident severity rating scale

Severity	Description
No harm	**Impact prevented:** any patient safety incident that has the potential to cause harm but which may be prevented, resulting in no harm to people receiving NHS-funded care **Impact not prevented:** any patient safety incident that has the potential to run to completion but no potential to cause harm occurring to people receiving NHS-funded care
Low	Any patient safety incident that has the potential to require extra observation or minor treatment and cause minimal harm, to one or more persons receiving NHS-funded care
Moderate	Any patient safety incident that has the potential to result in a moderate increase in treatment and which may cause significant but not permanent harm, to one or more persons receiving NHS-funded care
Severe	Any patient safety incident that has the potential to result in permanent harm to one or more persons receiving NHS-funded care
Death	Any patient safety incident that has the potential to directly result in the death of one or more persons receiving NHS funded care

3.3.4 Phase 2 Study 3: Determination of the prevalence and nature of prescribing errors in general practice in older patients 65 years and over, and children 0-12 years

Using the definitions outlined above, the researcher, a clinical pharmacist conducted thorough retrospective review of random samples of electronic patient medical records (PMR) on Vision and SystmOne GP clinical computer systems in the two general practices, using forms used in a previous study of the prevalence of prescribing errors in primary care (Avery, Barber, et al., 2012). These GP clinical computer systems are used to store patients' notes electronically. The data stored include all details of a patient's medical history, acute and repeat medication records and the results of blood and other investigations, including electronically transmitted information from secondary care such as discharge notes.

Sample size determination: In the PRACtISE Study, a 4.9% prescribing error rate was found from the retrospective review of case notes from a random sample of 2% of practice

registered patients. The study reviewed a total of 1,777 PMRs. Of these, 1,200 records had received a prescription for at least one medication in the 12-month data collection period (Avery et al., 2013). The advice of a University of Hertfordshire medical statistician was sought on determining an appropriate sample size for the current study. The statistician advised that determining sample size from the PRACtISE study was not appropriate as the study was not limited to the same age groups as in the current study. Based on these, the current study aimed to review a practical percentage registered older patients and children in the general practices. Based on the number of these patient groups registered in both practices, at least 10% sample was selected for review.

The research degree student carried out review of patient medication record in the 12 months to data collection for the purposes of identifying potential prescribing errors. Only the medical records of paediatric patients (aged 0-12 years) and older patients (aged 65 years and above) were reviewed. The selection of the study age groups was based on suggestions in the literature that these patients were more susceptible to higher error rates. Within these age groups, patients' records were randomly selected using randomization table generated by the researcher from www.randomizer.org.

The research data from the clinical retrospective review of patients' electronic records was validated by one of the supervisors of the project. The supervisor selected a random sample of the records of older patients (2%) and children (10%), which were reviewed in each practice. The supervisor then reviewed these records. There were no disagreements with the research data collected by the research degree student. The data entered onto the Access database was reviewed against original data collection forms in a data cleansing process.

Prescribing errors were assessed for potential harm by a panel of three pharmacists from clinical, community and academic pharmacy backgrounds using Dean and Barber's tool for assessing the severity of prescribing errors.

During their study of the Prevalence and Nature of Medication Errors in Primary Care, Avery et al (2012) developed a detailed list of "case law," following discussions by a multi-disciplinary error-judging panel. This list described what should, and should not, be included as an error, alongside rationale of these decisions. It was used throughout the study to ensure that judgements made by the researcher were reliable and appropriate (Appendix 18). This list of "case law" was also presented to the panel in the current study to provide some training in error-judging for the purposes of the study, and to ensure that their judgements were

comparable with the most recent study by Avery et al, which was commissioned and published by the General Medical Council (GMC) to improve prescribing practices in UK primary care. It was hoped that the media and professional attention given to the findings of the study would have influenced prescribing practices, and that the judgements in the current study were therefore reliable and appropriate.

Some of the principles established in the development of the "case laws" were: each prescription could be associated with more than one error; an overdose associated with the addition of two or more items was considered one error; drug interactions were recorded against the second of the two drugs affected to avoid duplication; dosing and frequency errors were combined as one to dose/strength error; no error documented if incomplete information meant that a decision could not be reached as to whether an error had taken place or not (Avery, Barber, et al., 2012).

Potential errors were compiled and presented in a questionnaire format and presented to the judges. The use of the two tools outlined above allowed comparison of results.

Analysis: All error data were coded and entered onto an Access database, and exported to Microsoft Excel for descriptive analyses. The overall prevalence of prescriptions errors was calculated and presented along with 95% confidence interval (CI). The different types of errors detected were presented. Appendix 19 presents the analysis framework, which guided the study and Appendix 17 shows the typology of errors used.

Limitations: the data was collected in two practices, which makes the findings difficult to generalise.

3.3.5 Phase 2 Study 4: Observation of pharmacists' interventions on prescriptions errors and MRPs in community pharmacies, and observation of pharmacists' daily activities

Prospective observation of community pharmacists' interventions on prescription errors and medicines-related problems (MRPs) was conducted. Three MPharm (final year MSc Pharmacy students) collected the community pharmacy data. The research student coached MPharm final year students to audit the role and activities of the pharmacists in prescription reviews and queries, and other MRPs identified by the pharmacist using forms used in in previous MPharm projects. Direct observation of the pharmacists' activities allowed the

collection of rich data unlikely to be recorded from spontaneous reports by pharmacists, particularly during dispensary busy hours. Information on patients' demographics and detailed description of detected problems were recorded. Origin of the prescription, type, medication involved, pharmacist intervention and an estimate of the time it took to resolve the problem were recorded. The incidence rates reported from a previous observational audit of medicines-related problems in three pharmacies were 1.5% per prescriptions and 0.8% per items. Based on these figures, the current observation was not limited to paediatrics (0 to 12 years) and older (65 years and over) patients though the analyses will involve reviewing the patient age groups susceptible to MRPs.

Analysis: based on their training and experience, the community pharmacists and researcher supported MPharm students to classify MRPs as mild, moderate or severe. Incidence rates and their corresponding 95% CI were determined using standard methods. Items and prescriptions dispensed were used as denominations in determining error rates.

3.4 Pilot study

The purpose of the pilot study or preliminary fieldwork was to assess the feasibility of the methods outlined, and the practicality of the data collection instruments. The pilot studies in the general practices and community studies did not identify any need to review the data collection instruments. As such, the results of the pilot study were analysed with the main study. However, study arrangements were adjusted as summarised below:

Study 2: PCT/CCG error management systems

The study had intended to send the survey electronically via email. To obtain the email addresses of the relevant person, phone calls were made to about 30 PCTs initially. However, it proved difficult and near impossible to obtain the email addresses of potential respondents, the Clinical Governance Leads. It was therefore decided to send the questionnaire by post. Another challenge, which was encountered, was identifying the most relevant person or role to address the questionnaire to. Although the questionnaire was initially designed with "Clinical Governance Leads" as the potential respondents, following the telephone conversations to PCTs, it became apparent that various titles were used for similar roles between PCTs. Since the survey was therefore invariably aimed at any member of the PCT or CCG dealing with medication incidents, it was difficult to ascertain exactly who should be completing the questionnaire. It was therefore decided to mail the questionnaire to both the "Heads of Medicines Management" and "Chief Pharmacists" as these were the most relevant

titles. Each questionnaire was marked with a unique code to ensure that more than one questionnaire was not recorded for any organisation, although the study did not receive more than one response from any PCT/CCG eventually.

Study 3: Retrospective review of the electronic clinical medical records of older patients and children in general practices

No amendments were required for the data collection forms. As such, data from the pilot study was analysed with the main study. To analyse data from the pilot study, an Access database was created specifically for the current study. It was however not practical to use the database as forms were originally designed to be independent of each other. The researcher therefore decided to obtain permission from the authors of the PRACtISE study to use an erstwhile database. Consent was obtained, and the database was adapted to suit the current study.

Chapter 4. Systematic Literature Review

4.0 Systematic literature review: Safety of medication use in primary care

4.1 Abstract

4.1.1 Background

Medication errors are one of the leading causes of harm in healthcare. Review and analysis of errors have often emphasized their preventable nature, and potential for re-occurrence. In the past decade, research has focussed on estimating the scale of medication errors and prevention. Much of this work has been in secondary care, which is associated with high-risk procedures and the use of high-risk medicines. However, patients receive most of their healthcare needs in primary care. Of the few error studies conducted in primary care to date, most have focussed on estimating the incidence, describing the nature of individual parts of the medicines management system, and evaluating individual error-prevention strategies. Studying individual parts of the system does not provide a complete perspective and may further weaken the evidence and undermine interventions.

4.1.2 Aim and Objectives

This study reviewed the existing literature on the incidence of medication errors in primary care across the entire medicines management system. The objectives were:

1. To appraise studies addressing medication error rates in primary care
    a. To report error rates at each point of the system
    b. To appraise the methods used to identify errors in the studies
    c. To identify of the most susceptible points and patient groups
    d. To compare error rates between healthcare settings, and

2. To identify studies on interventions to prevent medication errors in primary care.

4.1.3 Methods

A systematic search of the literature related to medication errors in primary care was performed in the following databases: PubMed (MEDLINE), International Pharmaceutical Abstracts (IPA), Embase, PsycINFO, PASCAL, Science Direct, Scopus, Web of Knowledge, and CINAHL PLUS from 1999 to November, 2012. Bibliographies of relevant publications were searched for additional studies.

4.1.4 Results

Thirty-three studies estimating the incidence of medication errors, and thirty-six studies evaluating the impact of error-prevention interventions in primary care were identified and reviewed. Studies stating definitions and methods used, and those measuring the impact of interventions were included. This review demonstrated that medication errors are common, and occur at every stage of the process, with error rates between < 1% and >90%, depending on the part of the system studied and the definitions and methods used. The prescribing error rate in primary care in the UK was between 4.9% and 8.3%. It was difficult to directly compare error rates between studies due to differing units of measurement and sampling methods. There is some evidence that the prescribing stage is the most susceptible, and that the elderly (over 65 years), and children (under 18 years) are more likely to experience significant errors, although little research has focussed on these age groups. Individual interventions such as medication reconciliation or pharmacist-led interventions demonstrated marginal improvements in medication safety when implemented on their own but had more impact when jointly implemented. The overall safety and quality of the medication system could be improved by adopting a holistic approach to management and interventions.

4.1.5 Conclusion

Targeting the more susceptible population groups and the most dangerous aspects of the system may be a more effective approach to error management and prevention in primary care. Co-implementation of existing interventions at points within the system may offer time- and cost-effective options to improving medication safety in primary care.

Keywords: Medication error (and related terms) and primary care (and related terms); not secondary care (and related terms).

4.2 Introduction

Medical error and patient safety have been the subjects of discussions for government bodies, healthcare organizations, the media, researchers and patients in the past decade. The American Institute of Medicine (IOM) report, "*To err is human",* describes the harmful, common, expensive and, importantly, the preventable nature of medical errors (Kohn et al., 1999). A UK Department of Health (DH) report, "*An organization with a memory: learning from adverse events in the NHS (National Health Service)"* (Department of Health, 2000), emphasises the importance of learning from errors based on their potential for reoccurrence. These government reports underscore the need for a paradigm shift in safety culture within healthcare teams and organisations, the role of teamwork, and active reporting. The USA, UK, World Health Organization and many developed countries including Australia and Denmark, have identified that priority needs to be given to improving patient safety and outcome (Britt et al., 1997; Department of Health, 2000, 2004; Thomsen et al., 2007; World Health Organisation, 2002).

Medication errors are one of the most common types of medical errors resulting in patient morbidity and mortality (Aronson, 2009b; Department of Health, 2008; Garfield et al., 2009; Vincent, 2010). Much of the research conducted on medication safety has focussed on the secondary care setting because of its associated high-risk procedures such as blood transfusion, surgery and the potential for hospital-acquired infections (Garfield et al., 2009). However, a few studies have indicated that patient safety incidents in hospitals take their roots from primary care management (Pirmohamed et al., 2004).

The medicines management process differs between secondary and primary care owing to variations in practitioner, patient and process features with implications for error potential. For example, in secondary care, there is close co-working amongst healthcare professionals – doctors, nurses, pharmacists – and medication administrations and reviews occur in collaboration. In primary care however, patients come into contact with these health care professionals at different times and places, and mostly self-administer their own medicines. Patients may frequent multiple pharmacies in primary care presenting challenges for medicines reconciliation (Gandhi et al., 2005). Medication monitoring in primary care is further complicated by relying on the patient to organise and book follow-up appointments (Gandhi et al., 2002). A World Health Organization (WHO) body, World Alliance for Patient Safety, concludes that inadequate or inappropriate communication and coordination are major priorities for patient safety research in developed countries (Kennedy et al., 2011).

Medication error studies evaluate whether a medicine is correctly handled within the medicines management system, which comprises of prescribing, transcribing, dispensing, administration and monitoring stages (Aronson, 2009b; Avery et al., 2002; Vincent, 2010). An Adverse Drug Event (ADE) is said to occur when patient harm is caused by the use of medication – a preventable ADE therefore may occur as a result of a medication error (Aronson, 2009a; Aronson, 2009b). The specific rates of medication errors (and preventable ADEs) are unknown; most errors in medication go unnoticed. Of those identified, few result in patient harm (Campbell & Cantrill, 2001). For instance, of a prescribing error rate of 1.5% detected in 36,200 medication orders in a UK hospital, *only* 0.4% orders contained a serious error (Dean et al., 2002). In a recent UK primary care study, 4.9% prescriptions contained a prescribing or monitoring error when the medical records of 1,200 patients from 15 general practices were reviewed (Avery, Barber, et al., 2012); of these, 1 in 550 (or 0.18%) of all prescriptions was judged to contain a severe error. In a UK study of 55 care homes, although 69.5% of all residents had one or more errors, the mean potential harm from errors in prescribing, monitoring, administration and dispensing were 2.6, 3.7, 2.1 and 2.0 (0 = no harm; 10 = death) respectively (Barber et al., 2009). These seemingly 'low' values of actual harm are better understood when interpreted in terms of the high volumes of prescriptions issued daily within any healthcare system. Even more so, associated patient morbidity and mortality is simply unquantifiable.

The preventable nature of medication errors, and the potential for re-occurrence are perhaps their most important characteristics. These attributes underpin medication safety concepts such as error reporting and learning, and the development and implementation of prevention strategies, as errors are often the results of the systems that produce them (Leape et al., 1995). A few studies have estimated the preventability of medication errors in primary care (Abramson, Bates, et al., 2011; Gandhi et al., 2003; Gurwitz et al., 2003; Kaushal et al., 2007; Knudsen et al., 2007a; Kuo et al., 2008; Lynskey et al., 2007; Martínez Sánchez & Campos, 2011; Miller et al., 2006). In the UK, approximately 5% admissions to secondary care have taken their roots from preventable drug-related problems at an estimated cost of over £750 million per year to the NHS (Department of Health, 2008). A healthcare system, with safety and quality at its heart, is therefore expected to capture errors, and most importantly, prevent re-occurrence.

System thinking has underpinned successful investigations into sub-optimal patient care – the events of the Bristol Royal Infirmary in the UK sparked an investigation, which focussed on

evaluations of the system rather than the events in isolation (Vincent, 2010). Most error studies focus on individual points within the medicines management system, instead of adopting critical and holistic evaluations of the whole system of the use of medicines (Garfield et al., 2009). Similarly, interventions have often concentrated on improving individual parts of the system. For instance, automation in hospital pharmacies has aimed at improving the dispensing process (Dean Franklin et al., 2008), – even though other parts of the system may also benefit from some form of automation . This individualistic approach fails to recognise that errors are indeed the results of the systems that produce them and does not provide information on the relationship between the units that make up the system (Leape et al., 1995; Reason, 2000).

To date, there have been few systematic reviews to appraise the safety of the entire medication use system in primary care across healthcare systems.

4.3 Aim and objectives of review

This paper reviewed the existing literature on the incidence of medication errors in primary care across the entire medicines management system. The objectives were:

1. To appraise studies addressing medication error rates in primary care
    a. To report error rates at each point of the system
    b. To appraise the methods used to identify errors in the studies
    c. To identify of the most susceptible points and patient groups

2. To identify studies on interventions to prevent medication errors in primary care.

4.4 Methods

4.4.1 Data sources

Electronic databases of MEDLINE, International Pharmaceutical Abstracts (IPA), Embase, PsycINFO, PASCAL (searched together on Wolters Kluwer/OVID SP platform in the British Library, BL), Science Direct, Scopus, Web of Knowledge and CINAHL PLUS were searched. The choice of databases was based on the BL resources in Medicine and Healthcare, University of Hertfordshire Medicines-related database recommendations, and relevant publications. Reference lists of retrieved articles and relevant review articles were checked manually for further relevant studies.

4.4.2 Search terms and strategy

An initial scoping review retrieved 2,530 hits after removal of 450 duplicates. Following screening of the first 350, over 200 articles were secondary care-related studies; subsequently, a revised search strategy excluded secondary care terms. Furthermore, the term "adverse drug event" was used as a medication error search term. This returned over 10,000 additional results. The first 300 articles were related to the harm due to drug use. However, this review aimed to identify failures in the medication use process in order to provide an overview of the overall reliability, efficiency and safety.

The search strategy, tailored for each database, therefore included two concepts, medication error and primary care, and excluded a third, secondary care (see Table 3). "Medication error" was used as MeSH term and keyword. A hand search of key journals, which included

International Journal of Pharmacy Practice (IJPP), Quality and Safety in Healthcare, and Pharmacy World and Science, was also performed.

4.4.3 Selection criteria

Studies conducted in any country between January 1999 and November 2012 and reported in English, were included. Studies, which reported the frequency of errors in the medicines management process, and interventions to prevent errors, were included. All definitions of error such as inappropriate prescribing, prescribing-, dispensing-, administration- and monitoring- errors, irrational drug use, hazardous prescribing, drug interactions, were included. Studies estimating error rates of one medication or therapeutic group, and those that did not report the method used for collecting error data or evaluating interventions were excluded.

The first author (JGO) screened all titles and abstracts to determine whether the article met the inclusion criteria and should be retrieved. Another reviewer (MG) screened a random 5% sample to check the reliability of the screening. JGO then read and extracted data from the articles included in this review.

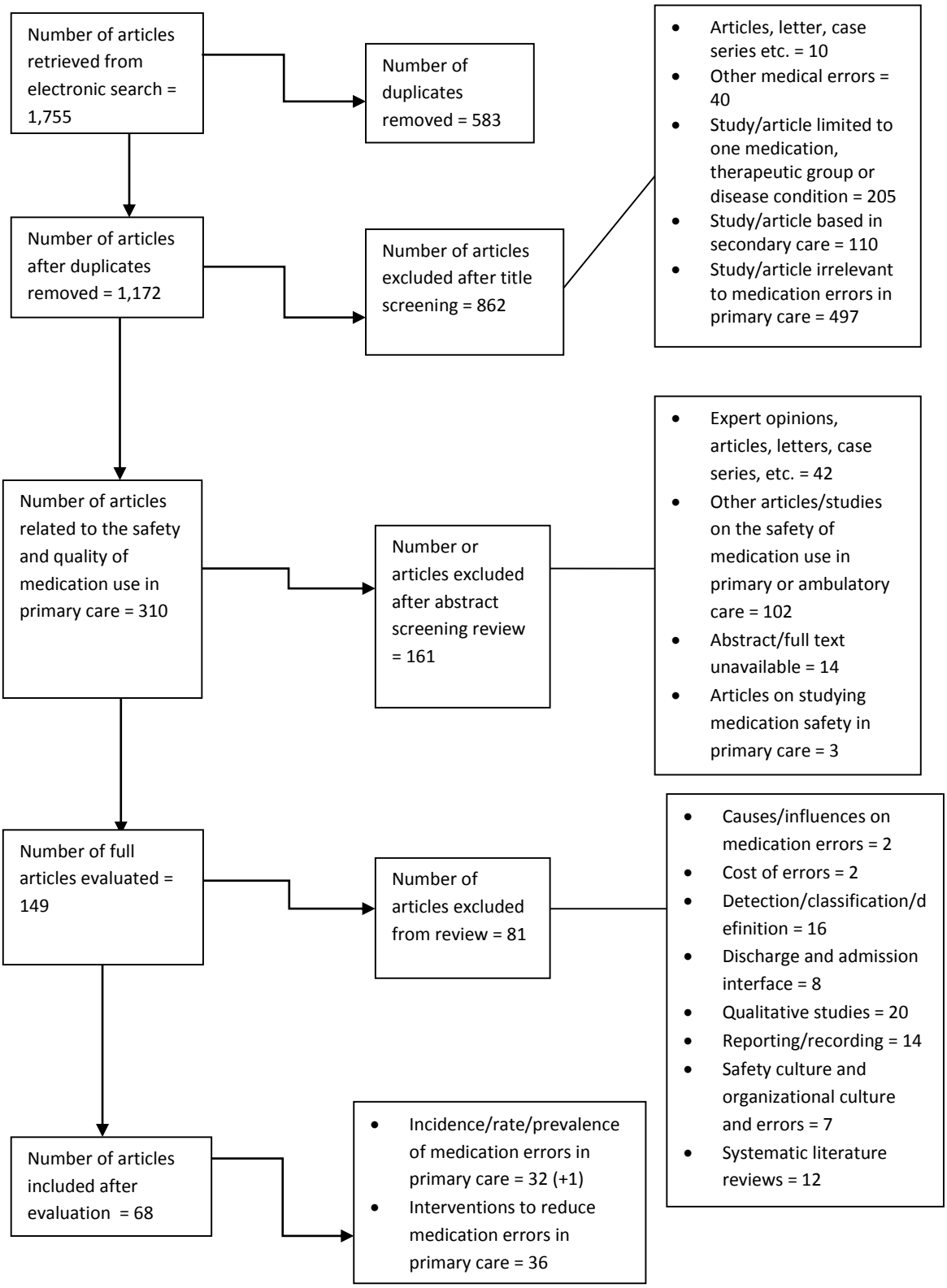
4.4.4 Process of data extraction

Search results were exported to Endnote X5 (Thomson Reuters). Duplicates were removed. Article titles and abstracts were initially reviewed for relevance followed by actual article review to clarify any ambiguities. Information from incidence studies was extracted onto a pro-forma showing primary author, year of publication, study design and setting, sample size, error type, error definitions and reported error rates (Appendix 20). Intervention studies were grouped into broad categories (Table 4).

Table 3: Search terms

Medication error terms		Primary healthcare terms		Secondary care-terms
Medication error, prescribing error, dispensing error, medication administration error, transcription error, drug error, drug mishap, medication mistake, medication mishap, dispensing mistake, prescribing mistake, wrong drug, wrong dose, incorrect drug, incorrect dose, drug death.	And	Primary care, primary healthcare, general practice, family practice, patient admission, patient discharge, continuity of patient care, doctors' office, ambulatory care, surgery.	Not	Secondary care, secondary healthcare, inpatient, hospital, ward, emergency department.

Figure 4: Flow chart of titles screening



4.5 Results

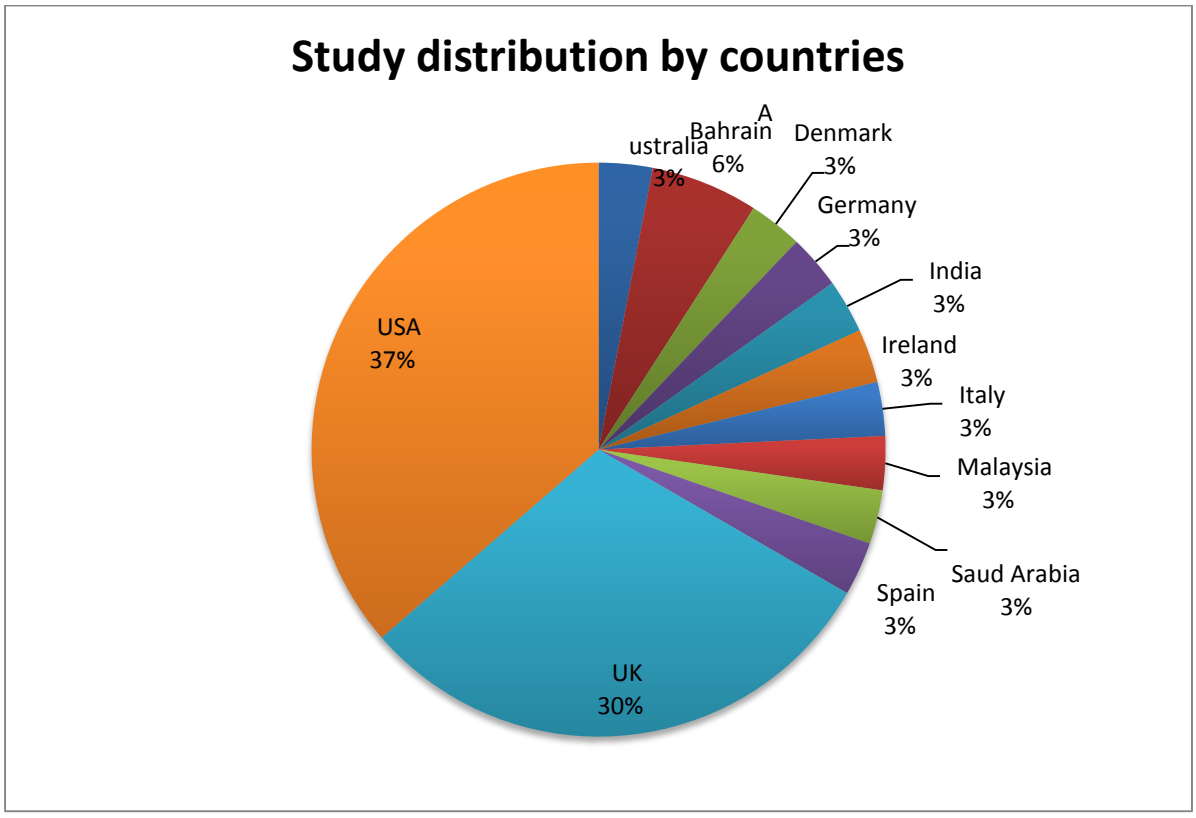
The output of the search process is shown in Figure 3. Thirty-two studies, which estimated the incidence of medication errors in primary care were identified; a manual search retrieved one additional study (Avery, Barber, et al., 2012). Thus, thirty-three studies were identified and reviewed.

Summary of studies reviewed on the incidence of medication errors in primary care is shown in Appendix 20.

4.5.1 Incidence of medication errors in primary care

Of the studies reviewed, twelve were conducted in the USA, ten in the UK, two in Bahrain, one each in Malaysia, Italy, Germany, Saudi Arabia, Denmark, Spain, India, Australia and Ireland between 1995 and 2013, and published between 1999 and 2012. Prescribing error rates were comparable across countries in some instances – Bahrain – 7.7% prescriptions (Al Khaja et al., 2005); UK 7.5% & 5% prescriptions (Avery, Barber, et al., 2012; Shah et al., 2001); USA 7.6% &11% prescriptions (Gandhi et al., 2005; Nanji et al., 2011); India 6.1% items (Marwaha et al., 2010) and Ireland 6.2% prescriptions (Sayers et al., 2009).

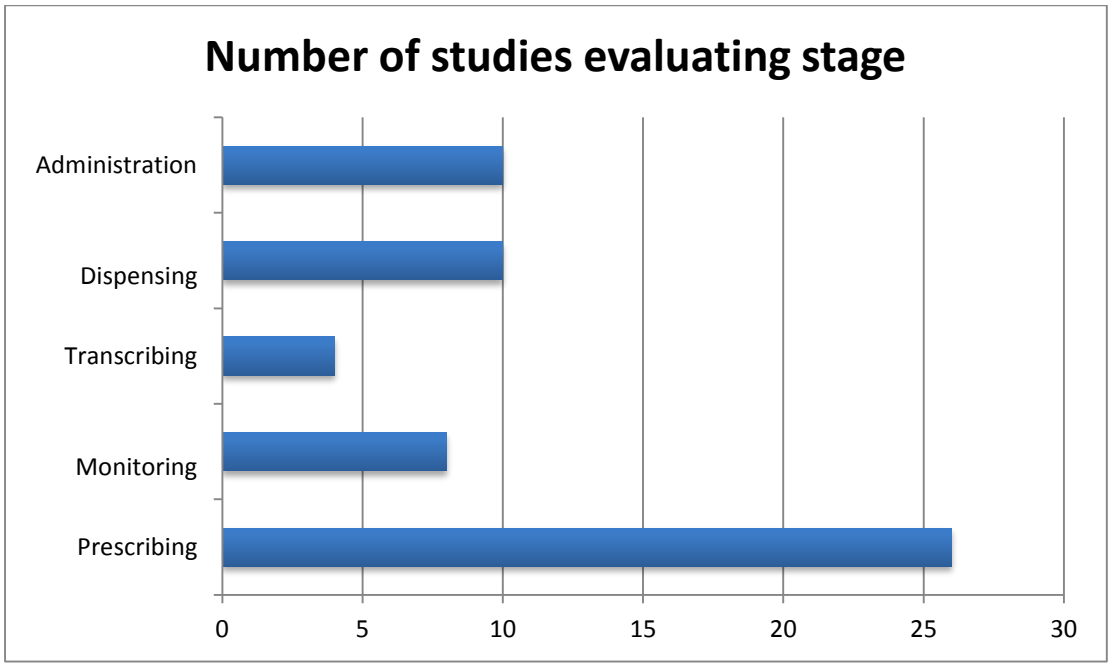
Figure 5: Country distribution of studies



Of the studies reviewed, nine were conducted in primary care centres (general practices). Ten of the studies were conducted in the community pharmacy setting, ranging from one to 1,146 pharmacies (Al Khaja et al., 2007; Ashcroft, Quinlan, et al., 2005; Chua et al., 2003; Dean Franklin & O'Grady, 2007; Flynn et al., 2009; Hämmerlein et al., 2007; Knudsen et al., 2007a; Lynskey et al., 2007; Martínez Sánchez & Campos, 2011; Warholak & Rupp, 2009). Two studies were conducted in care facilities – aged care (Carruthers et al., 2008), and nursing or residential homes (Barber et al., 2009). Two studies each estimated medication error rates in elderly patients (Carruthers et al., 2008; Gurwitz et al., 2003) and paediatrics (Al Khaja et al., 2007; Kaushal et al., 2010). One study was conducted in the primary care setting of a university (Dhabali et al., 2011).

The parts of the medication management system studied were sometimes apparent from the article title, aims or objectives; other times, they were inferred from the methods reported or the results presented. The part of the medication system studied comprised the prescribing stage (26 studies) (Abramson, Bates, et al., 2011; Al Khaja et al., 2007; Al Khaja et al., 2005; Avery, Barber, et al., 2012; Barber et al., 2009; Chen, Avery, et al., 2005; Dhabali et al., 2011; Gagne et al., 2008; Gandhi et al., 2003; Gandhi et al., 2005; Gurwitz et al., 2003; Hämmerlein et al., 2007; Kaushal et al., 2010; Kaushal et al., 2007; Khoja et al., 2011; Knudsen et al., 2007a; Kuo et al., 2008; Lasser et al., 2006; Lynskey et al., 2007; Martínez Sánchez & Campos, 2011; Marwaha et al., 2010; Nanji et al., 2011; Runciman et al., 2003; Sayers et al., 2009; Shah et al., 2001; Warholak & Rupp, 2009), transcription (4 studies) (Dean Franklin & O'Grady, 2007; Kaushal et al., 2010; Knudsen et al., 2007a; Martínez Sánchez & Campos, 2011), dispensing (10 studies) (Ashcroft, Quinlan, et al., 2005; Barber et al., 2009; Carruthers et al., 2008; Chua et al., 2003; Dean Franklin & O'Grady, 2007; Flynn et al., 2009; Hämmerlein et al., 2007; Knudsen et al., 2007a; Kuo et al., 2008; Lynskey et al., 2007), monitoring (8 studies) (Avery, Barber, et al., 2012; Barber et al., 2009; Gandhi et al., 2003; Gurwitz et al., 2003; Kaushal et al., 2010; Knudsen et al., 2007a; Kuo et al., 2008; Lasser et al., 2006) and administration(10 studies) (Barber et al., 2009; Field et al., 2007; Gandhi et al., 2003; Gurwitz et al., 2003; Hämmerlein et al., 2007; Kaushal et al., 2010; Kaushal et al., 2007; Kuo et al., 2008; Lynskey et al., 2007; Szczepura et al., 2011).

Figure 6: Number of studies at each stage of the medication management system in primary care



The studies used differing methods to collect error data. These methods were either retrospective or prospective and varied with the part of the medicines management system being studied:

Studies, which evaluated prescribing or monitoring errors, used one of these methods: patient clinical record reviews (Abramson, Bates, et al., 2011; Avery, Barber, et al., 2012; Barber et al., 2009; Chen, Avery, et al., 2005; Dhabali et al., 2011; Gandhi et al., 2003; Gandhi et al., 2005; Gurwitz et al., 2003; Kaushal et al., 2010; Khoja et al., 2011; Lasser et al., 2006), prescription audits (Abramson, Bates, et al., 2011; Al Khaja et al., 2007; Al Khaja et al., 2005; Gandhi et al., 2005; Hämmerlein et al., 2007; Kaushal et al., 2010; Khoja et al., 2011; Lynskey et al., 2007; Martínez Sánchez & Campos, 2011; Marwaha et al., 2010; Nanji et al., 2011; Sayers et al., 2009; Shah et al., 2001; Warholak & Rupp, 2009), incident reports reviews (Chua et al., 2003; Knudsen et al., 2007a; Kuo et al., 2008), patient surveys or interviews (Gandhi et al., 2003; Gandhi et al., 2005; Kaushal et al., 2010), and claims reviews (Gagne et al., 2008).

There were important variations even within methods; for instance, retrospective prescription reviews were conducted by reviewing patient medical records (Avery, Barber, et al., 2012),

through pharmacists' screening and intervention (Lynskey et al., 2007), or researchers' screening and/or observations (Abramson, Bates, et al., 2011; Al Khaja et al., 2007).

Dispensing errors were evaluated using one of these methods: direct observations of dispensing activities (Ashcroft, Quinlan, et al., 2005), retrospective examination of dispensed medicines (Barber et al., 2009; Carruthers et al., 2008; Dean Franklin & O'Grady, 2007; Flynn et al., 2009), incident reporting (Kuo et al., 2008), and review of self-reported incidents and 'near misses' (Chua et al., 2003; Hämmerlein et al., 2007; Knudsen et al., 2007a; Lynskey et al., 2007).

It was sometimes difficult to interpret the methods used to detect and evaluate administration errors; of those clearly stated, the methods used were direct observation (Barber et al., 2009), retrospective review of administration data (Kuo et al., 2008) or patient records (Field et al., 2007; Gurwitz et al., 2003), barcode systems (Szczepura et al., 2011), patient surveys and/or self-reports (Gandhi et al., 2003; Hämmerlein et al., 2007; Kaushal et al., 2010).

Three studies used more than one method to evaluate medication errors – in one study, prescriptions and clinical records were reviewed to evaluate prescribing errors (Abramson, Bates, et al., 2011); in another, patient surveys and medical record review were both used to study monitoring errors (Barber et al., 2009); and finally one study used, medical record reviews and healthcare professional interviews to detect and evaluate prescribing and monitoring errors (Avery, Barber, et al., 2012).

Of the studies reviewed, only a few studies stated the error definition used (Table 2). Two studies, which used the same definitions of prescribing and monitoring errors, had common authors (Avery, Barber, et al., 2012; Barber et al., 2009).

Varying denominators were used to calculate and determine error rates. As such, the units of expression varied between studies. Studies reviewed expressed error rates as: a percentage of – total prescriptions (Abramson, Bates, et al., 2011; Al Khaja et al., 2007; Al Khaja et al., 2005; Avery, Barber, et al., 2012; Flynn et al., 2009; Gandhi et al., 2005; Kaushal et al., 2010; Knudsen et al., 2007a; Martínez Sánchez & Campos, 2011; Nanji et al., 2011; Sayers et al., 2009), patients (Avery, Barber, et al., 2012; Carruthers et al., 2008; Dhabali et al., 2011;

Gandhi et al., 2003; Kaushal et al., 2010; Lasser et al., 2006), items/packs (Ashcroft, Quinlan, et al., 2005; Chua et al., 2003; Dean Franklin & O'Grady, 2007; Gagne et al., 2008; Khoja et al., 2011; Marwaha et al., 2010; Sayers et al., 2009; Shah et al., 2001; Szczepura et al., 2011), opportunities for errors (Barber et al., 2009), total errors (Kuo et al., 2008; Lynskey et al., 2007), and in patient/person years (Chen, Avery, et al., 2005; Gurwitz et al., 2003).

The highest error rates were recorded for the prescribing stage as follows: for paediatric patients – 90.5% of prescriptions (Bahrain) (Al Khaja et al., 2007) and 74% of prescriptions (USA) (Kaushal et al., 2010), for elderly patients – 8.3% of opportunities for error (Barber et al., 2009), and when all errors (including administrative errors such as illegibility with hand-written prescriptions) were recorded (Al Khaja et al., 2007).

The lowest error rates were recorded as follows: for incident report reviews – 23/10,000 prescriptions (prescribing error; Denmark) (Knudsen et al., 2007b), for dispensing error rates – 1.4/10,000 prescriptions (Denmark) (Knudsen et al., 2007b); 0.08% and 3.3% items and 3.99/10,000 items (UK) (Ashcroft, Quinlan, et al., 2005; Chua et al., 2003; Dean Franklin & O'Grady, 2007), and in studies, which focused on a specific prescribing category – 0.2% total items (Italy, interactions) (Gagne et al., 2008); 0.7% patients (USA, interactions) (Lasser et al., 2006).

4.5.2 Interventions to reduce medication errors in primary care

Thirty-six studies evaluating interventions to prevent errors in primary care were reviewed – computerisation including provider order entry systems (CPOE), electronic prescribing, clinical decision support/clinical alerts and electronic health records (Abramson, Barrón, et al., 2011; Berner et al., 2006; Boockvar et al., 2010; Devine et al., 2010; Gandhi et al., 2005; Gandhi et al., 2002; Hazlet et al., 2001; Humphries et al., 2007; Moniz et al., 2011; Nemeth & Wessell, 2010; Raebel et al., 2007; Sweidan et al., 2011; Tamblyn et al., 2008), personal digital assistants (PDAs) (Dallenbach et al., 2007), educational outreach and prescribing support (Ahmad et al., 2006; Avery, Rodgers, et al., 2012; Bregnhoj et al., 2009; Hume et al., 2011; Kennedy et al., 2011; Lafata et al., 2007; Lopez-Picazo et al., 2011; Nemeth &

Wessell, 2010; Stefanovic & Jankovic, 2011), formularies (Ahmad et al., 2006; Avery, Rodgers, et al., 2012), pharmacist-led interventions (Avery, Rodgers, et al., 2012; Booij et al., 2003; Braund et al., 2010; Buurma et al., 2004; Raebel et al., 2007), barcode systems (Wild et al., 2011), medication reconciliation and patient engagement (Bernstein et al., 2007; Boockvar et al., 2006; Lemer et al., 2009; Varkey et al., 2007), quality management strategies (Singh et al., 2012) (Table 4)

Previous systematic reviews and meta-analysis of interventions to prevent medication errors in primary care in the existing literature have demonstrated a weakness in the evidence of effectiveness interventions (Bayoumi et al., 2009; Eslami et al., 2007; Fischer et al., 2010; Royal et al., 2006). Most interventions have been individually implemented and evaluated.

Table 4: Interventions to reduce medication errors in primary care

Interventions	References[1]
Computerization/electronic interventions:	
• **Computerized physician/provider order entry (with or without clinical decision support, CDS e.g. monitoring alerts)**	Gandhi et al, 2005; 2002(Gandhi et al., 2005; Gandhi et al., 2002); Devine et al, 2010(Devine et al., 2010); Palen et al, 2006(Palen et al., 2006); Tamblyn et al, 2008(Tamblyn et al., 2008)[2], Gandhi et al, 2005
• **Electronic Health Record (EHR), electronic prescribing, and electronic transfer of prescriptions**	Abramson et al, 2011(Abramson, Barrón, et al., 2011); Devine et al, 2010 (Devine et al., 2010); Boockvar et al, 2010(Boockvar et al., 2010); Moniz et al, 2011(Moniz et al., 2011); Nemeth et al, 2010(Nemeth & Wessell, 2010)
• **Personal digital assistance with clinical decision support**	Berner et al, 2006(Berner et al., 2006); Dallenbach et al, 2007(Dallenbach et al., 2007)
• **EHR with weight-based prescribing (CDS)**	Ginzburg et al, 2009 (Ginzburg et al., 2009)
• **CPOE with retrospective medication profiling**	Glassman et al, 2007 (Glassman et al., 2007)[3]
• **Community pharmacy Patient Medication Record (PMR) with drug interaction software/other alerts**	Hazlet et al, 2001 (Hazlet et al., 2001); Humphries et al, 2007(Humphries et al., 2007); Raebel et al, 2007 (Raebel et al., 2007)
• **Authentication at the point of dispensing (stand-alone, PMR-linked and electronic transfer of prescriptions (ETP)-linked)**	Franklin and O'Grady, 2007(Dean Franklin & O'Grady, 2007)
• **Pharmacy computer system with dispensing support (medication alert/verification)**	Norden-Hagg et al, 2010 (Norden-Hagg et al., 2010); Raebel et al, 2007 (Raebel et al., 2007)
• **Computer-assisted feedback between**	Avery et al, 2012 (Avery, Rodgers, et al.,

[1] Studies demonstrating marginal impact (see footnotes 3 and 4 below) were included to reinforce the need for optimisation of interventions

[2] There was a significant reduction in therapeutic duplication problems in the computer-triggered group (odds ratio 0.55; p = 0.02) and no effect on prevalence of prescribing problems at follow-up.

[3] Marginal improvements in ADE preventability was reported (16% in the Usual Care group and 17% in the Provider Feedback group had an associated warning; 95% CI for the difference, -7 to 5%; p = 0.79)

Interventions	References[1]
healthcare professionals	2012)
• **Pharmacy system improvement strategies**	
Educational support, prescribing support and management:	
• **Academic detailing and educational outreach, Pharmacological profiling of patients, use of formulary/drug lists**	Ahmad et al, 2006 (Ahmad et al., 2006); Avery et al, 2012 (Avery, Barber, et al., 2012); Bregnhoj et al, 2009 (Bregnhoj et al., 2009); Lafata et al, 2007 (Lafata et al., 2007); Lopez-Picaso et al, 2011 (Lopez-Picazo et al., 2011); Nemeth et al, 2010 (Nemeth & Wessell, 2010); Stefanovic et al, 2011 (Stefanovic & Jankovic, 2011)
Pharmacy or Pharmacist-led interventions	
• **Collaborations between pharmacists and prescribers (general practice)**	Avery et al, 2012 (Avery, Barber, et al., 2012); Braund et al, 2010 (Braund et al., 2010); Buurma et al, 2004 (Buurma et al., 2004); Humphries et al, 2007 (Humphries et al., 2007); Raebel et al, 2007(Raebel et al., 2007); Bregnhoj et al, 2009 (Bregnhoj et al., 2009)
• **Collaborations amongst healthcare providers (e.g. from other healthcare setting)**	Booij et al, 2003 (Booij et al., 2003)
• **Clinical Pharmacy Services**	Sorensen et al, 2009 (Sorensen & Bernard, 2009)
• **Pharmacy-led bar code medication administration systems**	Wild et al, 2009 (Wild et al., 2011)
Medication reconciliation: medication reviews and medication monitoring	Bernstein et al, 2007 (Bernstein et al., 2007); Varkey et al, 2007 (Varkey et al., 2007)
Quality management strategies	Singh et al, 2012 (Singh et al., 2012)

4.6 Discussion

This review of the literature demonstrated that safety and quality issues currently exist at each stage of the medication management system, the prescribing stage being the most susceptible point. There is some evidence that children and the elderly are the more susceptible patient groups. Error rates ranged between <1% and 90% depending on the error definition, methods used, and on the patient population being studied. Direct comparison across settings was difficult due to variation in methodology, definitions and units of measurements. However, when error rates were expressed with a common denominator, rates were comparable between countries. Collaborations between practice and research may provide cost-effective options to interventions to prevent errors and improve patient outcomes (Garfield et al., 2009).

This review has tried to present a holistic view of the safety of the medication use pathway in primary care across different healthcare settings, and has evaluated a broad range of error types. By doing so, the susceptible points in the medicines use process, and the most vulnerable patient populations were identified. The results are applicable across a range of healthcare settings, and provide opportunities for stakeholders to influence practice and policies in a strategic, scientific manner.

Most of the studies reviewed were actually conducted in community pharmacies, not within general practices (Al Khaja et al., 2007; Ashcroft, Quinlan, et al., 2005; Chua et al., 2003; Dean Franklin & O'Grady, 2007; Flynn et al., 2009; Hämmerlein et al., 2007; Knudsen et al., 2007a; Lynskey et al., 2007; Martínez Sánchez & Campos, 2011; Warholak & Rupp, 2009) following patients' receipt of their prescriptions from general practices – even though the studies are often described as "primary health centres", (Al Khaja et al., 2007; Al Khaja et al., 2005; Marwaha et al., 2010; Nanji et al., 2011; Sayers et al., 2009; Shah et al., 2001), they may be better described as community-based.

The number of sites and the duration of observation were highly variable; one study was actually done in one community pharmacy (Martínez Sánchez & Campos, 2011). The absolute number of patients and/or prescription items is of significance based on the opportunities for errors. Only two studies (Avery, Barber, et al., 2012; Dean Franklin & O'Grady, 2007) reported a systematic and scientific determination of sample size. The sampling period is also an important variable. Study periods need to consider the effect of seasonal variations on prescription volumes and types, and hence error rates. As such,

prescription reviews conducted over a one-week period as reported in some of the studies reviewed (Al Khaja et al., 2007; Al Khaja et al., 2005; Hämmerlein et al., 2007) are not necessarily representative of day-to-day practice.

Although some of the studies suggest that older and younger patients are more likely to experience a clinically significant medication error than the rest of the population (Avery, Barber, et al., 2012; Barber et al., 2009; Kaushal et al., 2007; Wong et al., 2004), only two studies each, focussed on elderly patients (Carruthers et al., 2008; Gurwitz et al., 2003) and children (Al Khaja et al., 2007; Kaushal et al., 2010). With an aging population, co-morbidities, polypharmacy (Dhabali et al., 2011), contact with multiple providers (Dhabali et al., 2011; Green et al., 2007), care transitions (Barber et al., 2009) are on the increase. The need for weight-based therapeutic interventions in children (Ghaleb et al., 2005; Wong et al., 2004) and lack of readily available proprietary medicines in strengths suitable for paediatric dosing often necessitating titration, have long influenced medication safety in the paediatric setting. Moreover, the elderly and children use primary healthcare more than the rest of the population with implications for medication safety in the face of the ever-pressured healthcare system. There is therefore an urgent need for more research into medication safety amongst these patient populations.

Previous researchers have identified the prescribing and administration stages as the most dangerous stages of the medicines management system (Avery et al., 2002). Twenty-six of the thirty-three studies reviewed evaluated the prescribing stage in keeping with this finding. There is some suggestion in the existing literature that errors occur when patients take their medicines, and that there is a need to prioritize processes at the patient end of the system for interventions (Garfield et al., 2009). This review showed that there is a shortage of studies at the 'patient end of the system,' because of the obvious difficulties. Nonetheless, there is substantial evidence in practice that many patients may not be using their medicines as directed resulting in therapeutic failure and hospital admissions (Alldred et al., 2011; Coleman et al., 2005; Howard et al., 2003). Research and practice must therefore overcome the challenges of evaluating medication administration quality and safety in primary care to improve patient health outcomes.

Although the use of varying error definitions by researchers in determining error rates has been previously identified (Alldred et al., 2008; Dean et al., 2000; Garfield et al., 2009; Lisby et al., 2010), this review has confirmed that this problem still exists. This is reflected in the

wide range (<1% - >90%) of error rates reported. Such variance in definitions and data capture could lead to erroneous evaluations of the system causes of error. Attempts to develop common definitions for practice and research have been made (Dean et al., 2000; Dean Franklin & O'Grady, 2007; Ghaleb et al., 2005), and although more studies and practice in secondary care are adopting the use of these definitions (Lewis et al., 2009), there is still significant variation among the studies reviewed. One study (Avery, Barber, et al., 2012) adapted a definition developed in secondary care for use in primary care but due to differences in the medication handling system between both settings, this approach may be burdensome, difficult to interpret, and result in loss of important data. There is a need for a primary care practitioner-led definition of a prescribing error, where the highest error rates are recorded.

This review has also demonstrated that error rates varied with the method of identification. For example, the highest error rate of 90.5% prescriptions (Al Khaja et al., 2007) was recorded in Bahrain following the audit of paper prescriptions issued for paediatric patients from 20 primary health care centres. Although all errors, including illegibility were captured, this figure excluded 'minor errors of omission'. When paper prescriptions were reviewed in a prospective cohort study in the US, 94% of all medication errors (74% prescriptions) recorded were at the prescribing or ordering stage (Kaushal et al., 2010). While it may be argued that systems, which produce minor errors like incomplete prescriptions are also able to produce major errors that lead to patient harm (Leape et al., 1995), defences within the system would intercept some 'minor' errors such as illegibility; for example, a clinical check on a prescription prior to dispensing by a pharmacist is a major "defence process". Conversely, in healthcare systems where pharmacists' roles are circumvented (such as in a dispensing practice) or otherwise undeveloped (as in most developing countries), there is a breakdown in this defence.

A high prescribing error rate of 8.3% opportunities for error or 39% of all patients was also recorded in a study of elderly patients in residential and care homes (Barber et al., 2009). The methods used to record medication errors were robust, comprising patient interviews, note reviews, practice observations and dispensed items examination. This was possible because all elements of the methods were applicable on the same sites. Incomparably with other studies, the dispensing error rate in this study was higher than both the prescribing and administration error rates reported in the same study. In the healthcare setting in this study, general practitioners and community pharmacists manage home patients' prescribing and

dispensing activities. These patients also have carers who provide their intermediate healthcare needs, including medication administration. The challenge with this arrangement is that vulnerable patients who need healthcare the most do not have ample opportunities to interact directly with their practitioners and pharmacists. The use of cassette type monitored dosage systems appear to be a practical solution for dispensing their medication but the study demonstrated that the incidence of dispensing errors is highest with this type of delivery system. Should nursing and residential homes be viewed and treated like subsets of secondary care? This is a policy issue that should be thoroughly evaluated.

The lowest error rates were from data captured from incident reports – prescribing error study in Denmark (23/10,000 prescriptions/0.23% prescriptions) (Knudsen et al., 2007b), and in a US study (Kuo et al., 2008). This is in keeping with the literature. Although incident reporting is very useful for organizational error learning, and provides valuable feedback to practitioners (Sarvadikar et al., 2010), research has shown that they can grossly underestimate error rates (Sarvadikar et al., 2010; Tam et al., 2008). In the study in Denmark, community pharmacists documented prescription errors they had intercepted. Although community pharmacists are a practical source of data, and perform important error interceptions (Brown et al., 2006; Teinilä et al., 2011), under-reporting remains a risk when pharmacy owners or managers collect study data themselves as evident in the lower rates reported in such studies (Ashcroft, Quinlan, et al., 2005; Chua et al., 2003; Hämmerlein et al., 2007; Knudsen et al., 2007a; Kuo et al., 2008; Lynskey et al., 2007; Martínez Sánchez & Campos, 2011; Warholak & Rupp, 2009). In addition, when error rates are determined solely by recording pharmacists' prescription interventions, the lack of access to patients' medical histories at the time of data collection may become a barrier to adequate evaluation of the safety and quality of prescribing.

Review of patient medical or clinical notes in general practices is perceived as a rigorous method for collecting prescribing error data (Tam et al., 2008). This is reflected in this review – studies, which included an element of case note reviews reported consistently higher rates of errors even across countries, when compared to the use of incident reports and review of pharmacists' interventions (Appendix 20). However, notable issues around patient confidentiality, informed consent, and ethical provisions preclude access to patient medical records and prolong study duration. The gold standard is the use of a mix of methods for data collection (Tam et al., 2008), as a study showed no overlap when five methods were used (Wetzels et al., 2008). Studies, which used a mix of methods to evaluate the safety and

quality of the medication system provided pertinent information such as, causes of prescribing errors, clinical significance of errors, patient harm, and resultant hospital admission(Avery, Barber, et al., 2012; Barber et al., 2009; Field et al., 2007; Kaushal et al., 2010).

Dispensing error rates were consistently low across countries. A UK study where researchers directly observed dispensed items found higher rates than those studies where incident reporting and review of 'near misses' were used, emphasising the issue of under-reporting. The additional checks incorporated in the dispensing process impact accuracy. On another hand, the potential for detecting dispensing errors by patients is low when compared to the detection of prescribing errors by pharmacists and other healthcare professionals.

It can be difficult to compare error rates when they are expressed in varying units: as percentage of – prescriptions or items (Abramson, Bates, et al., 2011; Al Khaja et al., 2007; Al Khaja et al., 2005; Avery, Barber, et al., 2012; Gandhi et al., 2005), packs/doses prescribed, dispensed or administered (Carruthers et al., 2008; Chua et al., 2003), multiples of items or packs (Ashcroft, Quinlan, et al., 2005; Gagne et al., 2008), opportunities for errors(Barber et al., 2009), total number of patients recruited to the study (Dhabali et al., 2011), and in patient or person years(Chen, Avery, et al., 2005; Gurwitz et al., 2003). The use of varying denominators can also lead to variation in reported percentages. Based on the large volumes of prescription items used in primary care, error rates expressed as a percentage of total prescriptions or items will make easier interpretation.

It is interesting to note that when comparable denominators (error expressed as a percentage of prescription items) were used, there is much consistency in prescribing error rates across countries – Bahrain – 7.7% (Al Khaja et al., 2005); UK 7.5% & 5% (Avery, Barber, et al., 2012; Shah et al., 2001); USA 7.6% &11% (Gandhi et al., 2005; Nanji et al., 2011); India 6.1% items (Marwaha et al., 2010) and Ireland 6.2% items (Sayers et al., 2009).

4.6.1 Optimising interventions to prevent medication errors in primary care

Error-prevention strategies help to improve patient health outcomes, and reduce healthcare costs associated with drug-related harm (Adubofour et al., 2004). During the last decade, strategies to prevent error occurrence have been directed at secondary care (Dean Franklin et al., 2008). Attention is now being paid to methods for improving medication safety in primary care (Table 2). Interventions have been mostly implemented to individual parts of the medicines management system, without important collaborations between research and practice. Implementing interventions in an isolated manner may provide minimal effects as observed in previous studies (Glassman et al., 2007; Tamblyn et al., 2008).

Healthcare is a complex system with an overarching aim of improving patient health outcomes. Isolated, spontaneous reactions to serious critical incidents without rigorous evaluations of the interactions between various units of the system only yield multiplicity of similar interventions with slight and ineffective modifications. Indeed, a systematic review and meta-analysis of interventions in primary care demonstrated the weakness of the evidence for effectiveness of interventions aimed at reducing hospital admissions or preventable drug related morbidity (Royal et al., 2006).

With an aging population, availability of innovative but more expensive therapeutic agents, and tight healthcare budgets, optimising existing interventions becomes necessary. In the recently published Pharmacist-led Information Technology Complex Intervention (PINCER) Study, simple feedback plus PINCER (an educational outreach and dedicated support) in general practice, patients in the intervention group were significantly less likely to have experienced a range of medication errors (Avery, Rodgers, et al., 2012). This intervention demonstrated the benefit of collaborative interventions to improve the safety of medication use in primary care, and ultimately improve patient health outcomes.

4.7 Conclusion

This review has provided an international perspective on the safety of medication use in primary care across the medication management system. Targeting the more susceptible population groups and the most dangerous aspects of the system may be more effective to error prevention in primary care. Collaborative implementation of existing interventions may offer time- and cost-effective options to improving medication safety and patients' health outcome in primary care.

4.8 Study limitations

One of the limitations of this review is the exclusion of the term "adverse drug event" from the medication error terms, which may have meant that relevant articles were not identified. Furthermore, previous research show that patient safety incidents in hospitals take their roots from primary care management – in the UK, 6.5% admissions to hospital were related to adverse drug reactions in a study of 18,820 patients that were admitted to hospital (Pirmohamed et al., 2004). Valuable insight may have been obtained from studying the admission-discharge interface. However, due to the varying nature of the primary-secondary care interface across countries, studies at the admission-discharge interface were not included. Lastly, studies included in this review were not of the same level of evidence; the aim was to provide an estimate of the incidence of medication errors in primary care. As such, limiting the studies to the same evidence levels would have precluded the international insight, which has been hopefully provided.

Chapter 5. Primary Care Trusts (PCTs) and Clinical Commissioning Groups (CCGs) systems for managing medication errors in primary care

5.0 Primary Care Trust (PCT) error management system (pre-CCG)

5.1 Introduction

Two of the principles the National Health Service (NHS) abides by are: to provide "*high quality care that is safe*," and through its use of research, to "*improve the current and future health and care of the population*," (NHS England, 2013). Therefore, medication safety has been at the forefront of an extensive volume of research for many years.

The National Patient Safety Agency (NPSA) defines a medication safety incident as "any unintended or unexpected incident, which could have or did lead to harm for one or more patients" (NPSA, 2011, www.nrls.npsa.nhs.uk/). These incidents may include adverse drug reactions, contraindications, side effects and errors. Of all these medicines-related problems, medication errors are incidents, which are normally under the control of the healthcare professional or patient, thus making them preventable (National Coordinating Council for Medication Error Reporting and Prevention, NCC MERP). The NCC MERP takes the stance that there is no acceptable incidence rate for medication errors and that the goal should be to continually improve healthcare systems so that medication errors are prevented (NCC MERP, 2002).

Medication errors can occur at various stages during the delivery of a medicine to the patient, namely prescribing, verifying and dispensing or administration. A general practitioner, community nurse, dentist, optometrist or pharmacist may carry out prescribing in primary care. In secondary care, specialist doctors such as dermatologists, gynaecologists, etc. usually carry out most prescribing.

Errors occurring at the prescribing stage include those referred to as 'knowledge based errors,' which are usually due to ignorance of the patient or ignorance of the medication (Ferner & Aronson, 2006). Ignorance of the patient may include unnoticed allergies or contraindication with underlying conditions. Although the majority of prescribing within the NHS is done electronically using software that highlight drug interactions, most of them do not have safety features such as contraindication alerts (Ferner, 2004). This demonstrates that though technology is becoming increasing beneficial in error prevention, prescribers still have much responsibility in detecting errors, which computer systems are not able to.

Verification and dispensing of prescriptions follow prescribing, and usually remains the remit of the pharmacist, though in some cases, particularly within secondary care, doctors and

nurses may dispense directly to patients thereby eliminating the pharmacist from the process. Either way, healthcare professionals with the responsibility for prescription verification and dispensing are required to reduce the incidence of drug-related morbidity to optimise patient outcomes through the identification, resolution, and prevention of drug therapy problems (Planas et al., 2005). Problems, which should ideally be detected at this stage, may include improper drug selection, sub-therapeutic dose, over-dose, drug interactions or drug use without corresponding indication (Strand et al., 1990).

Errors occurring at the administration stage would usually involve an inpatient healthcare setting, involving a healthcare professional administering a medicine, usually a nurse. Errors occurring at administration could result from an error earlier in the process, which may not have been detected at the verification stage. Errors at administration involving a patient alone would be regarded as a compliance issue, which will not be discussed, as this does not fall under the scope of this study.

All the above-mentioned medicines-related problems are considered preventable, and therefore labelled as "errors." Errors left unnoticed could lead to potential morbidity, leading to increased or prolonged hospital admissions. Winterstein et al (2002) found that 59% of drug-related admissions are preventable (Winterstein et al., 2002). Phillips et al (2001) found that of all errors reported onto an American database, 9.8% resulted in death (Phillips et al., 2001).

In order to reduce medication errors and in turn improve patient safety, lessons must be learnt (Kohn et al., 1999). The concept of learning from errors may be applied at different levels namely individual, team or departmental, and organizational levels – a trust, local health authority or the whole NHS (Dean, 2002). "An organisation with a memory" made recommendation to the government on how to ensure that the NHS learns from its experiences and reduces the risks associated with preventable harm (Department of Health, 2000). Albeit, error reporting and meaningful analysis precede any learning from errors at an organizational level (Dean, 2002). Schemes for multidisciplinary error reporting have been set up by many hospitals and healthcare organisations so that common errors can be identified, and necessary preventative actions taken; this concept of error identification, reporting and learning has been extended nationally through the development and activities of the National Patient Safety Agency, NPSA (Dean, 2002). The Department of Health (DH) has established the NPSA, who has created the National Reporting and Learning System

(NRLS). DH highlights the importance of 'learning from error and adverse events' through the NRLS:

"*The system will enable reporting from local to national level. It will introduce a new integrated approach to learning from medical error, adverse event and near misses, and it will capture adverse event information from a wide variety of sources. Local reporting of adverse events and action to reduce risk within the organisation concerned is essential. On a selected basis, reports to national level will enable service-wide action where patterns, clusters or trends reveal the scope to reduce risk or prevent recurrence for future patients in other parts of the country*," (Department of Health, 2000).

The NPSA has further created a guide called "Seven Steps to Patient Safety." The fourth step particularly promotes reporting in primary care.

Table 5: NPSA Seven Steps to Patient Safety (www.npsa.nrls.co.uk)

Step 1	**Build a safety culture** **Create a culture that is open and fair**
Step 2	**Lead and support your staff** Establish a clear and strong focus on patient safety throughout your organization
Step 3	**Integrate your risk management activity** Develop systems and processes to manage your risks and identify and assess things that could go wrong
Step 4	**Promote reporting** Ensure your staff can easily report incidents locally and nationally
Step 5	**Involve and communicate with patients and the public** Develop ways to communicate openly with and listen to patients
Step 6	**Learn and share safety lessons** Encourage staff to use root cause analysis to learn how and why incidents happen
Step 7	**Implement solutions to prevent harm** Embed lessons through changes to practice, processes or systems

In primary care, local health authorities, that is, the former Primary Care Trusts, PCTs (which have now migrated to the newly-formed Clinical Commissioning Groups (CCGs) provide clinical governance support including collating information on errors, reporting, and shared learning to general practices, community pharmacies, and other health organizations within their localities.

It can be observed that much effort has been put into developing these systems for improving patient safety. However, the NRLS is a voluntary tool; therefore it is up to the healthcare professionals and the public to make use of it to harness any benefit. In 2007, over 70,000

incidents were reported via the NRLS as follows: 76% from hospitals, 5% from community pharmacy, and 1% from general practices. These figures are in line with Sarvadikar et al's findings that pharmacists are more likely to report errors than doctors (Sarvadikar et al., 2010).

The high percentage of reports carried out in hospitals may mostly be due to reporting done by nurses, as Evans et al found that nurses had a greater awareness of, and used the incident reporting systems than doctors (Evans et al., 2006). Evans et al further showed that barriers to doctors completing incident forms included such forms taking too long to complete or the belief that incidents were trivial. Other studies have shown that while the medical culture has emphasised privacy, professional autonomy and self-regulation, nurses were more likely to be governed by the need to follow protocol and the notion of having to 'cover themselves,' (Kingston et al., 2004).

The afore-mentioned studies may suggest why such little reporting is done in primary care. Patient safety and medication safety in primary care is extremely important, as primary care is the first port of call for patients. The majority of patients come in contact with primary care before referral to a secondary care setting, and will often return to primary care for continued care. To contextualise the relative importance of primary care, the NPSA estimates that 1 million people see a family doctor, 1.5 million prescriptions are dispensed, and community or district nurses make up to 100,000 visits each day (National Patient Safety Agency, 2006). Most patients' healthcare needs are not in secondary care but in primary care, where patients generally visit more than one site. Healthcare professionals working in primary care also tend to have less specialised knowledge and therefore may have lesser control over adequate medicines management. This is especially important with high-risk medicines that need regular monitoring such as Warfarin or Methotrexate.

Researchers have investigated why primary care healthcare professionals are less likely o report incidents (Ashcroft et al., 2006; Fernald et al., 2004). One of the related concepts used to explain non-reporting of errors is 'safety culture.' Safety culture of an organisation is the "ability of individuals or organisations to deal with risks and hazards, so as to avoid damage or losses and yet achieve their goals," (Reason, 2000). Safety culture has been an increasingly important concept in tackling medication errors, as errors, rather than being seen as personal failures, need to be opportunities to improve the system of medication use and prevent patient morbidity and mortality. The NHS and NPSA are working to develop a truly 'open and fair

culture' and a no-blame attitude towards reporting. This is however not as straightforward as it appears from the recent discussions on decriminalisation of dispensing errors.

There is some contradicting evidence on the safety culture within primary care. Ashcroft et al (2005) found in their study, that the majority of community pharmacists may be categorised as 'pathological,' which corresponds to level one, the 'least desirable' of the five levels of organisational safety culture outlined by Parker and Hudson (2001) as cited in (Ashcroft, Morecroft, et al., 2005). On another hand, other researchers observed that Primary Care Trust (PCT) staff judged the safety culture within primary care organisations within their remit to be between the 'reactive and calculative,' which correspond to levels 2 and 3 of Parker and Hudson's organisational safety culture (Kirk et al., 2007) – PCTs were the commissioning bodies at the time of the study. It is ironic that only 6% of all errors reported to the NRLS in 2007 were from general practitioners and pharmacists. Is it possible that governing bodies may believe things are better than they are within their wards?

The Health and Social Care Act of 2012 saw abolition of PCTs and Strategic Health Authorities to form Clinical Commissioning Groups (CCGs). In England, 212 CCGs were formed, each made up of several general practitioners, a registered nurse, a specialist secondary care doctor, a senior pharmacist, and other allied healthcare professionals. Under the Health and Social Care Act 2012 and the NHS Act 2006, a CCG will retain legal responsibility for its functions. CCGs will also be subject to public law duties, which will mean that they have legal responsibilities for the functions they carry out. As such, CCGs will take some responsibility for issued, which may affect patient safety such as a GP not reporting an error.

The Health and Social Care Act, 2012 states that CCGs "must give advice and guidance…for the purposes of maintaining and improving the safety of services provided by the health service," (NHS Commissioning Board, 2013). This further shows that CCGs have a responsibility to guide the healthcare professionals within their groups on how to improve patient safety, for example, by recording and reporting medication errors to aid error learning (NHS Commissioning Board, 2013). CCGs do not only hold a legal responsibility to improve the quality of care, they are also expected to promote continuous education and training of healthcare practitioners and organisations (NHS Commissioning Board, 2013), which has the potential to impact safety culture and drive organisations towards a more mature culture, described by Parker and Hudson (2001) as cited in (Ashcroft, Morecroft, et al., 2005) as

"proactive' or 'generative.' It is therefore in order to surmise that CCGs have a role to play in the safety culture characteristics of their organisations, which improve error reporting and learning. Rather than assuming that incidents are not being reported solely as a result of the level of the organisations' safety culture, CCGs should be equally accountable. Such approach is already in use in Canada, where minimum standards require each pharmacy to have a process for documenting all suspected and known medication incidents, with local authorities further requiring quarterly review of incidents to assess trends (Boyle et al., 2014; Boyle et al., 2011).

It is against this background that PCTs and CCGs in England will be directly contacted with respect to their systems for managing medication errors in primary care to promote patient safety, in a before-and-after (CCG) study. The purpose will be to characterise existing systems for medication error identification, recording and reporting in primary care. The study will focus on incidents from general practices and community pharmacies in particular.

Boyle et al conducted a similar study in community pharmacies in Canada (Boyle et al., 2014). In their study Boyle et al analysed the perceived role of the pharmacy regulatory authority in enhancing and promoting quality-related event reporting through focus groups. The focus groups consisted of deputy registrars, practice managers and pharmacy inspectors. The researchers concluded on a consensus that the pharmacy regulatory body had a strong role in enhancing reporting of incidents, and that compliance with reporting was increased through the use of reporting standards. The study creates an ideal for governing bodies to actively support medication errors in primary care to enhance patient safety and ultimately the quality of care. However, pharmacy inspectors mentioned that community pharmacists 'did not know of the last time they made a mistake,' which highlights the issue of the many definitions of medication errors. Furthermore, the 'blame culture' was evidently prevalent as members of the focus group highlighted that pharmacists are afraid to report errors (even anonymously) due to the fear of consequences. The research gives valuable evidence that regulatory bodies have a huge role in influencing healthcare professionals to report medication errors. Although the pharmacy regulator is doing well in ensuring logbooks are kept, the system is still limited as there is no protocol in place to ensure incidents are learnt from. One inspector stated 'I don't have to look at the incidents themselves; I look and see that you're doing your job,' (Boyle et al., 2014). The ultimate aim of reporting is to ensure that lessons are learnt.

To date, the systems used by PCTs (now CCGs) to identify, collate, analyse, and share learning from errors in general, and prescribing and dispensing errors in particular, have not been studied nor described. In the face of a changing NHS however, an understanding of local arrangements for error management and learning is pertinent to optimizing the system, and ultimately, improving patient health outcomes locally. The research questions, which arise from this background, are:

- What types of incidents do English PCTs and CCGs record as prescribing or dispensing errors?
- What systems exist for English PCTs and CCGs to identify errors in general practices and community pharmacies?
- What systems are used to report and manage error learning within English PCTs and CCGs?
- How do PCTs and CCGs support healthcare practitioners who have made an error, and what interventions have been implemented to prevent error occurrence?

Information will be collated from PCTs and CCGs using a survey, and the results will be used to describe similarities and differences between different wards. The survey will consist of closed questions in order to establish demographics and open-ended questions in order to allow respondents to give their own opinions and not limit the information they provide. Although this will not allow for statistical analyses of the results, it will provide rich and varied data, upon which conclusions may be drawn. This will hopefully help to highlight unclear areas with suggestions on how to improve the systems.

5.2 Aim and objectives

The aim of this study was to investigate and describe the existing systems, processes and procedures used by Primary Care Trusts (PCTs) and now, Clinical Commissioning Groups (CCGs) to collate reports on medication errors from general practices and community pharmacies.

The objectives were

1. To describe the categories of incidents collated as prescribing and dispensing errors

2. To get an insight into the processes of identifying, reporting and reviewing prescribing and dispensing errors
3. To understand the responsibilities for managing errors at PCT and CCG levels
4. To make recommendations to improve the system of medication error management in primary care at PCT and CCG levels

5.3 Methods

5.3.1 Pre-CCG

A questionnaire was designed and piloted with seven health care professionals within the Department of Pharmacy, who have clinical governance-related roles in primary care organisations. The questionnaire covered five sections, which intended to extract certain information from the respondent to make inferences with respect to management of medication error learning in primary care organisations from the point of view of local authorities (see below).

The healthcare professionals found the questionnaire clear and easy to fill; the only amendment was to split the first question into two separate questions.

Question 1 originally stated:

"What types of incident(s) would you class as error(s) based upon your experience or reports from general practices (surgeries) and pharmacies?"

The feedback was that as prescribing and dispensing errors varied, questions about these incidents should be asked separately. As such, the question was split into two. Addresses of the PCTs were compiled from the Research and Development Forum and the NHS Choices Website. The final questionnaire, made up of eight questions was sent by post to the Heads of Medicines Management and Chief Pharmacists in the 146 PCTs in England between December 2012 and January 2013 (see below). The questionnaire was sent with a consent form and a pre-paid envelope. A reminder was sent to non-respondents within two to four weeks from the initial post. The reminders also had a fresh questionnaire and pre-paid envelope to facilitate ease of response. Data collection ceased after six weeks of sending the original questionnaire.

5.3.2 Post-CCG

An MPharm student sent the Post-CCG study as part of their final year research project.

Following the PCT or phase one study, it was deduced that there might have been some confusion regarding question 3. Question 3 originally stated:

"How are critical incidents (prescribing and dispensing errors) reported to your PCT?

a. Are general practices (surgeries) and community pharmacies instructed to submit their periodic critical incident reports OR

b. Do you ask them for periodic critical incident reports?

(Circle as appropriate, and add further comments below)."

The question was re-worded to make it easier to understand, and the change was validated with the supervisors.

The CCG survey was conducted in October 2013. A research-driven healthcare company (Merck Sharpe & Dohme, MSD) provided a list of CCG addresses. MSD had compiled the list for their use from the Health Research Authority. The list provided was compared to details on the NHS Choices Website to ensure correct addresses were provided. Although lists of 246 addresses were compiled, these only included 108 CCGs as some CCGs had more than one registered address. As it was not feasible to ascertain which site the participants were most likely to be located at, the questionnaire was sometimes sent to each known address for some CCGs.

From the experience of the pre-PCT survey, each CCG were also sent two questionnaires by post: one was addressed to the Head of Medicines Management (HOMM), and the other to the Chief Pharmacist (CP). In order to identify the recipient, each questionnaire was coded: each CCG had a unique number 1 to 108, with HOMM questionnaires coded A and CP, coded B. For example, the HOMM in the first CCG was coded 1A. The full list was stored in an Excel spreadsheet.

For both study phases, Microsoft Word was used to address each questionnaire using the Mail Merge tool. The Mail Merge tool was also used to produce address labels for each PCT and CCG, and for the return envelopes. Each process was repeated for the HOMM and the CP in all PCTs and CCGs. Each envelope consisted of a covering letter, a consent letter, a questionnaire, and a freepost envelope to return the questionnaire to the researcher. The covering letter included a description of the study. The consent letter outlined instructions and provided contact details of the researchers. The questionnaire began with five

demographic questions; this did not include the recipients' names to maintain confidentiality. The questionnaire included the following question:

- What types of incident(s) would you class as prescribing error(s) based upon your experience or reports from general practices (surgeries)?

- What types of incidents(s) would you class as dispensing error(s) based upon your experience or reports from community pharmacies?

- How are critical incidents (prescribing and dispensing errors) reported to your CCG –
    a. General practices (surgeries) and community pharmacies submit reports as and when incidents occur OR
    b. General practices (surgeries) and community pharmacies submit reports periodically OR
    c. Your CCG request reports periodically?
    (Circle as appropriate, and add further comments below)
- How often are critical incident data from general practices (surgeries) and community pharmacies collated by your CCG?
  (Please tick as appropriate)
  Monthly □ Quarterly □ Yearly □ Other (Specify) □

- Could you describe any processes or protocols currently **in use by general practices (surgeries) and community pharmacies** in your CCG to identify, record, and report medication error incidents to the CCG clinical governance or medicines management department?

- Does your clinical governance or medicines management department have any systems in place to review critical incidents?
  Yes □ No □
  If 'Yes', please describe the system briefly, adding how often this is done

- Do you collect information on medication **"near miss"** incidents from general practices and community pharmacies?
  Yes □ No □
  If 'Yes', how often? Please tick as appropriate:
  Monthly □ Quarterly □ Yearly □ Other (Specify) □
- What interventions have been implemented by your clinical governance/medicines management department to **prevent** occurrence of medication incidents in primary care organizations within your ward, notably in GP surgeries and community pharmacies?

In the first week of sending the questionnaires out, majority of respondents indicated that it was not the CCGs' responsibility to record or manage medication errors, and that it was in fact the NHS England (NHSE) Area Teams' responsibility. As a result of this, rather than

sending a reminder letter to CCG HOMMs and CPs as initially planned and done under phase 1 or Pre-CCG (PCT) study, the questionnaire was sent to each NHSE Area Teams.

The NHSE Area Teams' addresses were compiled from the website, www.england.nhs.uk. There are a total of 28 NHSE Area Teams across England, and each was sent a questionnaire addressed to the Medicines Management Department. These questionnaires were prepared in the same manner as those sent to PCTs and CCGs. Data collection ceased after five weeks from the initial post-CCG survey.

5.4 Analysis and validation

All responses were entered onto separate excel workbooks and/or sheets i.e. responses from PCTs, CCGs and NHSE Area Teams. Each question was assigned themes in order to allow inductive thematic analyses of responses.

The results were inductively analysed by collating and interacting with data to identify themes. The principal academic supervisor (MG) verified all questionnaires and data entry, and randomly selected 7 (≈ 25%) responses for separate analysis. There were no disagreements in the resulting themes.

5.5 Results

5.5.1 PCT phase (Pre-CCG)

Responses

Of the 146 PCTs contacted, 27 (response rate, 18.5%) completed and returned the questionnaire. The low response rate may be attributed to the imminent changes within the structure of the NHS at the time of the survey. The most relevant change was the abolition of PCTs with the formation of general practitioner-led CCGs on April 1st 2013; as such, many roles within local health authorities were changing. Also at the time, some PCTs were operating as clusters such that two or more PCTs had a joint Head and/or Department of Medicines Management. As such, the true response rate is not known.

All (10) the then Strategic Health Authorities (SHA) of the NHS were represented, with Yorkshire and The Humber having the highest response rate (18.5% of all responses). The "current role" as stated by respondents widely varied – eleven different titles were used, the most frequently occurring being Head, Medicines Management (33% responses). The average "number of years in role" of the respondents was 6.1, ranging from 6 months to 12 years. However, most respondents (81% responses) had held related roles for more than 5 years. Most respondents (85% responses) were aged over 40 years, with 48% of respondents being over 50 years.

Categories of incidents classed as prescribing or dispensing errors:

Twenty-three categories each of prescribing and dispensing errors were identified following analysis. The most frequently occurring categories included wrong drug, dose, patient, strength, direction, formulation and quantity for both prescribing and dispensing errors. The least frequently mentioned categories for prescribing errors included omission, duplication, reconciliation, prescribing outside local guidance/tariff, prescribing on repeats without checks and excessive prescribing, and for dispensing errors, dispensing without prescription, dispensing in the face of known allergies, and missing patient information leaflets (PIL).

Mode of receipt of critical incident data from general practices and community pharmacies by PCTs:

PCTs mostly received critical incident data from general practices and community pharmacies through spontaneous reports from third parties, and occasionally from general practices and community pharmacies on ad hoc bases. Such third parties included patients (often as complaints), hospitals (during admissions), other healthcare professionals (such as practice reporting a dispensing error), and through the NPSA database. Only three PCTs requested periodic incident reports from general practices and community pharmacies bi-monthly or quarterly. General practices and community pharmacies were also able to submit error reports anonymously in which case PCTs could not follow up. Organizations (community pharmacies in particular) are also able to report errors via their own reporting systems. Another commonly occurring theme was in relation to controlled drug (CD) error reporting – ten PCTs mentioned that as a legal requirement, it was mandatory to report all CD

errors unlike other incidents. In addition to CD errors, a few PCTs mentioned that all "serious incidents" such as "death", "press-relevant", "serious consequences", were to be reported by general practices and/or community pharmacies as soon as they are made aware of them. General practices are also able to report via DATIX®-web[4], which feeds directly to the National Report and Learning System (NRLS) of the NPSA. Prescribing incident information is also captured occasionally through ePACT[5] prescribing data under the Quality of Outcomes Framework (QoF).

Frequency of collation of critical incident data from general practices and community pharmacies by PCTs:

The themes in responses were: following spontaneous error reports from general practices and community pharmacies, from third parties, and via the NRLS, PCTs collate incident data from general practices and community pharmacies monthly (3 PCTs), quarterly (mostly CDs, 2 PCTs) and at least annually (3 PCTs). Others collate reports "as and when" i.e. following occurrence and on an ad hoc basis.

Existing protocols by PCTs for general practices and community pharmacies to manage critical incidents:

PCTs were also asked if they had any existing protocol for general practices and community pharmacies to identify, record and report critical incidents. The responses to this question were very varied. Only one PCT appended a full protocol to their response: following an error report, PCTs commonly request significant event analyses, SEA or internal event analysis, IEA, or root cause analysis, RCA for serious untoward incidents, SUI. Other responses include the use of standard operating procedures (SOPs) and practice prescribing policies for managing critical incidents. Other themes, which occurred in response to this question, included provision of many avenues to report serious incidents to PCT (telephone

[4] DATIX is the leading supplier of patient safety software for healthcare risk management, incident reporting software and adverse event reporting www.datix.co.uk

[5] ePACT is an application, which allows nominated users at PCT or Trust or National level to electronically access prescription data. It allows real time on-line analysis of the previous sixty months prescribing data held on the NHS Prescription Services Prescribing Database http://www.nhsbsa.nhs.uk/PrescriptionServices/3230.aspx

call, letter or email, use of online voluntary reporting, DATIX, NPSA, own system), contract monitoring, RCA, use of standard forms for reporting CD errors, the use of policy documents relating to error recording and reporting, use of prescribing protocols or algorithms, reporting systems in care homes, and learning from errors and prevention. Two PCTs reported they had no existing protocols.

Existing systems within PCT to review critical incident data:

While 3 PCTs (11%) answered no, most PCTs (92%) answered yes to having existing systems to review critical incident data within their medicines management departments. These include practice or pharmacy follow-up by medicines management to ensure corresponding action is taken, discussion of case summaries, SEA/RCA, interrogations of data captured, investigations of practices or pharmacies, facilitated discussions at prescribing lead meetings, dissemination of learning points with primary care providers, analysis of safety trends, and dedicating an incident team to work with and support pharmacies/practices.

Collation of "near miss" incidents from general practices and community pharmacies:

17 PCTs (17; 63%) did not collect "near miss" logs from general practices or community pharmacies. Of the 10 PCTs who collected "near miss" data, most of them did so at irregular intervals; three PCTs, however collated "near miss" data annually "as part of contract monitoring" procedures. One PCT, which collated "near miss" data, noted that "it is hard to define a near miss" in their response.

Existing PCT interventions to prevent medication incidents in general practices and community pharmacies:

Lastly, PCTs were asked about the interventions they have implemented to prevent occurrence of medication incidents within general practices and community pharmacies. One respondent mentioned that no interventions had been implemented "as far as they were aware". Two PCTs did not answer this question. Therefore, 24 PCTs (88%) mentioned one or more interventions; these included issuance of prescribing and dispensing policies and

updates, shared learning, development and dissemination of newsletters, raising awareness of common incidents via memos, letters, "learning from reporting" bulletins, annual safety audits of prescriptions of high risk drugs in practices, altering GP computer systems on security access and formulary, SOP, updates through ScriptSwitch, reviews of service level agreement, contract monitoring, reporting concerns to the General Pharmaceutical Council (GPhC), inspection visits, and contractual sanctions and warnings.

The most important data from the PCT study are summarised below

Questionnaire survey enquiries	**PCT responses (main themes)**
Mode of receipt of critical incident (CI) data by PCT from Primary Care Organisations, PCOs (general practices and community pharmacies)	**Most PCTs received information through spontaneous reports from general practice**
Frequency of collation of CI data from PCOs by PCT	Most PCTs collated or reviewed information on "as and when" bases.
Existing PCT protocols for PCOs to manage their CI data	Practices follow their own prescribing policies and practices may report via DATIX-Web
Existing PCT systems to review CI data from PCOs locally	Most PCTs agreed that they had systems in place. These comprised internal reviews of incident data, completion of Significant Event Analyses (SEA) and Root Cause Analyses (RCA) for Serious Untoward Incidents (SUI) by practices or pharmacies with support from PCT medicines management, PCT reviews and recommendations with action plansx
Collation of near miss incident reports from PCOs	PCTs did not often review near miss logs from PCOs
PCT interventions to prevent medication incidents in PCOs	Shared learning practices, periodic issue of newsletters highlighting trends in incidents, use of education memos such as "Learning from Reporting Bulletins," policy guidance development and reviews, review of service level agreements.

5.5.2 CCG phase (Post-CCG)

Response

Of the 108 CCGs contacted, 16 (response rate = 14.8%) responded.

Categories of incidents classed as prescribing or dispensing errors:

68.6% (n=11) of respondents mentioned that a prescribing error would have occurred if a 'wrong medication' or 'wrong dose' were prescribed. The respondents also judged that dispensing the wrong medication would be an error; however, only 6 respondents mentioned 'wrong dose' as a category of dispensing error.

43.8% of respondents mentioned that errors involving ignorance of a patient's history would result in a prescribing error; for example, where a prescriber issues a 'drug combination that harms a patient,' or a drug, to which a patient has known allergies. These errors were mostly considered to be an error from a prescriber as opposed to a dispenser, even if they were dispensed. Only one respondent thought that a dispensing error would have occurred if interacting drugs were dispensed against a doctor's prescription.

A large number of respondents suggested that dispensing errors were related to issues that do 'not match up with what was on a prescription.' These included labelling errors (n=8), wrong formulation (n=7), wrong quantity (n=6), and wrong strength (n=6). A lower percentage of respondents mentioned these types of incidents as prescribing errors; for example, 4 respondents mentioned that a prescribing error would be said to have occurred if the wrong formulation were prescribed; 3 respondents mentioned that wrong quantities and wrong strengths were considered prescribing errors.

Other incidents, which respondents considered would be categorised as prescribing errors were wrong brand, hospital consultants' letters not being acted upon, prescribing outside licensing recommendations without a 'good' reason, controlled drug writing errors, oversupply of prescription items. The only miscellaneous dispensing error mentioned by one recipient was 'providing incorrect advice,' which is assumed to mean oral advice as opposed to directions on a label. These are summarised in Figure 7 and Figure 8 below.

Figure 7: Incidents listed by respondents as prescribing errors

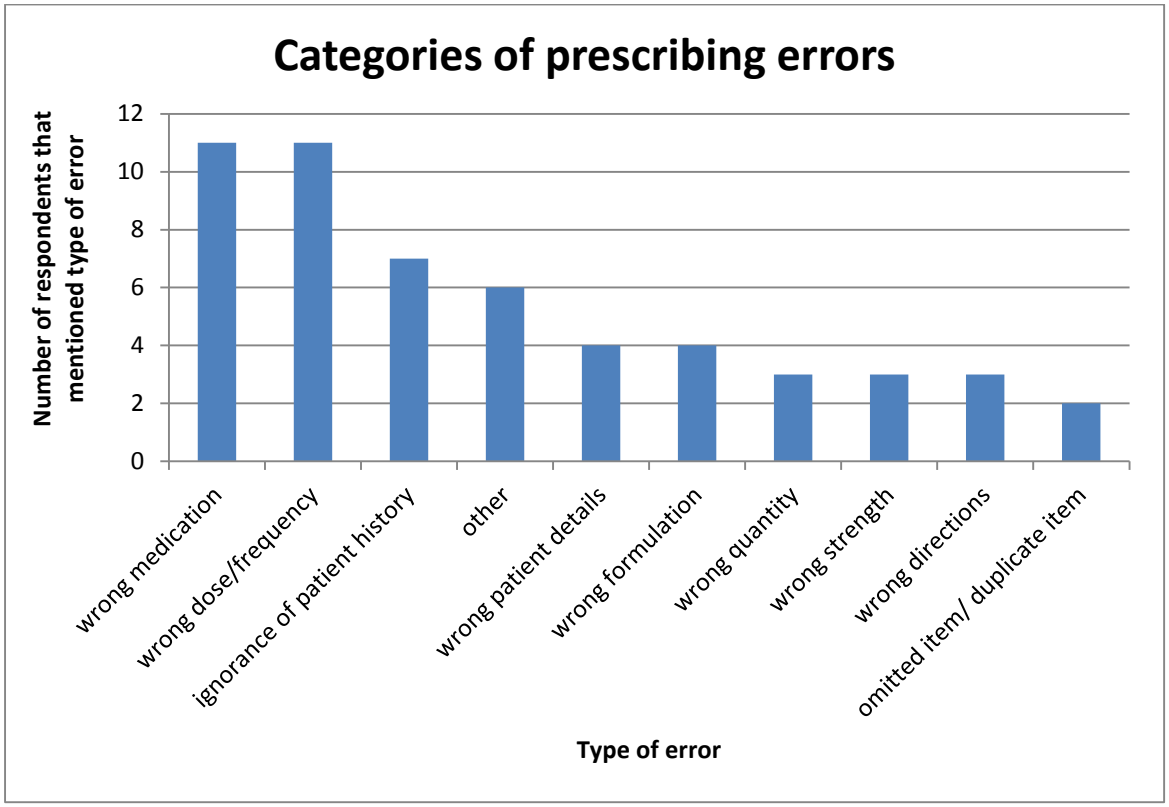
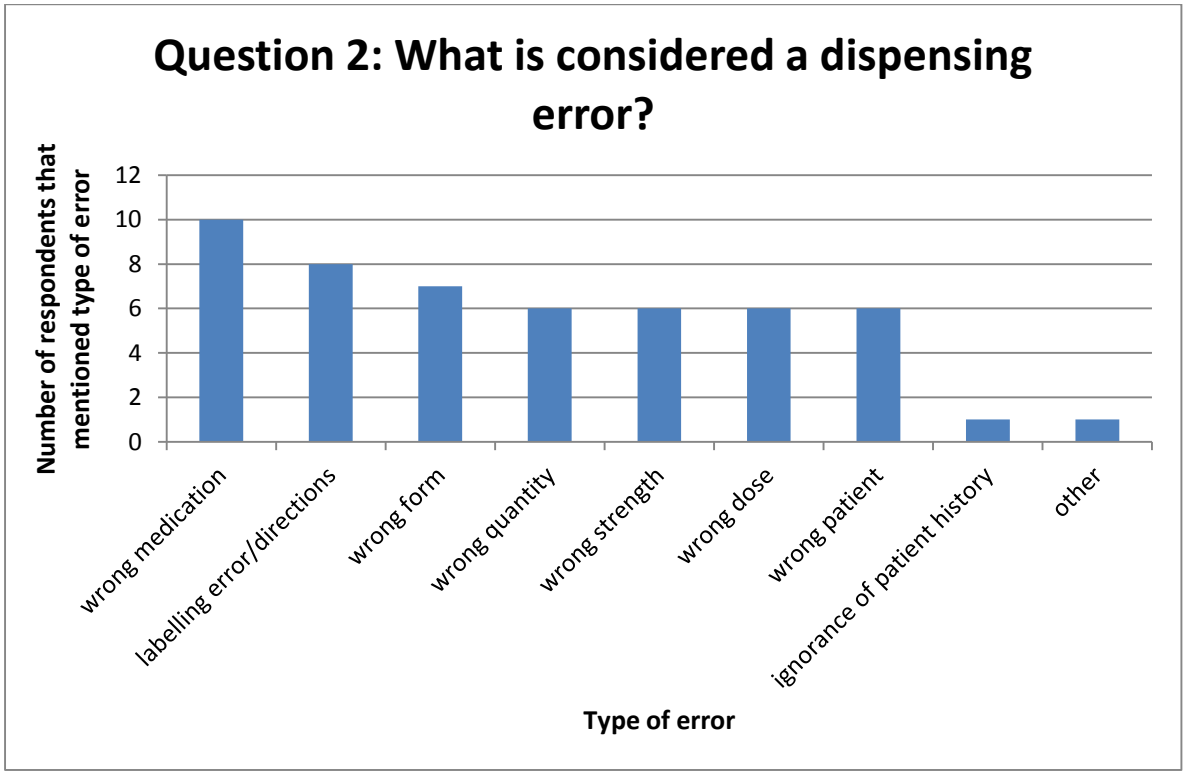


Figure 8: Incidents listed by respondents as dispensing errors



Mode of receipt of critical incident data from general practices and community pharmacies by CCGs:

This related to questions three and four: mode of receipt of critical incident data from general practices and community pharmacies by CCGs, and the frequency of collation of critical incident data from general practices and community pharmacies by CCGs. Of the 16 recipients, 62.5% (n=10) did not provide an answer to these questions. Some of the common responses to these questions were "currently, all GP and pharmacy incidents are reported to NHSE Area Teams," and "please note CCGs do not commission community pharmacy or GP practices since April 1st, so there is no obligation for errors to be reported to the CCG."

Frequency of collation of critical incident data from general practices and community pharmacies by CCGs:

6 respondents answered the two questions: four stated that incidents are reported to the CCG "as and when they occurred," though some of these CCGs deleted community pharmacies. Two CCGs mentioned that serious incidents should ideally be reported to them though the Area Teams were now directly responsible.

In response to question 4, which asked about the frequency of collation of critical incident data, 3 respondents mentioned that errors were collated monthly, and 1 respondent each mentioned that errors were collated quarterly, "when required," and "on an on-going basis through the use of DATIX system."

Existing protocols by CCGs for general practices and community pharmacies to manage critical incidents:

This section comprised of questions five and six: question five asked what CCGs protocols existed for general practices and community pharmacies to manage critical incidents, and question six asked if there were existing systems within the CCG to review critical incident data. Of the respondents, 7 mentioned the protocols used to record incidents as follows: standardised incident reporting forms, risk scoring forms, and DATIX (electronic incident reporting forms). 9 respondents did not mention any protocol, often leaving the question blank or stating "not applicable," or "this is NHSE's role."

9 of respondents stated that there was a system in place to review critical incidents. Some of the comments provided by respondents suggested that management of medication incidents was under the remit of the medicines management teams.

Collation of "near miss" incidents from general practices and community pharmacies:

Question 7 asked if information is collected with respect to near misses, and if so, how often. 18.8% (n=3) mentioned that information on 'near misses' was collected. The respondents mentioned that information on 'near misses' was collated via DATIX, self-reporting or complaints. 50% (n=8) mentioned that information was not collated about 'near misses.' One of the respondents added that Eclipse Live categorised potential errors according to their likelihood of harm. 31.3% (n=5) did not give any comment on the question but left it blank or stated that 'near misses' were reported to NHSE.

Existing CCG interventions to prevent medication incidents in general practices and community pharmacies

Newsletters were mostly mentioned as an intervention used to prevent reoccurrence of medication incidents. 37.5% (n=6) respondents stated that their CCG used newsletters and bulletins about potential incidents. 25% (n=4) respondents mentioned that medication incidents are routinely highlighted during training, while 12.5% (n=2) discussed them during forums. One CCG mentioned that incidents were addressed during monitoring visits to sites. 25% (n=4) respondents mentioned two tools used to prevent reoccurrence of medication errors namely 'Script Switch' and 'Eclipse Live.' 18.8% (n=3) respondents mentioned other methods, which included monitoring CD prescribing, querying large doses and quantities, and using 'prescribing incentive schemes,' which focus on safety in the use of Lithium and Methotrexate.

5.5.3 Results on survey sent to NHS England Area Teams (Post-CCG formation)

A further 28 surveys were sent to NHSE Area Teams across England. Two respondents returned their completed surveys (response rate = 7.1%). Their responses are discussed below.

Categories of incidents classed as prescribing or dispensing errors

Issues considered to be both prescribing and dispensing errors, by either one or both of the respondents, included wrong medication, wrong dose, wrong strength, wrong patient, wrong formulation, omission error and ignorance of patient history, [which may lead to contra-indication or interaction errors]. Issues highlighted as dispensing errors only include wrong quantity, labelling error, and "any aspect of pharmacy law and ethics." Complaints and near misses were also highlighted as possible prescribing errors.

How reporting takes place

Both respondents mentioned that errors reported "as and when they occur." A respondent further commented that "otherwise, how will they remember, and some have to be resolved immediately." One of the respondents mentioned that there is no scheduled collation of critical incident data, while the other stated that "CD occurrences are collated quarterly."

Protocols to manage errors

With respect to protocols used to identify, record, and report medication errors, one NHSE Area Team mentioned that each institution have their own system in place, and that all pharmacies and GP surgeries must report controlled drug errors to them. The other Area Team mentioned that institutions either use a template provided by them or in some cases, multiple pharmacy groups use their own processes. Both respondents stated that systems are in place to review critical incidents either on "an incident by incident basis," or "weekly patient safety meetings to review incidents across the Area Team."

Near misses

One NHSE Area Team stated that ‘near misses’ are not recorded, while the other mentioned that they collated via self-reporting or complaints. ‘Near misses’ were also mentioned as a type of prescribing error to question 1.

Prevention of reoccurrence of errors

One of the respondents did not answer the question relating to prevention of errors. The other respondent mentioned the use of newsletters, and action plans on designated forms. Also, the involvement of GPhC, Police, and “NHS protect,” were highlighted as part of the Area Team’s patient safety group.

5.6 Discussion

This survey provided the opportunity for the recently abolished PCTs and recently formed CCGs medicines management teams to characterise their existing systems for identification and management of medication incidents in primary care, particularly general practices and community pharmacies.

A survey was sent to 146 PCTs, with 27 responses (response rate=18.5%), 108 CCGs, with 16 responses (response rate=14.8%), and 28 NHS Area Teams, with 2 responses (response rate=7.2%). There are various theories as to why questionnaire surveys may achieve a low response rate; a few are discussed below.

The study design has a major impact on results achieved and conclusions made. The study had intended to send the survey electronically via email. To obtain the email addresses of the relevant person, phone calls were made to about 50 PCTs. However, it proved difficult and near impossible to obtain the email addresses of potential respondents. With increasing use of technologies and computers to conduct surveys, it is possible that some people were less keen to fill out and post a research questionnaire.

Another challenge, which was encountered, was identifying the most relevant person or role to address the questionnaire to. Although the questionnaire was initially designed with "clinical governance leads" as the potential respondents, following the telephone conversations to PCTs, it had become apparent that various titles were used for related roles. Since the survey was therefore invariably aimed at any member of the PCT or CCG dealing with medication incidents, it was difficult to ascertain exactly who should be completing the questionnaire. It was therefore decided to mail the questionnaire to the "Heads of Medicines Management" and "Chief Pharmacists" as these were the most relevant titles. This was a limitation as Dillman states as part of his 'Total Design Method' (TDM), that personalizing questionnaires achieves a higher response rate (Dillman, 1978; Hoddinott & Bass, 1986). This could be because the recipient was then less likely to assume someone else would take responsibility for it. In UK secondary care, medicines management personnel are readily 'visible,' and organizational structures are clearer. This is necessary in primary care to promote accountability. An important role like the Head of Medicines Management or the Clinical Governance Lead of a local health authority or commissioning groups should indeed be readily available on the PC/CCG or NHS website. This is even more relevant in the face of

changes in the NHS. Standardization of roles and titles across CCGs in England may promote this.

Questionnaires were sent to a subset of CCGs, which were conveniently chosen. This may have introduced some bias. Furthermore, the list of addresses was supplied by a research driven health care company, who may have only had CCGs they were interested in contacting on their mail list. The list may also have been compiled during the early stages of abolition of PCTs and formation of CCGs, which may have consisted of those CCGs, developed first. Nevertheless, the use of this mailing list was the most convenient option due to time constraints. The list contained approximately 51% of CCGs in England (108 of 211), which is a sufficient sample to obtain an overall idea of how CCGs dealt with medication incidents.

This was a cross-sectional study, as a portrait of one group's opinion at a particular time was required (Fink, 1995b) (pg. 3). The survey mostly required qualitative responses, and was self-administered. The fact that the survey was self-administered may have led to bias, as it is possible that only those interested in the topic may have been willing to complete it.

As the questionnaire was aimed at senior members of the PCT/CCG, it is possible that as busy individuals, they may not have had the time to complete it. Jenkins and Dillman surmise that self-administered questionnaires require cognition and motivation. Hence, the questionnaire included a covering letter as it was hoped that this would highlight the importance of the study, thereby persuading the respondents to take some time out of their busy schedule to complete and return it (Jenkins & Dillman, 1997).

The questionnaire consisted mostly of open-ended questions. These required respondents to use their own words. Open-ended questions are generally used when answers are unanticipated, and respondents are judged capable of voicing their own opinions in writing (Fink, 1995a) (pg. 32). The disadvantage of this is that the researcher is unable to rate or rank data, and statistical tests cannot be used to report on results. Interpreting answers may require elaborate coding systems, which may be complicated (Fink, 2006) (pg. 14).

The questionnaires covered 5 sections. The first section covered what incidents members of PCTs, CCGs and NHSE considered to be prescribing and dispensing errors. This question was asked due to existing ambiguities around the definitions of medication errors. Research and practice do not often clarify their working definitions on medical errors leading to assumptions and multiplicity of definitions (Sandars & Esmail, 2003). Sandars and Esmail found 16 different definitions of medication-related errors; some of these included incidents

that caused actual harm to the patient, incidents that could have potentially caused harm, adverse drug reactions, and not conforming to the British National Formulary. Other researchers have further highlighted this issue (Olaniyan et al., 2014). Although the various categories of incidents categorised as prescribing and dispensing errors by respondents were in keeping with the literature (Ashcroft, Quinlan, et al., 2005; Avery, Barber, et al., 2012; Dean Franklin & O'Grady, 2007; Spencer et al., 2011), it would appear that most PCTs did not have a validated reference source for categorizing errors as different descriptors were used for similar types or categories of errors. In addition, what appeared to be a "major" error category or "irritate" respondents were fairly varied; for example, the only category of prescribing error described by one respondent was "prescribing on repeats without appropriate checks", and another "wrong strength, commonly MST (morphine sulphate) 100mg instead of 10 mg, Oramorph® concentrated versus 10mg/5ml". It may therefore be concluded that healthcare professionals working within primary care do not have a working definition of what constitutes a prescribing error so that error management is somewhat subjective and dependent on the opinion of a person rather than an organisation.

It was further interesting to observe that during some respondents considered 'near misses' as a medication error. The NPSA's "Seven Steps to Patient Safety in Primary Care" stated that 'near misses' are under-reported, as healthcare professionals do not understand what they are. The NPSA has further recommended that the term 'near miss' should no longer be used, but should be replaced by the term 'patient safety incident (prevented).' NPSA further highlights that it is important that prevented or potential incidents are reported and analysed, as they are a good way to learn about which controls have worked and which need to be improved (National Patient Safety Agency, 2006). Figure 2 (Page 10) highlights the definition of a medication error that should be understood by healthcare professionals working for the NHS or alongside the NHS. The figure shows that medication-related incidents fall under two categories: those that are preventable and those that are not. Only those, which are preventable, are considered as errors. Also, medication errors do not necessarily have to cause harm to the patient and could be incidents, which may have potentially caused harm (Morimoto et al., 2004).

Another issue that was highlighted when analysing the first section on error categories was that there are differences between what is considered a prescribing error and a dispensing error. There are certain categories of errors, which may be common to both prescribing and dispensing namely issuing the wrong product, wrong dose, wrong strength, wrong

formulation, wrong quantity etc. However, results showed differences between those included as answers to questions one and two. This may not be because, for example, issuing the wrong product is considered as a only a prescribing error, but could possibly be due to respondents finding the task of writing the same answer twice repetitive and time consuming. This is evident as some respondents suggested referring to question one when they answered question two. This is further highlighted by up to a 6% reduction in error categories mentioned in question two compared to question one.

Respondents also suggested that errors that occurred as a result of ignorance of a patient's history, for example, allergies or contraindications, were errors of a prescriber rather than a dispenser. On the other hand, a dispensing error would generally occur when exactly what a prescriber intends is not supplied.

Another interesting error mentioned by a respondent was giving incorrect oral advice about a medication. According to the definitions highlighted in Figure 1, incorrect oral advice will count as an error, as it has the potential to cause harm to a patient. However, an incorrect advice is difficult to quantify or record. As there is rarely any written evidence to suggest incorrect advice was given, it is difficult to trace whether a patient's health outcome was compromised as a result of the incorrect advice. There is also the problem of inaccurate interpretation, as a healthcare professional may argue that patient's interpretation was inaccurate.

Section two (questions three and four) of the survey sought to understand how reporting took place within the PCT/CCG: how critical incidents were reported to the CCG, and how often the reports were reviewed. Respondents referred to the use of DATIX, ePACT (see above), and more recently, ScriptSwitch[6] and Eclipse Live[7] to capture medication incidents. These aid the prescriber's decisions on medication switches and dosage optimisation while identifying inappropriate prescribing and safer alternatives.

Most of respondents from CCGs did not think this was under their remit though, and often commented that this was now under the NHSE Area Team's administration. It was however

[6] ScriptSwitch is a prescribing decision support for healthcare professionals within the primary care sector. Although it's main aim to provide savings at the point of prescribing, it can provide patient safety effect by supporting clinicians to optimise prescribing and improve patient health outcomes (www.scriptswitch.com).

[7] Eclipse Live: Eclipse stands for Education & Cost-analysis Leading to Improved Prescribing Safety & Efficiency. Eclipse is a new service to optimise prescribing by using powerful computer technology to improve cost-effectiveness of prescribing and patient safety in primary care (www.eclipsesolutions.org).

interesting to observe some CCG's actually had their own protocol to capture medication errors. For example, one CCG stated, "critical incident data is reviewed by our GP governance lead," and "serious incident reporting policy in place and contains process to be followed." Such variations in responses may indicate some confusion at management level, which may compromise patient safety. If roles around managing the reporting and collation of medication incidents are unclear, it is possible to assume that errors may go unnoticed. In the National Patient Safety Agency (NPSA) document 'Seven Steps to Patient Safety,' step 4 relates to promoting reporting of incidents within the NHS. The NPSA recognizes that one of the key areas that the NHS needs to address is to successfully achieve a unified mechanism for reporting and analysing incidents when things go wrong. What is readily apparent from this study is the lack of such 'unified mechanisms,' particularly within local authorities or commissioning groups.

5.7 Conclusion

There appeared to be a consensus that the NHSE Area Teams have responsibility for capturing and managing the recording, reporting and review of medication errors. This led the research team to take the decision to send the intended reminder to the NHSE Area Teams as opposed to the CCG. Again, after contacting some Area Teams directly, it became apparent that the most relevant addressees would be members of the Medicines Management Department, to which the surveys were sent. It was therefore surprising that only 2 (7.1%) of 28 NHSE Area Teams completed the survey. Nevertheless, it is possible to conclude that responsibilities for managing medication errors in primary care laid with the now defunct PCTs, though processes were not necessarily standardised across PCTs at the time. Although CCGs have some responsibility to "*maintain and improve the safety of services provided by the health service*," it is the within the remit of the NHSE Area Teams to collate and review medication error reports to facilitate learning in primary healthcare organisations. Without clear guidelines as to who is responsible and accountability within CCGs however, there is potential that important lessons are not being learnt within primary care.

This is particularly important as the NHS has been put under the spotlight to get patient safety right in the wake of scandals such as the Mid Staffordshire Scandal (Holmes, 2013). Furthermore, the fourth report from the Patient Safety Observatory states that the annual cost

of avoidable harm to patients on the NHS is £774 million, £359 million of which are a result of avoidable admissions to hospital (National Patient Safety Agency, 2007).

5.8 Study limitations

The response rate is determined from the number of eligible respondents included in the study, as a percentage of the total eligible study population (Bowling, 2014). Over the past two decades, academic, policy and government survey researchers have found themselves competing with market researchers, leading to increased time pressures on people's daily lives (Bowling, 2014). Although there is no agreed standard for a minimum response rate, a response rate of 60% is generally acceptable (Groves and Couper, 1998) as cited in (Bowling, 2014). Response rate greater than 75% is considered good. Non-response can therefore affect the quality of research data and reduce the accuracy of results.

There is general consensus that response rates are higher for interviews than for postal or telephone surveys, with up to a 20% difference (Cartwright, 1988) as cited in (Bowling, 2014). Bowling (2014) has summarised some of the methods for increasing response. These include including a covering letter, use of an advance letter, provision incentives, use of postal reminders, impact of length of questionnaire and sponsorship, etc. Although the current study attempted to improve response rates by applying some of these principles, the study's response rate was still very low. The NHS primary care climate was less outlined as at the time of this survey due to the abolition of PCTs and creation of CCGs with uncertainties and handovers. It is therefore highly possible that this adversely impacted response rates.

Considering some of the recommendations by (Bowling, 2014; Dillman, 1978; Fink, 1995a), the survey may be improved to include closed questions. This would make the questionnaire easier to complete and allow statistical tests to be conducted thereby making conclusion valid. The use of closed questions will further improve the reliability of the instrument and enable to researcher to achieve similar results each time.

Chapter 6. The prevalence and nature of prescribing and monitoring errors in older patients and in children: introduction and study setting

6.0 Introduction

This chapter will explore the aim, methods, data validation, data cleansing and the characteristics of the GP settings where the studies were undertaken.

Chapter 7 will then describe the characteristics of older patients and prescriptions studies, and the results of the investigations on older patients

Chapter 8 will explore the paediatric data – characteristics and results of investigations. Chapter 8 will also provide the discussions on the findings of the investigations in older patients and children.

Medication errors are a common source of preventable harm (Department of Health, 2000). The National Patient Safety Agency (NPSA) reported that between April 2008 and March 2009, the most common incident type reported to the National Reporting and Learning Service (NRLS) from general practice were related to the use of medication at 24% (National Patient Safety Agency, 2009). Research has estimated that about 6.5% of hospital admissions take their root from management in primary care (Pirmohamed et al., 2004); for elderly patients however, the figure rises to 19% of hospital admissions as a result of medicines-related problem Cannon and Hughes, 1997 in (Barber et al., 2009).

The problem of medication errors has been studied; however, much of this work has been focused in secondary care, though most patients get treated in the community, with ≥ 1.03 billion items prescribed in 2013 compared to 649.7 million 2003 (Prescribing and Primary Care Health and Social Care Information Centre, 2014). Research is emerging on the prevalence and nature of medication errors in primary care (Avery, Barber, et al., 2012; Barber et al., 2009), with suggestions that older patients and children may be more susceptible to significant risk of harm from medication errors (Avery, Barber, et al., 2012; Barber et al., 2009; Garfield et al., 2009).

Older patients are more susceptible to risks of harm from medication errors and subsequent adverse drug events (ADE) due to co-morbidities and resultant polypharmacy, susceptibility to changes in pharmacodynamics and pharmacokinetics, possible renal and hepatic impairment, contact with various multi-disciplinary healthcare practitioners within and between visits, etc. For example, Barber et al (2009) found an error rate of 8.3% prescriptions or 69.5% of patients when they studied medication errors in older patients in care homes with a mean age of 85 years, while a GMC-commissioned study of medication errors in all

patients with a mean age of 39.3 years found an error rate of 4.9% prescriptions or 12% of patients (Avery, Barber, et al., 2012).

Evolution of newer drugs and therapeutic procedures, and increase in an aging population has posed even more challenges for the art of prescribing (Maxwell et al., 2002). In addition, some conditions, which were previously managed in secondary care, are increasingly being managed in primary care. These have meant an increase in the potential for errors in prescribing and primary care management. There has however, been no study to date in the UK to evaluate the incidence and nature of medication errors in older patients living in the community, though a higher number of older patients would normally live in the community.

The need for weight- or age- or surface area-related dosage determinations, titration of strengths of existing proprietary medicines to make them safe for use in children, unlicensed or off-label drug use, etc. may account for the inherent challenges and risk of harm from medication errors in children (Wong et al., 2004). The evidence suggesting higher prevalence of medication errors and corresponding harm in children is sparse, although some research suggest that errors and harm could be higher in children than in adults. For example, in a prospective cohort study of paediatrics patients in six outpatient offices, researchers found that 68% of patients (53% of prescriptions) contained an error with minimal potential for harm, and 26% of patients and (21% of prescriptions) had potentially harmful medication errors (i.e. near misses) (Kaushal et al., 2010). These rates were much higher than the 13.2% of medication orders, which contained prescribing error from an in-patient evaluation of paediatric medication errors in the UK (Ghaleb et al., 2010). There have also been no studies to evaluate the incidence and nature of prescribing and monitoring errors in children in the community in the UK.

6.1 Aim and objectives

Aim

To determine the prevalence and nature of prescribing and monitoring errors in older patients and children in general practice

Objectives

1. To investigate the rates and types of prescribing errors in older patients ≥65 years old and in children 0-12 years old
2. To investigate the rates and types of monitoring errors for prescribed medications, which require laboratory blood monitoring in older patients ≥65 years old and in children 0-12 years old
3. To determine the nature of prescribing and monitoring errors in older patients ≥65 years old and in children 0-12 years old
4. To explore if prevalence and nature of identified errors vary with characteristics of the general practice, of patients or of prescriptions:
    a. To identify drugs, which are most commonly associated with a prescribing or monitoring error
    b. To identify the British National Formulary, BNF sections most commonly associated with a prescribing error
    c. To investigate associations between error rates and age
    d. To investigate associations between error rates and prescription types
    e. To investigate associations between error rates and patients' sex
    f. To investigate associations between error rates and number of prescription items issued
5. To provide feedback to participating practices, with identification and recommendation of best practices and/or pragmatic educational interventions to prevent error occurrence in older patients and in children in general practice

Participants and methods

Data collection commenced in November 2013 and was completed in October 2014.

6.2 Recruitment of PCTs, CCGs, and general practices

The study approached all the general practices in Luton CCG through their Prescribing and Medicines Optimisation team, by sending out a letter of invitation to participate, and participant information sheets (see appendices). A reminder was sent two weeks after the initial invite. Due to very low response rates, the study purposively selected two practices, which then agreed to participate.

Based on the experience of recruitment from Luton, the study approached the Prescribing and Medicines Optimization team in Bedfordshire CCG to identify five practices, with different

deprivation levels, and a mix of suburban, rural and urban settings, from those of Luton. Two practices, with a larger list size and different levels of deprivation, than those of Luton CCG were then purposively selected from the initial list. In all, four practices, two each from both CCGs were recruited to participate in the study, although the study was eventually conducted in one practice in each CCG, with a decision to increase the number of patients reviewed per practice.

A clinical pharmacist, the chief investigator, reviewed the patients' electronic medical records. The pharmacist received 2 days training on the use of the Vision and SystmOne clinical computer systems, and on the identification of prescribing and monitoring errors in general practice using the study's definition from the research supervisory team and CCG pharmacists, whose roles involved retrospective review of electronic medical records.

6.3 Quantitative data collection

The practices' were requested to provide information on their list size, age-sex breakdown, number of GPs and other independent prescribers, clinical computer system used, whether they were a dispensing practice or not, their performance in the NHS Quality and Outcomes Framework, QoF, and whether they were a training practice. A pilot study was conducted in each practice over two days to estimate how long it took to review records, and the practicalities of collecting study data on electronic forms.

A list of all registered patients aged 65 years and over, and 0-12 years was generated from the electronic record in each practice. From these lists of all registered patients in the study age groups of interest, a random sample of patients was selected using computer-generated random numbers as follows: 18% and 11% of older patients ≥65 years old, and 18.76% and 16.28% of younger patients 0-12 years, from the two practices, which were named L1 and B1 respectively for the purposes of the study.

The clinical pharmacist then conducted a thorough review of the medical records of those patients, whose records were randomly selected, to identify potential prescribing and monitoring errors for each unique prescription item issued in the 12-months preceding the data collection date. The pharmacist included everything they thought would fit within the error definition, and reviewed only the last issues of prescriptions, which had been issued more than once in the 12-months period. The pharmacist recorded prescription data on

specially designed forms, which had been used in a previous study of medication errors in primary care, and piloted for the current study:

- Appendix 13: form used to record data on patient demographics and prescription items
- Appendix 14: form used to record details of prescribing and monitoring errors
- Appendix 15: form used to record details of omission errors relating to failure to prescribe for an existing clinical condition

6.3.1 Definition and classification of prescribing and monitoring errors

The definition of a prescribing error used in this study is as follows (Dean et al., 2000):

"A prescribing error occurs when, as a result of a prescribing decision or prescription-writing process, there is an unintentional, significant reduction: in the probability of treatment being timely and effective or increase in the risk of harm when compared to generally accepted practice." A list of examples of what should, and should not, be included as an error accompanied this definition (Dean et al., 2000).

The following definition was used for a monitoring error (Alldred et al., 2008):

"A monitoring error occurs when a prescribed medicine is not monitored in the way which would be considered acceptable in routine general practice. It includes the absence of tests being carried out at the frequency listed in the criteria, with tolerance of +50%. This means for example, that if a drug requires liver function tests at 6 monthly intervals, we would class as an error if a test has not been conducted within 9 months. If a patient refused to give consent for a test, then this would not constitute an error."

The pharmacist referred to a list of medicines requiring blood test monitoring Appendix 16), which was created and used by primary care researchers in a previous study of monitoring errors in general practice (Avery, Barber, et al., 2012). Potential errors were then classified by type (Appendix 17).

6.3.2 Identification of prescribing and monitoring errors

An error-judging panel, which comprised of an academic pharmacist, primary care or community pharmacist and a clinical pharmacist, discussed each error identified by the reviewer using the study definitions outlined above. The panel also reviewed the error classification and either agreed or disagreed with the recorded classification by the reviewer.

When two of the three panellists and reviewer agreed that an error had occurred, or on the error classification, it was judged accordingly.

6.3.3 Data collection on potential omission errors relating to failure to prescribe for an existing clinical condition

A third category of errors, in addition to prescribing and monitoring errors, which was captured by the study was potential omission errors relating to failure to prescribe for an existing clinical condition. An example of this type of error may be failure to prescribe a bisphosphonate/calcium supplement for an older patient with diagnosed osteoporosis where no allergies, contraindications nor patient preferences were recorded (Avery, Barber, et al., 2012).

6.3.4 Data entry

The raw data were entered into a Microsoft Access database, which was previously created and used by the PRACtISE study. The database forms were made to be similar to the original paper copies of the data collection forms used to collect data from practices. A sample of the form used to record patient demographics and prescription data onto the database is shown in **Figure 9** below. The information recorded in this section of the database form included database number, practice and patient identity codes, gender, age, number of months patient had been registered with the practice, and a tick box displaying if patient had had medication within the 12-months review period. Drop down menus were available for selecting prescriptions issued to the patient during the review period, and for selecting the type of prescriber who had issued the prescription item. There were also tick boxes for each prescription item to indicate if a prescription was on the monitoring list, and if it was an acute or repeat prescription. Lastly, there was a section to record the number of potential error(s) identified for the prescription item.

Information on prescription items with a potential error was entered on Form 2 (Figure 10). This form contained information on drug name, strength, dose, quantity, and a unique reference number. There was a drop-down menu to select the error type from. The description of the error and potential reason for occurrence were also recorded in this form.

Figure 9: Example of a Microsoft Access database form used for entering data on patient demographics and prescription items

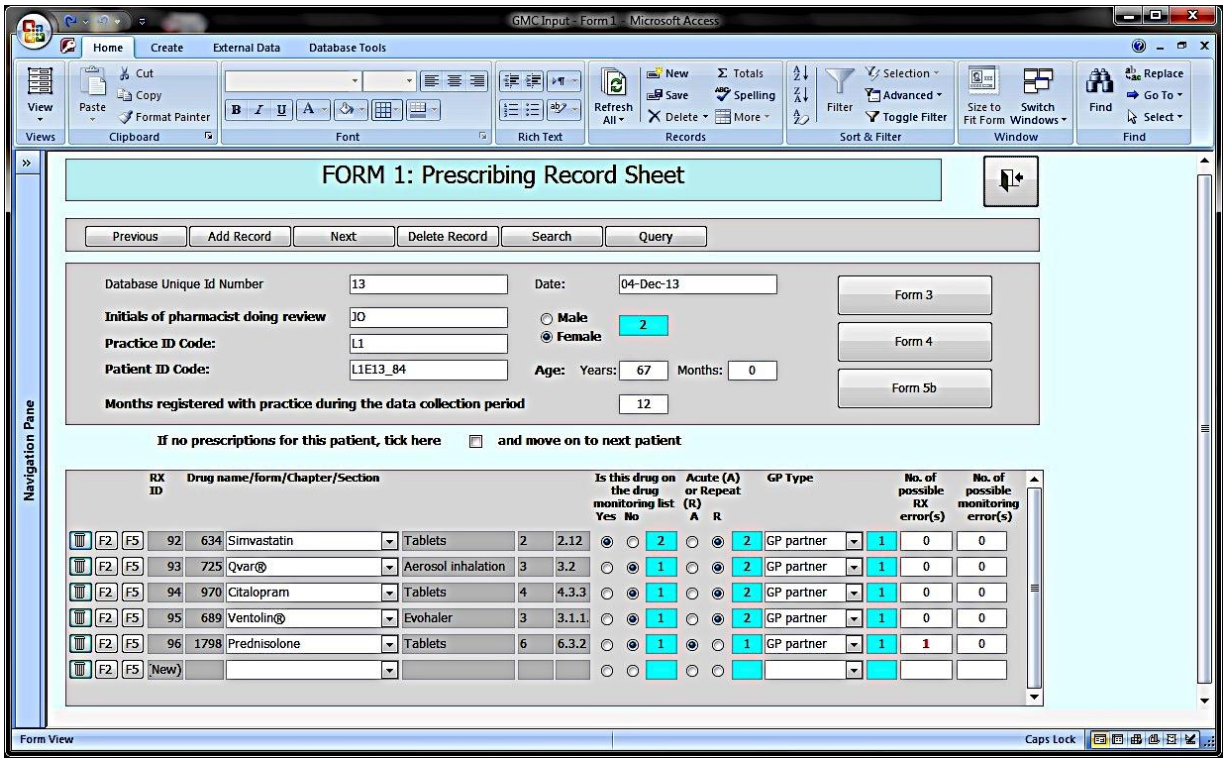
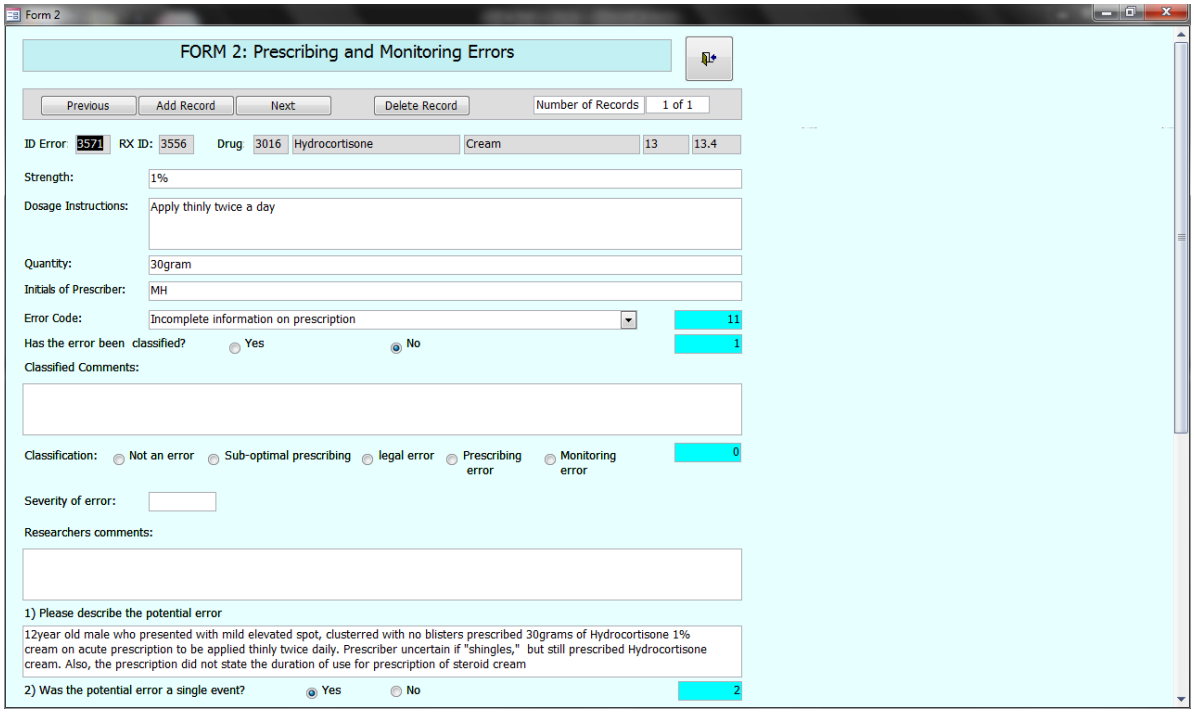


Figure 10: Example of a Microsoft Access form used for recording information on potential prescribing and monitoring errors



6.3.5 Data cleansing

The number of electronic patient data collections forms recorded in each practice and transcribed into the database was reconciled with the randomised patient list in an Excel worksheet. Then, the database entries were checked for errors. For example, a table of patient codes was generated to ascertain if the information was exactly as recorded in the Excel worksheet. Age-specific medication information was checked to match patients' recorded ages. All errors were also reviewed to ensure that complete information had been recorded, and that there were no duplications. Medicines, which were routinely used for more than one indication and therefore belonged to more than one BNF section, were checked to ensure that the appropriate section had been entered; for example, dispersible aspirin as an antiplatelet (BNF chapter 2) or an NSAID (BNF chapter 4). A detailed review of 10 randomly selected database records was also conducted.

Due to the identification of approximately 2% errors in the database entries, each database record was double-checked against the original electronic data by the reviewer: patient demographics, gender, age, prescription information etc. For example, age- and gender-related dosage forms and medications. Patients and prescriptions with potential prescribing and monitoring errors were thoroughly checked for any inconsistencies. The research degree student performed this exercise twice. A log was created to document changes made following the thorough checking of the database.

6.3.6 Data extraction

Tables were generated in Microsoft Access database using existing and newly created queries. These tables were exported into Excel worksheets for analyses. Queries included information on:

- Patient demographics
    - Age
    - Sex
    - Number of drugs prescribed during the 12-months review period
- Drugs prescribed
    - Name, strength, quantity, formulation, BNF drug class, BNF section for each drug
    - Number of acute and repeat prescription

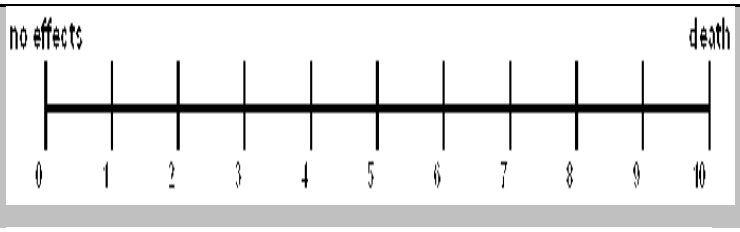
- Number and type of drugs on monitoring list
- Errors
- Prescriber types

Each of these queries was combined onto the patient demographics detail. Also, queries captured prescription information with patient demographics including age, gender, practice codes, acute or repeat medication etc., to enable interrogation of how prescription information varied with patient demographics.

6.3.7 Severity assessment of errors

A validated method for assessing the severity of medication errors, which was adapted for use with prescribing errors, was used in this study (Dean & Barber, 1999). The current study also used an adapted version of the National Patient Safety Agency, NPSA severity assessment tool for comparison and applicability (Table 2). A short summary of each identified potential error, the visual analogue scale (Figure 11), and NPSA severity categories were presented to the judging panel. The panel comprised three clinical pharmacists. The mean score across all the three judges and the reviewer was calculated to determine severity.

Figure 11: An example of the visual analogue scale used to assess error severity

Patient ID	Error summary	Scale
L1E3_25	76-year old male taking Priadel 400mg at night. Lithium requires 12-monthly Thyroid Function Tests (TFTs). TFTs last ordered in 2011 (2 years)	
L1E3_25	76-year old male prescribed Diprosalic ointment with the directions: use on the skin in the mornings as advised by dermatologist. Part of the body to be treated, and duration thin application not specified. Patient's mental difficulties documented in notes	

6.3.8 Quantitative data analyses

A framework for analyses was designed for the study (Appendix 19). Most of the data analysis was undertaken in Microsoft Excel. Descriptive statistics were used to analyse many variables relating to patient, practice and prescriber, and prescription characteristics, error types, BNF chapters of drugs commonly prescribed, and commonly associated with errors, and types of medication errors identified. Frequencies, percentages, means, and standard deviations or medians and interquartile ranges were used to characterise continuous variables, based on the their distribution.

6.4 Results

Sample characteristics

Information on the characteristics of the study boroughs/towns, general practices, patients and prescriptions are presented in the following section, followed by analyses of errors.

Two general practices, L1 located in Luton, and B1, located in Central Bedfordshire, were recruited for this study. Their characteristics are described below.

6.4.1 Characteristics of Boroughs/Towns

Bedfordshire County is made up of three unitary authorities namely Luton, Central Bedfordshire and Bedford boroughs.

Luton Borough is predominantly an urban area located about 30 miles north of London. From the Office of National Statistics, OFN and Luton Borough Council, the 2011 census estimated that 203,201 people live in Luton; the proportion of male and female residents were 50.2% and 49.8% respectively (49.2% and 50.8% for both East of England and England and Wales). Luton has a much higher population density per square kilometre at 4,690/Km^2, compared with 310/Km^2 for the East of England, and 370/Km^2 for England and Wales.

Ethnicities for Luton were reported as 54.7% White, 29.9% Asian, 9.8% Black, 4.2% Mixed, and 1.5% others; in England and Wales ethnicities were reported as 85.9% White, 7.5% Asian, 3.4% Black, 2.2% Mixed, and 1% others. Therefore, Luton has a diverse ethnic combination with a significant population of Asian descent mainly Pakistani, Indian and Bangladeshi (14.4%, 5.2% and 6.7% of Luton's population respectively. 21.7% of the population are younger people 0-14 years old (17.6% in England & Wales). Older people ≥ 65 years account for 11.8% compared with 16.5% in England & Wales (www.luton.gov.uk/about).

Central Bedfordshire is a predominantly rural area made of countryside and market towns. From the 2011 Census, its population was estimated as 264,500 people. Population-wise, Central Bedfordshire is the 15th largest unitary council in England. None of her neighbourhoods are in the 10% most deprived nationally, although pockets of deprivation do exist. It occupies 716Km^2, with a density of 369 people/Km^2, making it one of the least densely populated unitary councils. 61% of residents live in areas classed as urban. When compared with England as a whole, Central Bedfordshire is less diverse, with 89.7% people of White British ethnicity. The biggest ethnic minority groups were White other – 2.8% (not

White Irish or Gypsy or Irish Traveller), White Irish (1.2%), and Indian (1%). About 92% of Central Bedfordshire residents were born in the UK. The most common countries of birth outside of the UK were the Republic of Ireland, Poland, India, Germany and South Africa.

Younger people aged 0-15 accounted for 19.5% of the population, while 19.8% of the population were older people ≥ 65 years old. One or more persons aged 65 years and over occupied 19.9% of households in 2011 while 31.5% of households had dependent children, defined as a person aged 0-15 or 16-18 in full-time education. (www.centralbedfordshire.gov.uk).

6.4.1.1 Indices of Multiple Deprivation (IMD) 2010 scores

The Department for Communities and Local Government's Indices of Deprivation is an umbrella name, which measure and provide a comparative measure of deprivation in small areas across England. The scores and ranks produced for each index are based on the view that deprivation is not just due to poverty, but also points to a general lack of resources and opportunities. In addition to examining income-based measures, deprivation further looks at other socio-economic issues such as crime, education, employment and health (https://www.gov.uk/government/statistics/english-indices-of-deprivation-2010).

Seven domains are created from grouping thirty-eight separate indicators. These domains show different aspects of deprivation, and are used to produce an overall Index of Multiple Deprivation (IMD) score for each English small area. The seven domains are income, employment, health, education, crime, access to services, and living environment. Each domain has their scores and ranks enabling focus on specific areas of deprivation. The income measure is divided into two: the Income Deprivation Affecting Children Index (IDACI), which examines specifically, income deprivation in households containing children 0-15 years, and Income Deprivation Affecting Older People Index (IDAOPI), which looks specifically at income deprivation in households containing older people aged 60 and over.

Deprivation is measured for small areas known as Lower layer Super Output Areas (LSOAs), boundaries of which were created by the Office for National Statistics in 2001. England has been divided into 32,482 small areas, each with similar estimate of the number of people. The most and least deprived small areas in England could be identified and compared from rankings according to their IMD score. If the proportion of people living in a small area who

are classed as deprived is higher, such an area has a higher deprivation score than another one.

Of 326 district and unitary local authorities in England, Luton was ranked the 69th most deprived local authority district according to the 2010 IMD summaries. Central Bedfordshire has a Rank of Average Score of 269. The first general practice L1, which participated in the current study, is located in Wigmore LSOA in Luton, while the second practice, B1 is located in Leighton Buzzard South LSOA in Central Bedfordshire. Both LSOAs have an IMD rank for 2010 in the top 10%-20% least deprived areas nationally. However, there are numerous LSOAs in the least deprived areas in Central Bedfordshire, when compared with Luton.

Wigmore LSOA is ranked in the top 20%-50% least deprived area nationally according to the Indices of Deprivation for Education, Health, and Income Deprivation Affecting Children in Luton in 2010. However, for Employment and Income Deprivation Affecting Older People (IDAOPI), it is ranked in the top 10% least deprived area nationally, although the levels of deprivation were particularly high in Luton for IDAOPI, with 22 LSOAs in Luton in the top 10% most deprived areas in the country. Summarily, Luton has higher levels of deprivation than neighbours, Bedford and Central Bedfordshire. Luton had the most LSOAs in the top 10% most deprived areas in England for the deprivation categories measuring indices affecting children and older people.

There are 154 LSOAs in Central Bedfordshire. Central Bedfordshire has relatively low levels of deprivation with 127 LSOAs in the least deprived 50% of areas in England. Six LSOAs (including Leighton Buzzard North) were however in the 20-30% most deprived areas in England, and three LSOAs in the 10-20% most deprived areas. Central Bedfordshire LSOAs are in the most deprived 20% of LSOAs in England in all but one of the domains, namely Living Environment.

In Central Bedfordshire, 9 LSOAs were in the most deprived 30% for Employment in England, 19 LSOAs are in the most deprived 30% in England for Education, Skills and Training Deprivation domain, and 15 LSOAs were in the most deprived 10%-20% in England for Barriers to housing and services domain. Leighton Buzzard North LSOA was in all three categories, although Leighton Buzzard South, were B1 is located, was not named in any of these categories. Six LSOAs in Central Bedfordshire were in the most deprived 30% in England for Health Deprivation and Disability in 2010. All of these areas are in the South

of Central Bedfordshire, and include both Leighton Buzzard North and South where B1 is Located.

15 LSOAs in Central Bedfordshire (including Leighton Buzzard North and Leighton Buzzard South) are in the most deprived 30% in England for the Income Deprivation Affecting Children Index, with 36% of children in Leighton Buzzard living in income-deprived households; the average figure for Central Bedfordshire was 13% of children living in income-deprived households, while the average for England was 22%.

On the other hand, 11 LSOAs in Central Bedfordshire (including Leighton Buzzard North and Leighton Buzzard South) are also in the most deprived 30% in England for the Income Deprivation Affecting Older People Index, with 26% of older people in Leighton Buzzard living in income-deprived households; the average figure for Central Bedfordshire was 13% of older people living in income deprived households, and the average for England was 18%. Table 6 provides a summary of the rank of scores for Indices of Deprivation and IMD scores and ranks for L1 and B1 LSOAs.

Summarily, Luton has higher levels of deprivation than neighbours, Bedford and Central Bedfordshire. Luton had the most LSOAs in the top 10% most deprived areas in England for the deprivation categories measuring indices affecting children and older people.

Table 6: Indices of Deprivation Ranks for Central Bedfordshire (B1) and Luton (L1)[8]

Local Authority Code	Local Authority Name	Rank of Local Concentration	Rank of Extent	Rank of Income scale	Rank of Employment Scale	Average score	Rank of Average Score	Rank of Average Rank
00KC	Central Bedfordshire	227	224	110	117	10.73	269	278
00KA	Luton	112	74	63	87	25.78	69	60

[8] Rank of score of English Indices of Deprivation 2010 (available from https://www.gov.uk/government/collections/english-indices-of-deprivation)

6.4.2 Characteristics of general practices

L1 is a five-doctor, five-nurse, training practice, with over 8000 registered patients and high Quality of Outcomes Framework (QOF) scores. Housing in the practice area attracts young families, so that the practice has about twice the usual number of young children, and fewer elderly patients.

It is a National Minor Illness, which the holds University-accredited courses during the year for health professionals who need to assess urgent care, "Is it minor illness or not?" The practice has written the definitive textbook on the subject. Most of their students are practice nurses, who wish to improve access to healthcare in their own practices by being first contacts for assessment. The practice is also involved in teaching GP registrars, Foundation Year Doctors, nurses, medical students from University College London, and runs courses for practice administrative staff on repeat prescribing.

L1 is a Royal College of General Practitioners (RCGP) research accredited practice. Historically, the practice had undertaken independent research in broad areas including childbirth, urinary infection in children, prescribing and patient perceptions of medication, etc. However, due to funding difficulties, the practice currently participates more in collaborative and multi-centre projects. The practice mentions that it holds regular clinical team meetings including audit discussion, significant event reviews, and meetings with the extended primary care team including district nurses and other nurses.

The practice building also houses a different practice, and has a Lloyds Pharmacy just outside its front door. The practice used INPS Vision clinical computer system when records were first reviewed. The system has since changed to SystmOne. Surgery hours are between 08.00 am and 18.30pm Monday to Friday. The practice information mentions that although patients are registered with the practice rather than an individual GP, continuity of care is encouraged. Routinely, a doctor has twenty pre-booked fifteen-minute appointments plus slots for urgent care. Visits are fewer than for many comparable practices because of the practice's young list. The on-call rota is shared with the neighbouring practice so that urgent visit requests are less disruptive to the practice's schedule.

In their "Ethos of the Practice" statement, the practice notes that although they want to maximize the practice's income, they are happy to forego money when they see no benefit to patients from "chasing a particular target." They state that they are not a high-earning practice

but hope to gain their rewards mainly from achieving more than might be expected for their patients and ensuring their students develop great skills.

B1 is also a five-doctor, four-nurse, practice with just under 11,000-registered patients. Unlike L1, housing in the practice area attracts working families, so that the practice has comparable proportions of younger patients 0-12 years old and older patients 65 years and over, which account for approximately 16.0% and 17.9% of the surgery's registered population, respectively

The practice states in its policy that it is a training and research practice, which encourages patient participation to "shape the future of healthcare" in primary care where the treatment outcomes are important being the "real setting," when compared to secondary care or hospital care. The practice's research interests lie in "important conditions affecting primary care." Although the practice does not mention specific types of training undertaken, it states that medical students may see patients with their permission before their appointment with a GP.

The practice is open from 8.00 am to 6.30 pm Monday to Friday. Opening times have also been extended to include Saturdays 8.30 am -12.30 pm, and varied late opening on Thursdays and Fridays. Like L1, the practice uses SystmOne clinical computer system. The practice lists services offered as counselling, community nursing, family planning, smoking cessation, travel health, and other non-NHS services. There is a pharmacy next to the surgery, and a door links both. There are also several pharmacies within 300 yards walk of the practice.

The characteristics of the two practices are compared below in Table 7 and Table 8.

- The mean list size was 9,518 (standard deviation, SD = 1359)
- Both are involved in some form training, although L1 gives more information on this
- Neither were dispensing practices, though both had dispensing pharmacies next to them

Table 7: Characteristics of the two English General Practices involved in the SAFECaRE study

GP Practice code[1]	Practice List size	Is the practice a GP training practice?	Is the practice urban or rural?	Dispensing practice or non-dispensing	Deprivation score[2]	Number of GPs	Clinical computer system used within the practice
L1	8,159	Yes	Urban	No	25.78	5	SystmOne
B1	10, 877	Yes	Rural	No	10.73	5	SystmOne

[1]Code is for the purposes of the study only; [2]Based on 2010 Index of Multiple Deprivation figures

Table 8: Comparison of characteristics of general practices involved in the study with national figures for England

Characteristic	Mean (practices studied)	Mean National Figure
Practice list size	9,518	7,294
IMD 2010 score	18.26	19.15
QOF total points per practice	79%	92.4%[2]

[2]2013/2014 Quality and Outcomes Framework figures for England (available from: http://www.ic.nhs.uk/qof)

Chapter 7. Results of the investigations of the prevalence and nature of prescribing and monitoring errors in older patients

7.0 Characteristics of older patients reviewed

Chapter 6 above has provided the introduction, aim and objectives, the general methods, and descriptions of the study settings on the prevalence and nature of prescribing errors in older patients and in children. This chapter provides the results of the investigations on older patients and Chapter 8 below provides the results of the investigations in younger patients, and the general discussions of this study.

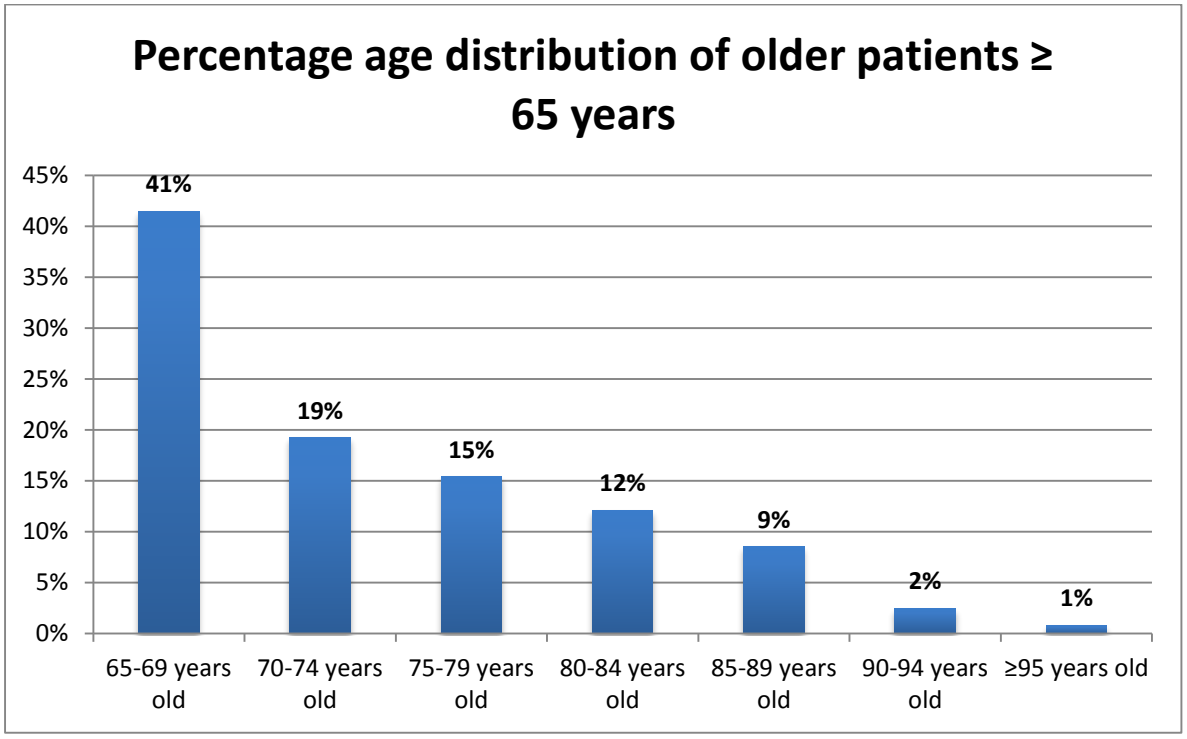
The study involved the retrospective review of the records of 364 older patients 65 years and over, with a mean age of 73.68 years (standard deviation, SD = 7.75) and 193 (53.02%) female patients. Of the 12-months retrospective record review period, these patients were registered for an average of 11.84 months (SD = 0.97).

Of the 364 older patients reviewed, 323 (88.74%) had had at least one prescription during the 12-months retrospective review of their records; the percentage of patients reviewed, in each of the following age categories that had received at least one prescription, were

- 93% of all patients ≥85 years old (40 of 43)
- 93% of all patients 75-84 years old (93 of 100) and
- 85% of all patients 65-74 years old (190 of 221).

The percentage age distribution of older patients whose records were examined is shown below in Figure 12. It can be seen that over a third of patients were ≥75 years old (n=143).

Figure 12: Age distribution of older patients ≥65 years old



At practice level, the study involved the examination of 150 of 840 (17.86%) registered older patients 65 years and over in L1; the number of records reviewed in B1 was 214 of 1978 (10.82%) registered patients. The mean ages of these patients were 72.90 years (SD = 7.39) and 74.22 years (SD = 7.94) in L1 and B1 respectively. The proportion of older male and female patients reviewed in L1 was comparable with national figures at 50.67% and 49.33% respectively. In B1 however, a higher proportion of patients reviewed in this study were females, at 55.61%. Of the 12-months retrospective record review period, these patients were registered for an average of 11.71- and 11.93-months in L1 and B1 respectively.

The proportion of older patients who had had at least one medication in the 12-months record review period in L1 and B1 were 84.67% and 91.59% respectively. This difference reached statistical significance (two-tailed Chi-squared test at $p<0.05$; P-Value=0.04), and showed that significantly more prescriptions are issued to older patients in B1 than in L1 for patients, ≥65 years old. The percentage of patients reviewed, in each of the following age categories that had received at least one prescription in L1, were

- 100% of all patients, ≥85 years old (8 of 8)

- 93% of all patients 75-84 years old (40 of 43)
- 81% of all patients 65-74 years old (79 of 97) in L1;

- 100% of all patients, ≥85 years old (32 of 32)
- 93% of all patients 75-84 years old (53 of 57)
- 90% of all patients 65-74 years old (111 of 124) in B1.

It can therefore be observed that 65-74 year old patients in B1 were more likely to receive a prescription when compared with L1. This however did not reach statistical significance (two-tailed z-test at $p<0.05$; P-Value = 0.09).

At practice level, the age distribution of patients whose records were reviewed in L1 and B1 were mostly comparable for patients 65-84 years old; however, older patients ≥85 years old were relatively fewer in L1 as shown below in

Table 9.

Table 9: Comparison of age distribution of older patients ≥65 years old in L1 and B1

Age range	Number of patients L1	Percentage L1 (%)	Number of patients B1	Percentage B1 (%)
65-69	68	45.33	83	38.79
70-74	29	19.33	41	19.16
75-79	21	14.00	35	16.36
80-84	22	14.67	22	10.28
85-89	7	4.67	24	11.21
90-94	1	0.67	8	3.74
≥95	2	1.33	1	0.47
All ≥65 years	150	100.00	214	100.00

7.1 Characteristics of the prescriptions reviewed for older patients 65 years and over

In total, 2739 unique prescription items for 364 older patients 65 years and over were reviewed. Of these, 1884 (68.78%) were repeat prescriptions, and 855 (31.22%) were acute prescriptions. 548 (20%) were items, which were considered as requiring blood test monitoring.

When those patients without a prescription item issued in the 12-months record review period were included, the median number of prescriptions per older patient was 6 (interquartile range, IQR 8.75); excluding patients without a prescription item, the median number of prescriptions was 7 (IQR 7). The highest number of unique prescription items issued to any older patient during the review period was 39.

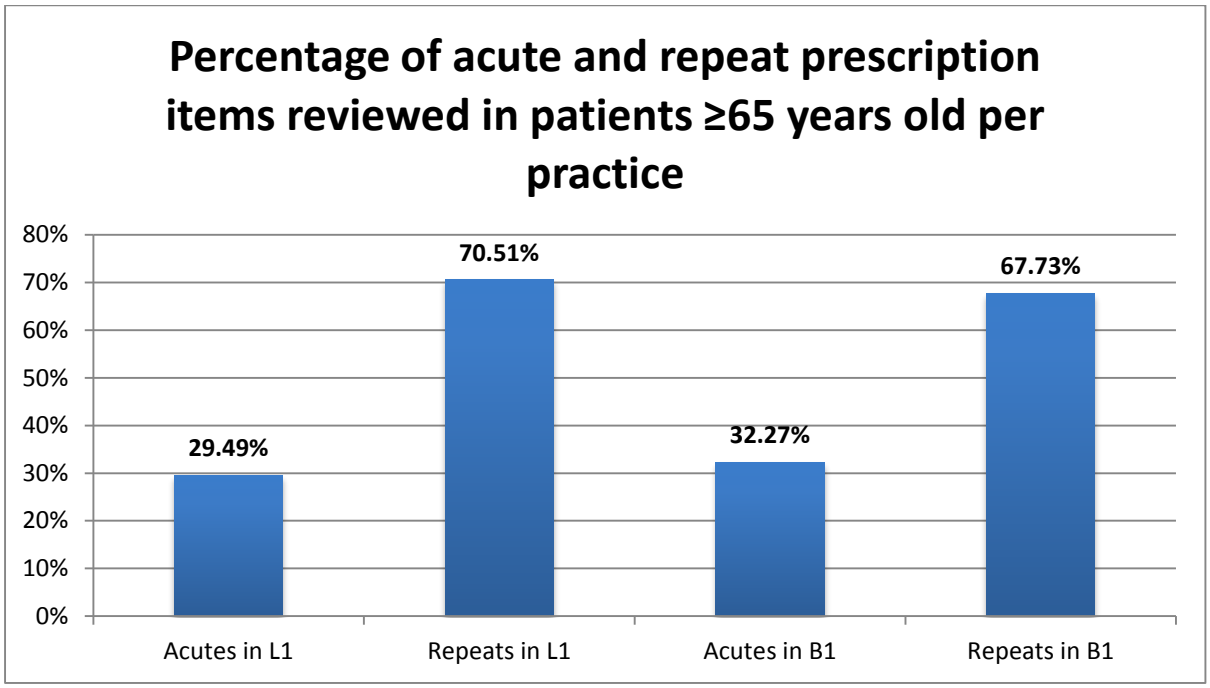
Of the 2739 prescriptions items, female patients received the majority of 1578 (57.61%). Table 10 below provides information on how the number of prescription items varied with older patients' age ranges. It can be seen that average number of prescriptions per patient increased with age.

Table 10: How prescription items varied with age in older patients ≥65 years

Age range (years)	Number of prescriptions	Number of patients with at least one prescription item	Average number of prescription items per patient
65-74	1358	190	**7.15**
75-84	849	93	**9.13**
≥85	532	40	**13.30**
All ≥ 65	2739	323	**8.48**

At practice level, 1041 unique prescription items for 150 patients were reviewed in L1. Of these, 734 (70.51%) were repeat prescriptions and 307 (29.49%) were acute. In B1, 1698 unique prescription items for 214 older patients were reviewed. The proportions of repeat and acute prescriptions in B1 were comparable with those of L1 at 1150 (67.73%) and 548 (32.27%) respectively (Figure 13).

Figure 13: Percentage of acute and repeat prescription items in older patients in L1 and B1



The proportions of drugs, which were considered as requiring blood test monitoring, were comparable in L1 and B1 at 191 (18%) and 357 (21%) respectively.

Including and excluding patients without a prescription item in the 12-months review period, the median number of prescriptions per older patient in both L1 and B1 were comparable at 6 (IQR 8) and 7 (IQR 8) respectively.

Of the 1041 and 1698 unique prescription items reviewed in L1 and B1, female patients received the majority in both L1 and B1, at 544 (52.26%) and 1034 (60.90%) respectively.

Table 11 below compares how the number of prescription items varied with older patients' age ranges in L1 and B1. It can be seen that average number of prescription items per patient increased with age in both practices. It can be observed that patients who were ≥85 years had the more items.

Table 11: How prescription items varied with age in older patients between L1 and B1

Age range (years)	Number of Rx items L1	Patients with at least one Rx item	Average number of prescription items per	Number of Rx items B1	Patients with at least one Rx item	Average number of prescription items per

		L1	patient L1		B1	patient B1
65-74	553	79	**7.00**	805	111	**7.25**
75-84	405	40	**10.13**	444	53	**8.38**
≥85	83	8	**10.38**	449	32	**14.03**
All ≥ 65	1041	127	**8.20**	1698	196	**8.66**

7.1.1 Characteristics of acute and repeat prescription items reviewed in older patients

Acute prescription items were recorded for 251 older patients, and the median number of unique acute prescription items per older patient was 3 (IQR 3), with the highest number of acute prescriptions issued to any patient being 16.

Repeat prescription items were recorded for 300 older patients, and the median number of unique repeat prescription items per older patient was 5 (IQR 5.75), with the highest number prescribed being 31.

Table 12 below shows the number of older patients who were prescribed a range number of acute and repeat prescriptions. It can be seen that over two thirds of older patients had four or more repeat prescription items, and almost two thirds of patients had three or less acute prescription items.

Table 12: Number of older patients with ranges of acute and repeat prescription items

Number of acute prescription items	Number of older patients ≥65 yrs. (%)		Number of repeat prescription items	Number of older patients ≥65 yrs. (%)
≤3	159 (63.35)		≤3	101 (33.67)
4-7	73 (29.08)		4-7	109 (36.33)
8-11	15 (5.98)		8-11	54 (18.00)
12-15	3 (1.20)		12-15	18 (6.00)
≥16	1 (0.40)		≥16	18 (6.00)
855	251 (100)		1884	300 (100)

At practice level, acute prescription items were recorded for 98 older patients in L1, and the median number of unique acute prescription items per older patient was 2 (IQR 3), with the highest number of acute prescriptions issued to any patient being 14. Acute prescription items were recorded for 153 older patients in B1, and the median number of unique acute

prescription items per older patient was comparable with L1 at 3 (IQR 3), with a maximum of 16 acute prescriptions issued to any patient.

In L1, repeat prescription items were recorded for 120 older patients, and the median number of unique repeat prescription items per older patient was 5 (IQR 6.75) with the highest number prescribed to any patient being 25. Repeat prescription items were recorded for 180 older patients in B1, and the median number of unique repeat prescription items per older patient was 5 (IQR 5), the maximum number of repeat prescription items issued to any patient being 31.

Table 13 below compared the number of older patients who were prescribed a specific number of acute and repeat prescriptions in L1 and B1. Almost two thirds and over two thirds of older patients had four or more repeat prescription items in L1 and B1 respectively. Over 60% of patients had three or less acute prescription items in both practices.

Table 13: How the number of older patients with ranges acute and repeat prescription items varied between L1 and B1

Number of acute prescription items	**Number of older patients ≥65 years**		**Number of repeat prescription items**	**Number of older patients ≥65 years**	
	L1	B1		L1 (%)	B1 (%)
≤3	66 (67.35)	93 (60.78)	≤3	46 (38.33)	55 (30.56)
4-7	25 (25.51)	48 (31.37)	4-7	37 (30.83)	72 (40.00)
8-11	5 (5.10)	10 (6.54)	8-11	23 (19.17)	31 (17.22)
12-15	2 (2.04)	1 (0.65)	12-15	5 (4.17)	13 (7.22)
≥16	0 (0)	1 (0.65)	≥16	9 (7.50)	9 (5.00)
Total	98 (100)	153 (100)		120 (100)	180 (100)

Results on how the average number of acute and repeat prescription items varied with older patients' age is provided in Table 14 below. It can be seen that the average numbers of acute prescriptions per patient were comparable across the three age ranges, while the average number of repeat prescription items increased with age. This was similar at practice level as shown in Table 15 below.

Table 14: How acute and repeat prescription items varied with older patients' age

Age range (years)	**Total Acute items**	**Number of patients**	**Average number of acute prescriptions per patient**	**Total Repeat items**	**Number of patients**	**Average number of repeat prescriptions per patient**

65-74	461	142	**3.25**	897	175	**5.13**
75-84	250	73	**3.42**	599	86	**6.97**
≥85	144	36	**4.00**	388	39	**9.95**
All ≥ 65	855	251	**3.41**	1884	300	**6.28**

Table 15: How acute and repeat prescription items varied with older patients' age between L1 and B1

Age range (years)	Total Acute items	Number of patients	Average number of acute prescriptions per patient	Total Repeat items	Number of patients	Average number of repeat prescriptions per patient
L1						
65-74	190	57	**3.33**	363	73	**4.97**
75-84	94	33	**2.85**	311	39	**7.97**
≥85	23	8	**2.88**	60	8	**7.50**
All ≥ 65	307	98	**3.13**	734	120	**6.12**
B1						
65-74	271	85	**3.19**	534	102	**5.24**
75-84	156	40	**3.90**	288	47	**6.13**
≥85	121	28	**4.32**	328	31	**10.58**
All ≥ 65	548	153	**3.58**	1150	180	**6.39**

7.1.2 Characteristics of drugs commonly prescribed to older patients

7.1.2.1 BNF chapters

The different groups of drugs prescribed to older patients by British National Formulary, BNF chapter are shown in Table 16 below. It can be observed that the most commonly prescribed drugs for older patients were those for cardiovascular disease, central nervous system (CNS), gastro-intestinal system, and infections. These drugs made up almost a third of prescriptions.

Table 16: Distribution of prescription items reviewed by British National Formulary, BNF Chapter for older patients ≥65 years

Chapter	BNF Chapter name	Frequency	Percentage
2	Cardiovascular system	765	27.93
4	Central nervous system	441	16.10
1	Gastro-intestinal system	255	9.31
5	Infections	238	8.69
6	Endocrine system	207	7.56

13	Skin	196	7.16
3	Respiratory system	172	6.28
11	Eye	114	4.16
10	Musculoskeletal and joint diseases	109	3.98
9	Nutrition and blood	88	3.21
12	Ear, nose and oropharynx	65	2.37
7	Obstetrics, gynaecology, and urinary-tract disorders	63	2.30
8	Malignant disease and immunosuppression	11	0.40
15	Anaesthesia	10	0.37
14	Immunological products and vaccines	4	0.15
	Unclassified (Deep freeze gel)	1	0.04
		2739	100.00

At practice level, drugs for cardiovascular disease, CNS, gastro-intestinal system were three of the top four BNF chapters most commonly prescribed in both practices; the fourth BNF chapter in L1 was skin, and infections in B1 (Table 17).

Table 17: Comparison of the distribution of prescription items reviewed by BNF chapter between L1 and B1

BNF chapter	BNF chapter name	Frequency L1	% L1	Frequency B1	% B1
1	**Gastro-intestinal system**	**89**	**8.55**	**166**	**9.78**
2	**Cardiovascular system**	**257**	**24.69**	**508**	**29.92**
3	Respiratory system	77	7.40	95	5.59
4	**Central nervous system**	**162**	**15.56**	**279**	**16.43**
5	**Infections**	**89**	**8.55**	**149**	**8.78**
6	Endocrine system	70	6.72	137	8.07
7	Obstetrics, gynaecology, and urinary-tract disorders	31	2.98	32	1.88
8	Malignant disease and immunosuppression	5	0.48	6	0.35
9	Nutrition and blood	34	3.27	54	3.18
10	Musculoskeletal and joint diseases	53	5.09	56	3.30
11	Eye	42	4.03	72	4.24
12	Ear, nose and oropharynx	31	2.98	34	2.00
13	**Skin**	**92**	**8.84**	**104**	**6.12**
14	Immunological products and vaccines	4	0.38	0	0.00
15	Anaesthesia	4	0.38	6	0.35
Deep freeze gel	Unclassified	1	0.10	0	0
	Total	1041	100	1698	100

7.1.2.2 Drugs commonly prescribed in older patients

Of 389 different drugs, the top 20 most frequently prescribed to older patients are shown in Table 18 below. It can be observed that these drugs made up more than a third of prescriptions. This was also true in both practices L1 and B1 as shown in Table 19

Table 18: Top 20 drugs most commonly prescribed to older patients ≥65 years old

Preparation name	Frequency	Percentage (%)
Simvastatin	92	3.36
Paracetamol	75	2.74
Amoxicillin	68	2.48
Omeprazole	66	2.41
Amlodipine	64	2.34
Aspirin	61	2.23
Levothyroxine	57	2.08
Warfarin	50	1.83
Salbutamol	49	1.79
Codeine Phosphate or Codeine Linctus	46	1.68
Bendroflumethiazide	45	1.64
Lansoprazole	45	1.64
Lisinopril	44	1.61
Ramipril	43	1.57
Furosemide	42	1.53
Macrogol Oral Powder, Compound	42	1.53
Prednisolone	38	1.39
Co-codamol 30/500 (and 15/500)	36	1.31
Metformin	34	1.24
Lipitor® (Atorvastatin)	34	1.24
Total	1031	37.64

At practice level, fourteen and eighteen of the combined top 20 drugs, were most frequently prescribed in L1 and B1 respectively (see Table 19 below). It can be observed that these to 20 drugs made up consistently over a third of all prescriptions issued in both practices.

Table 19: Comparison of the top 20 drugs most commonly prescribed to older patients in L1 and B1

L1			**B1**		
Preparation name	**Frequency**	**%**	**Preparation name**	**Frequency**	**%**
Simvastatin	41	3.94	Simvastatin	51	3.00
Paracetamol	32	3.07	Amoxicillin	50	2.94
Omeprazole	30	2.88	Aspirin	44	2.59
Amlodipine	21	2.02	Amlodipine	43	2.53
Ramipril	20	1.92	Paracetamol	43	2.53

Salbutamol	20	1.92	Levothyroxine	39	2.30
Amoxicillin	18	1.73	Lisinopril	39	2.30
Bendroflumethiazide	18	1.73	Lansoprazole	37	2.18
Levothyroxine	18	1.73	Omeprazole	36	2.12
Aspirin	17	1.63	Warfarin	36	2.12
Codeine Phosphate	17	1.63	Macrogol Oral Powder	33	1.94
Furosemide	17	1.63	Co-codamol	29	1.71
Flucloxacillin	16	1.54	Codeine Phosphate	29	1.71
Candesartan	15	1.44	Salbutamol	29	1.71
Metformin	15	1.44	Bendroflumethiazide	27	1.59
Warfarin	14	1.34	Atorvastatin	27	1.59
Beclometasone	12	1.15	Losartan Potassium	27	1.59
Ibuprofen	12	1.15	Prednisolone	27	1.59
Atenolol	11	1.06	Furosemide	25	1.47
Cetirizine	11	1.06	Calcium/Colecalciferol	23	1.35
Total	375	36.02		694	40.87

High-risk drugs prescribed included Warfarin, various NSAIDs, Amiodarone, Azathioprine, Slo-Phyllin, etc.

7.1.2.3 Therapeutic classes of commonly prescribed drugs in older patients

When the drugs prescribed to older patients were grouped into their therapeutic classes, antibacterial drugs were topmost on the list. This was also the case in both L1 and B1. The top 20 drug classes most commonly prescribed to older patients are shown in Table 20 below. It can be seen that these drug classes made up almost three quarters of the prescriptions.

Table 20: Top 20 drug classes most commonly prescribed to older patients ≥65 years

Therapeutic Drug class	Frequency	Percentage (%)
Antibacterial	250	9.13
ACE-I/ACE Antagonist, and with diuretic	165	6.02
Corticosteroid	155	5.66
Statin	132	4.82
Antisecretory and mucosal protectants	130	4.75
Diuretic	116	4.24
Opioid	115	4.20
NSAID	92	3.36
Antiplatelet	83	3.03
Calcium Channel Blockers	82	2.99
Laxative	81	2.96
Antidepressant	77	2.81

Non-opioid analgesic	75	2.74
Bronchodilator	71	2.59
Emollient	71	2.59
Beta blocker	62	2.26
Thyroid and antithyroid hormones	58	2.12
Antidiabetic	56	2.04
Anticoagulant	53	1.94
Calcium supplement	49	1.79
Total	1973	72.03

At practice level, antibacterial drugs were also topmost on the list of the therapeutic drug classes prescribed to older patients. Angiotensin Receptor Antagonists and Angiotensin II Receptor Blockers, Corticosteroids, and Statins, were in the top five therapeutic drug classes most commonly prescribed to older patients in both practices as shown in Table 21.

Table 21: Comparison of the top 20 drug classes most commonly prescribed to older patients in L1 and B1

L1			**B1**		
Therapeutic Drug class	**Frequency**	**%**	**Therapeutic Drug class**	**Frequency**	**%**
Antibacterial	87	8.36	Antibacterial	163	9.60
Corticosteroid	66	6.34	ACE-I/ACE II Antagonist, and with diuretic	116	6.83
Statin	51	4.90	Corticosteroid	89	5.24
Diuretic	50	4.80	Antisecretory and mucosal protectants	88	5.18
ACE-I/ACE Antagonist, and with diuretic	49	4.71	Statin	81	4.77
Antisecretory and mucosal protectants	42	4.03	Opioid	78	4.59
NSAID	42	4.03	Diuretic	66	3.89
Opioid	37	3.55	Antiplatelet	58	3.42
Emollient	36	3.46	CCB	57	3.36
Non-opioid analgesic	32	3.07	Laxative	50	2.94
Antidepressant	30	2.88	NSAID	50	2.94
Bronchodilator	30	2.88	Antidepressant	47	2.77
Antihistamine	25	2.40	Non-opioid analgesic	43	2.53
Antiplatelet	25	2.40	Bronchodilator	41	2.41
CCB	25	2.40	Beta blocker	40	2.36
Antidiabetic	23	2.21	Thyroid and antithyroid	40	2.36

			hormones		
Laxative	23	2.21	Anticoagulant	38	2.24
Beta blocker	22	2.11	Non-opioid + opioid	36	2.12
Anti-infective	19	1.83	Emollient	34	2.00
Calcium supplement	18	1.73	Antidiabetic	33	1.94
Total	732	70.32		1279	75.32

7.1.2.4 Characteristics of drug formulations commonly prescribed in older patients

Table 22 shows the distribution of different formulations for the 2739 prescription items issued to older patients. It can be seen that oral medications made up over 75% of prescriptions for this age group.

Table 22: Distribution of different types of formulation prescribed to older patients ≥65 years

Formulation	Frequency	Percentage
Solid oral	2035	74.30
Topical	260	9.49
Eye/ear/nose ointment or drops or sprays	162	5.91
Inhalers	124	4.53
Liquid oral	73	2.67
Injection	47	1.72
Patches	16	0.58
Pessaries/suppositories	12	0.44
Shampoo	6	0.22
Mouthwash	3	0.11
Implant	1	0.04%
Total	2739	100.00%

At practice level, the distribution of the formulations for the prescription items to older patients were comparable as shown below in Table 23. Oral medications made up over 70% of prescriptions in both practices.

Table 23: Comparison of the distribution of different types of formulation prescribed to older patients between L1 and B1

Formulation	Frequency L1	Percentage L1	Frequency B1	Percentage B1
Eye/ear/nose ointment or drops or sprays	50	4.80	79	4.65

Implant	1	0.10	0	0.00
Inhalers	71	6.82	75	4.42
Injection	16	1.54	31	1.83
Liquid oral	33	3.17	36	2.12
Mouthwash	2	0.19	1	0.06
Patches	0	0.00	12	0.71
Pessaries/suppositories	4	0.38	8	0.47
Shampoo	0	0.00	4	0.24
Solid oral	733	70.41	1299	76.50
Topical	131	12.58	153	9.01
Total	1041	100.00	1698	100.00

7.2 Drugs on the monitoring list prescribed to older patients ≥65 years old

548 of the 2739 unique prescription items prescribed to 224 older patients were considered as drugs requiring laboratory blood test monitoring. The median number of prescriptions on the monitoring list per older patient was 2 (IQR 2). The highest number of unique prescription items on the monitoring list issued to any older patient during the review period was 9.

Table 24 below provides information on the average number of prescriptions on the monitoring list per older patients' in three age ranges. It can be observed that the average number of prescription items, which required monitoring was consistent across the age groups.

Table 24: How prescription items on the monitoring list varied with older patients' age

Age range (years)	Number of prescription items on the monitoring list[9]	Number of patients with at least one prescription item on the monitoring list	Prescription items on monitoring list per patient
65-74	269	125	2.2
75-84	190	67	2.8
≥85	89	32	2.8
All ≥ 65	548	224	2.4

[1]

At practice level, 83 patients received 191 prescriptions on the monitoring list in L1; in B1, 141 patients received 357 prescriptions, which required monitoring. The median number of prescriptions on the monitoring list per older patient was 2 (IQR 2) in both L1 and B1. The average number of prescription items on the monitoring list was comparable in both practices across the three age groups as shown in Table 25.

Table 25: Comparison of how prescription items on the monitoring list varied with older patients' age in L1 and B1

Age range (years)	Number of prescription items on the monitoring list[1]		Number of patients with at least one prescription item on the monitoring list		Prescription items on monitoring list per patient	
	L1	B1	L1	B1	L1	B1
65-74	96	173	51	74	**1.9**	**2.3**
75-84	84	106	28	39	**3.0**	**2.7**
≥85	11	78	4	28	**2.8**	**2.8**
All ≥ 65	191	357	83	141	**2.3**	**2.5**

[9]The list of drugs, which were considered to require monitoring

7.2.1 BNF Chapters of drugs on the monitoring list prescribed to older patients

The different categories of drugs on the monitoring list prescribed by BNF chapter for older patients are shown in Table 26. It can be seen that the most commonly prescribed drugs on the monitoring list were for cardiovascular disease.

Table 26: Prescription items on the monitoring list prescribed to older patients ≥65 years old

Chapter	BNF Chapter name	Frequency	Percentage
2	Cardiovascular system	480	87.59
3	Respiratory system	2	0.36
4	Central nervous system	2	0.36
6	Endocrine system	58	10.58
8	Malignant disease and immunosuppression	3	0.55
9	Nutrition and blood	1	0.18
10	Musculoskeletal and joint diseases	2	0.36
	Total	548	100.00

At practice level, cardiovascular drugs accounted for over 85% of drugs on the monitoring list in L1 and B1 as shown in Table 27 below.

Table 27: Comparison of the prescription items on the monitoring list prescribed to older patients in L1 and B1 by their BNF chapters

Chapter	BNF chapter name	Frequency L1	Percentage L1	Frequency B1	Percentage B1
2	Cardiovascular system	169	88.48	311	87.11
6	Endocrine system	18	9.42	40	11.20
4	Central nervous system	2	1.05	0	0
3	Respiratory system	1	0.52	1	0.28
10	Musculoskeletal and joint diseases	1	0.52	1	0.28
8	Malignant disease and immunosuppression	0	0.00	3	0.84
9	Nutrition and blood	0	0.00	1	0.28
	Total	191	100	357	100

7.2.2 Specific drugs on the monitoring list prescribed to older patients

The top 20 drugs on the monitoring list most commonly prescribed to older patients are shown in Table 28 below. For older patients, these drugs made up 95% of the prescriptions.

Table 28: Top drugs on the monitoring list most commonly prescribed to patients ≥65 years old

Preparation name	Frequency	Percentage
Simvastatin	92	16.79
Levothyroxine	57	10.40
Warfarin	50	9.12
Bendroflumethiazide	45	8.21
Lisinopril	44	8.03
Ramipril	43	7.85
Furosemide	42	7.66
Atorvastatin	34	6.20
Losartan Potassium	28	5.11
Candesartan	23	4.20
Digoxin	16	2.92
Enalapril Maleate	10	1.82
Perindopril	10	1.82
Spironolactone	7	1.28
Indapamide	6	1.09
Co-amilozide/Moduretic	5	0.91
Pravastatin	5	0.91
Amiloride	3	0.55
Azathioprine	3	0.55
Irbesartan	3	0.55
Total	528	96.35

In the two practices, the top 20 drugs on the monitoring list commonly prescribed to older patients were comparable as shown in Table 29 below. These drugs made up over 95% of the prescriptions.

Table 29: Comparison of the top 20 drugs on the monitoring list commonly prescribed to older patients in L1 and B1

Preparation name	Frequency L1	% L1	Preparation name	Frequency B1	% B1
Simvastatin	41	21.47	Simvastatin	51	14.29
Ramipril	20	10.47	Levothyroxine	39	10.92
Bendroflumethiazide	18	9.42	Lisinopril	39	10.92
Levothyroxine	18	9.42	Warfarin	36	10.08
Furosemide	17	8.90	Bendroflumethiazide	27	7.56
Candesartan	15	7.8	Atorvastatin	27	7.56
Warfarin	14	7.33	Losartan Potassium	27	7.56
Atorvastatin	7	3.66	Furosemide	25	7.00
Digoxin	5	2.62	Ramipril	23	6.44
Lisinopril	5	2.62	Digoxin	11	3.08
Indapamide	4	2.09	Candesartan	8	2.24

Enalapril Maleate	3	1.57	Enalapril Maleate	7	1.96
Perindopril	3	1.57	Perindopril	7	1.96
Pravastatin	3	1.57	Spironolactone	4	1.12
Spironolactone	3	1.57	Irbesartan	3	0.84
Amiloride	2	1.05	Azathioprine	3	0.84
Co-amilozide	2	1.05	Co-amilozide	3	0.84
Priadel®	2	1.05	Valsartan	2	0.56
Amiodarone	1	0.52	Indapamide	2	0.56
Bumetanide	1	0.52	Pravastatin	2	0.56
Total	184	96.34		346	96.92

7.2.3 Therapeutic classes of monitored drugs commonly prescribed

The drugs on the monitoring list prescribed to older patients were grouped into their therapeutic drug classes as shown in Table 30 below. It can be observed that ACE-I and angiotensin II receptor agonists, statin and diuretics accounted for approximately 75% of all drugs requiring monitoring.

Table 30: Drug classes of prescriptions on the monitoring list

Drug class	Frequency	Percentage
ACE-I/Angiotensin II receptor antagonist	164	29.93%
Statin	132	24.09%
Diuretic	115	20.99%
Thyroxine	57	10.40%
Coumarins	50	9.12%
Digoxin	16	2.92%
Methotrexate/Azathioprine	4	0.73%
Amiodarone	2	0.36%
Lithium	2	0.36%
ACE-I/Diuretic	1	0.18%
Theophylline	2	0.36%
Carbimazole	1	0.18%
Hydroxocobalamin	1	0.18%
Sulfasalazine	1	0.18%
Total	548	100.00%

7.3 Prevalence of prescribing and monitoring errors in older patients 65 years and over

From the review of the 2739 prescription items in older patients 65 years and over, 216 medication errors were identified as shown:

1. 168 prescribing errors
2. 23 omission errors relating to failure to prescribe for an existing condition, and
3. 25 monitoring errors (total, 216).

7.3.1 Prescribing and monitoring error rates in older patients

7.3.1.1 Error rate per patient

- 108 of 323 older patients ≥65 years old (33.44%, 95% CI 28.52%-38.75%) that had been prescribed at least one prescription item in the record review period, had at least one prescribing error. There was a mean of 1.56 errors per patient.
- When prescribing and omission errors (relating to failure to prescribe for an existing condition) were combined, 116 patients of 323 older patients, (35.91%, 95% CI 30.87%-41.28%), had at least one prescribing error.
- 21 older patients (9.38%, 95% CI 6.22%-13.91%), out of 224 patients who had been prescribed at least one prescription on the monitoring list in the 12-months review period, had at least one monitoring error, with a mean of 1.2 errors per patient.
- For all three categories of errors studied (prescribing, monitoring and omission errors), 132 of 323 older patients ≥65 years old (40.87%, 95% CI 35.65% – 46.31%), with at least one prescription item in the 12-months review period, had at least one error with a mean of 1.63 errors per patient.

The prevalence of prescribing and monitoring errors in older patients grouped into three age bands is shown in Table 31 below:

Table 31: Error rate per older patient with at least one prescribed item and at least one potential error

Age (yrs.)	Number of patients with errors	Number of patients with at least one prescription item	Prevalence of all errors %; (95% CI)
65-74	74	190	38.95; (32.30-46.04)
75-84	41	93	44.05; (34.43-54.22)|
≥85	17	40	42.50; (28.51-57.80)
Total	132	323	40.87; (35.65-46.31)

It can be observed that error rate increased with patient's age but decreased slightly in patients who were ≥85 years old. This may be due to the relatively few number of patients in this age range whose prescriptions were reviewed. There was no statistically significant difference between L1 and B1 with respect to the number of patients with or without errors (Chi-square 2-tailed test P-value=0.256, $p < 0.05$).

7.3.1.2 Error rate per item

- Of 2739 prescription items reviewed, 168 prescribing errors were identified with a prevalence rate of prescribing errors per item being 6.13% (95% CI 5.29%-7.09%).
- When prescribing and omission errors (relating to failure to prescribe for an existing condition) were combined, 191 errors were identified. This gave a prevalence of prescribing errors per item of 6.97% (95% CI 6.08%-7.99%).
- 25 monitoring errors were identified from the review of 548 prescription items on the monitoring list, with a prevalence error rate of 4.56% (95% CI 3.11%-6.65%).
- For all three categories of errors, the prevalence of prescription items with prescribing or monitoring errors was 7.89% per item (95% CI 6.94%-8.96%).

At practice level, there was no significant difference in error rate. In L1 (7.88%) and B1 (7.89%) (P-value = 0.99; Z-test for two population proportions).

Summarily, the prevalence of prescribing and monitoring errors by age range in older patient in the 12-months record review period is shown in Table 32 below.

Table 32: Prevalence of prescribing and monitoring errors for older patients over the 12-months record review period

Age (yrs.)	Prescribing (and omission error) error rate (%)		Monitoring error rate (%)		Prescribing and monitoring error rate (total) %	
	Per item	Per patient	Per item	Per patient	Per item	Per patient
65-74	7.22	34.74	4.83	8.00	8.17	38.95
75-84	7.30	36.56	5.26	13.43	8.48	44.05
≥85	5.83	40.00	2.25	6.25	6.20	42.50
All ≥65	6.97	35.91	4.56	9.38	**7.89**	**40.87**

The error rates per patient shown above did not reflect that one patient could have had more than one error. When the error rate was determined by expressing the total number of errors as

a percentage of patients with at least one prescription item, a higher prevalence of 66.87% (95% CI 61.57%-71.78%) was obtained. The prevalence of errors per patient in L1 and B1 was comparable at 64.57% (95% CI 55.94%-72.35%) and 68.37% (95% CI 61.56%-74.47%) respectively, with any difference not significant (Z-test for 2 population proportions, $p<0.05$, P-Value = 1.0). Error rate per patient age range were also comparable in both practices, and tended to increase with age, but this did not reach statistical significance (Chi-square test at $p<0.05$, P-value = 0.49) (Figure 14 and Figure 15 below).

Figure 14: Error rates per patient ≥65 years old

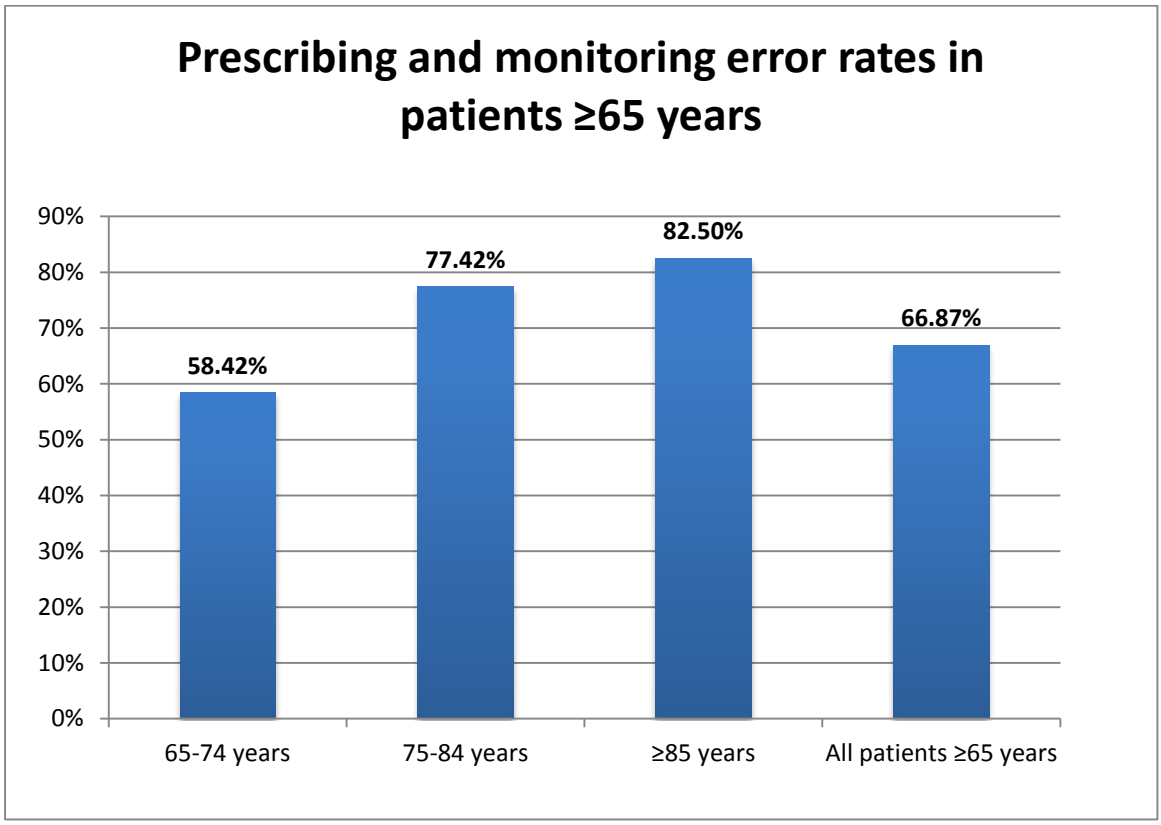
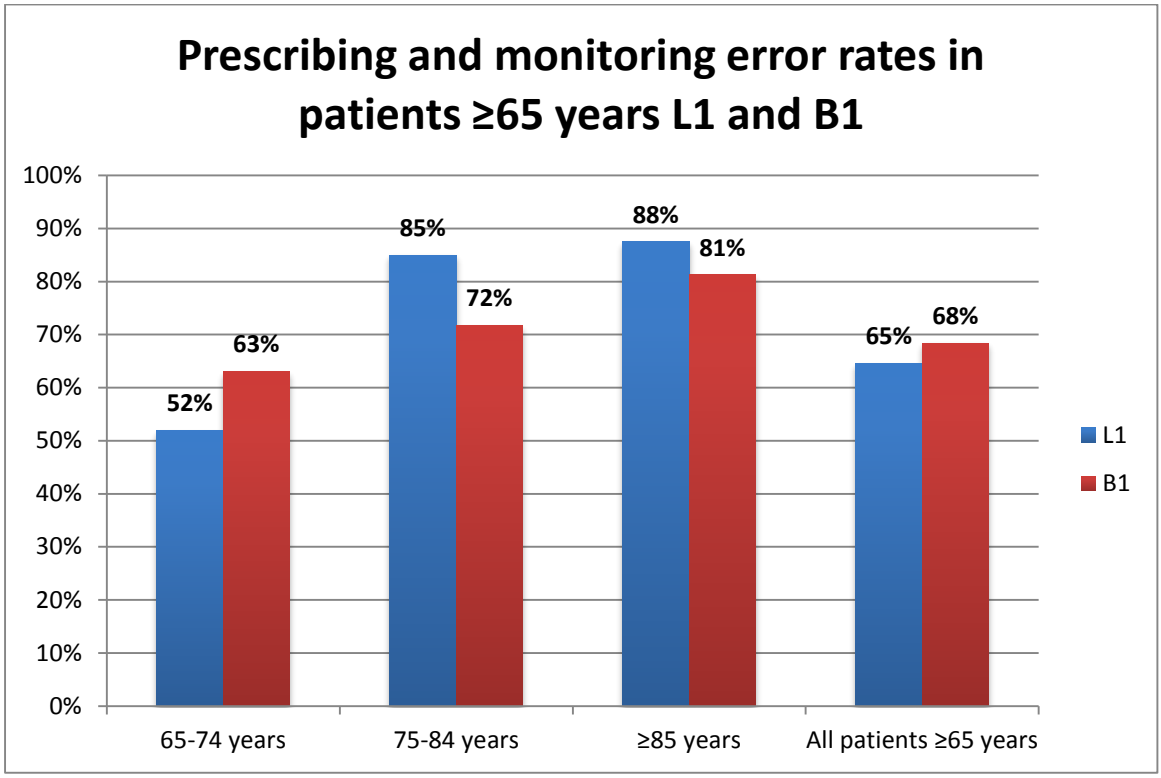


Figure 15: Prescribing and monitoring error rates per patient ≥65 years old in L1 and B1



7.3.2 How prescribing and monitoring error rates varied with older patients' sex

The prevalence of prescribing and monitoring errors per older male and female patients over the 12-months record review period is presented in Table 33 below. It can be observed that more errors were associated with female patients when compared with male patients.

Table 33: Prevalence of prescribing and monitoring error for older male and female older patients over the 12-months record review period

	Number of errors	Number of prescription items	Error rate per item	Patients with at least one prescription item	Error rate per patient
Female	133	1578	8.43%	178	74.72%
Male	83	1161	7.15%	145	57.24%
Total	216	2739	7.89%	323	66.87%

When the prevalence of errors was determined by expressing the number of patients who had at least one error, as a percentage of patients with at least one prescription item, error rate per female and male patients were 46.07% and 34.48% respectively as shown in Table 34 below. It can be observed that over two thirds of female patients had at least one error compared with

just over a third of male patients. Chi-square two-tailed test showed that the result was significant (P-Value=0.035). This was also observed in individual practices with no significant difference between practices.

Table 34: Prevalence of errors with the numbers of older female and male patients

Sex	Number of patients with at least one error	Number of patients with at least one prescription item	Error rate per patient (95% CI)
Female	82	178	46.07% (38.91-53.40)
Male	50	145	34.48% (27.23-42.53)
Total	132	323	40.87% (35.65-46.31)

7.3.3 How prescribing and monitoring errors varied with acute and repeat prescriptions in older patients

The prevalence of prescribing and monitoring errors on acute and repeat prescriptions over the 12-months record review period is presented in Table 35 below. It can be seen that repeat prescription items were associated with more errors than acute prescription items issued to older patients. Chi-squared two-tailed test showed that the difference was significant at $p < 0.05$ (P-Value=3.3E-05). This was also true at practice level.

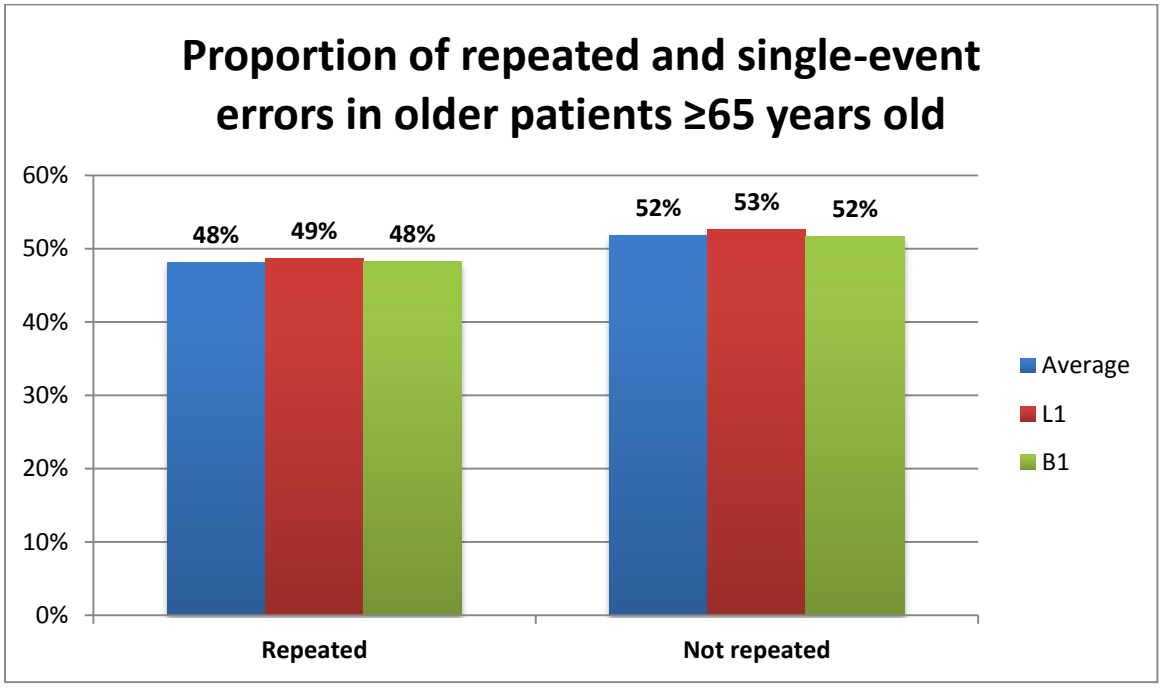
Table 35: Prevalence of prescribing and monitoring error for acute and repeat prescriptions prescribed to older patients ≥65 years old

Type of prescription	Number of errors on prescription	Percentage (95% CI)
Acute items	86	44.56% (37.72-51.61)
Repeat items	107	55.44% (48.39-62.28)
Total	193	100%

7.3.4 Reoccurrences of prescribing and monitoring errors in older patients ≥65 years old

During data collection, potential errors were reviewed as to whether they had occurred as a single event or had been repeated. Figure 16 below shows that comparable proportions of errors had occurred as single events and repeated in both practices.

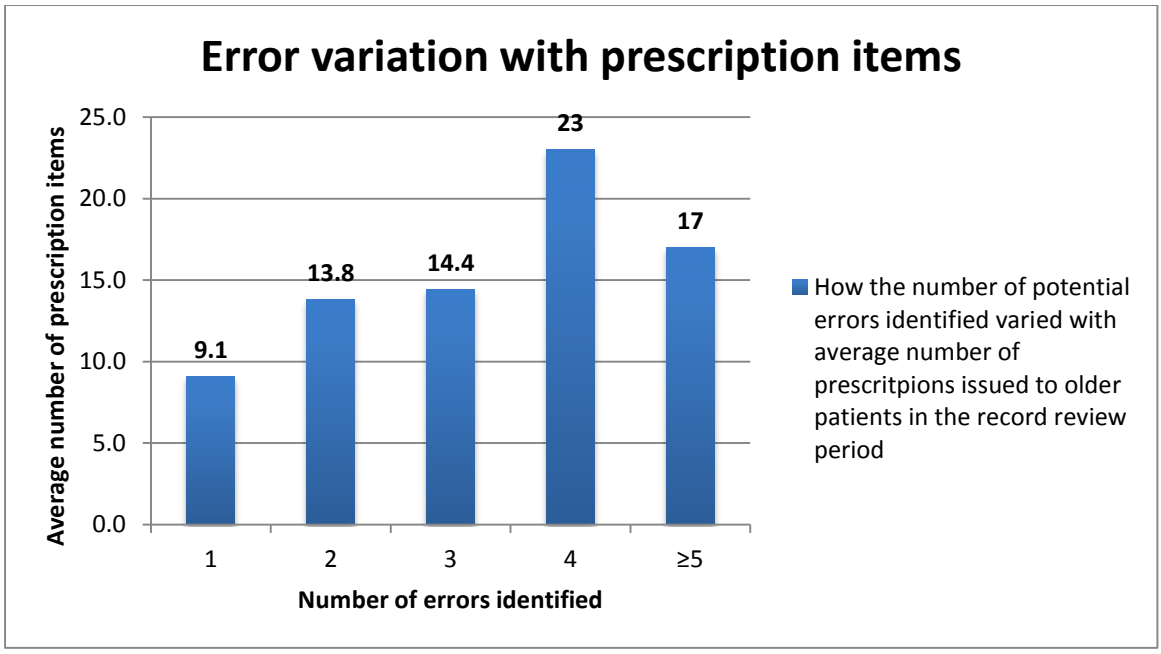
Figure 16: Reoccurrences of potential prescribing and monitoring errors in older patients



7.3.5 How prescribing and monitoring error rates varied with the number of prescription items in older patients

Figure 17 below shows that number of errors identified in older patients increased with the average number of prescription items issued. This was also true in both practices.

Figure 17: How the average number of prescription items varied with the number of errors identified



7.4 Types of prescribing and monitoring errors in older patients 65 years and over

The distributions of the different types of prescribing and monitoring errors for older patients are shown in Table 36 and Table 37 below respectively. It can be observed that more than a third of prescription errors were associated with information being incomplete on the prescription. Over two thirds or 70% of prescribing errors were associated with the top four categories of prescribing errors namely incomplete information on prescription, omission error relating to failure to prescribe concomitant medication, duplication, and inadequate review.

Table 36: Distribution of different types of prescribing errors for older patients ≥65 years

Types of prescribing error	Frequency	Percentage
Incomplete information on prescription	62	37%
Omission error relating to failure to prescribe concomitant medication	22	13%
Duplication	21	13%
Inadequate Review	11	7%
Dose/strength error	8	5%
Quantity error	8	5%
Timing error	7	4%
Frequency error	6	4%
Interaction error	5	3%
Inadequate documentation on medical records	5	3%
Allergy error	4	2%
Formulation error	4	2%
Duration Error	4	2%
Incorrect drug	1	1%
Unnecessary drug	0	0%
Contraindication error	0	0%
Generic/brand name error	0	0%
Not classified	0	0%
Total	168	100%

Table 37: Distribution of different types of monitoring errors in older patients ≥65 years

Types of monitoring error	Frequency	Percentage
Monitoring not requested	23	92.00%
Requested but not done	0	0.00%
Results not available	0	0.00%
Results not acted upon	2	8.00%
Total	25	100.00%

Most monitoring errors were associated with laboratory testing not ordered (Table 37).

At practice level, incomplete information on prescription remained the most frequently occurring type of prescribing error representing 42% and 32% of all categories in L1 and B1 respectively. The top four categories accounted for just over 70% of all types of errors in each individual practice, and comprised the top four categories shown in Table 36 above in B1; inL1, dose/strength error, was 4th in place of inadequate review (Table 38 below).

Table 38: Comparison of distribution of different types of prescribing errors for older patients ≥65 years old in L1 and B1

Types of prescribing error	Frequency L1	%, L1	Types of prescribing error	Frequency B1	%, B1
Incomplete information on prescription	32	42.11	Incomplete information on prescription	30	32.61
Duplication	9	11.84	Omission error relating to failure to prescribe concomitant medication	15	16.30
Omission error relating to failure to prescribe concomitant medication	7	9.21	Duplication	12	13.04
Dose/strength error	6	7.89	Inadequate Review	10	10.87
Timing error	6	7.89	Inadequate documentation on medical records	5	5.43
Quantity error	6	7.89	Formulation error	4	4.35
Interaction error	5	6.58	Frequency error	4	4.35
Frequency error	2	2.63	Duration Error	4	4.35
Incorrect drug	1	1.32	Allergy error	3	3.26
Allergy error	1	1.32	Dose/strength error	2	2.17
Inadequate Review	1	1.32	Quantity error	2	2.17
Unnecessary drug	0	0	Timing error	1	1.09
Contraindication	0	0	Unnecessary drug	0	0
Formulation error	0	0	Incorrect drug	0	0
Generic/brand name error	0	0	Contraindication error	0	0
Inadequate documentation on medical records	0	0	Interaction error	0	0
Not classified	0	0	Generic/brand name error	0	0
Duration Error	0	0	Not classified	0	0
Total	76	100		92	100

7.4.1 Drugs commonly associated with potential errors in older patients

Table 39 below shows the drugs most commonly associated with prescribing errors in older patients. There were 73 different drugs associated with prescribing errors in older patients in total, and the 14 shown in the table accounted for over 50% of the errors.

Table 39: Drugs most commonly associated with prescribing errors in older patients ≥65 years old

Preparation name	Dosage form	Frequency	Percentage
Naproxen	Tablets	17	10.12
Eumovate®	Cream and ointment	12	7.14
Prednisolone	Tablets	10	5.95
Betamethasone/Betnovate®	Cream/ointment/scalp application	7	4.17
Hydrocortisone	Cream and ointment	7	4.17
Levothyroxine	Tablets	7	4.17
Dermovate®	Cream and ointment	6	3.57
Daktacort®	Cream and ointment	5	2.98
Chloramphenicol	Eye drops and eye ointment	4	2.38
Simvastatin	Tablets	4	2.38
Alendronic acid	Tablets	3	1.79
Diprosalic®	Ointment and scalp application	3	1.79
Furosemide	Tablets	3	1.79
Ibuprofen	Tablets	3	1.79
Paracetamol	Capsules and tablets and caplets	3	1.79
Total		94	55.95

Table 40 below shows the drugs most commonly associated with prescribing errors in older patients in L1 and B1. There were 43 and 46 drugs associated with prescribing errors in total, in L1 and B1 respectively, and the 16 shown in Table 40 below accounted for 64% and 65% of the errors in both practices respectively.

Table 40: Comparison of drugs most commonly associated with prescribing errors in older patients ≥65 years old in L1 and B1

Preparation name	Frequency L1	% L1	Preparation name	Frequency B1	% B1
Levothyroxine	6	7.89	Naproxen	11	11.96
Naproxen	6	7.89	Clobetasone	7	7.61
Betamethasone valerate	5	6.58	Prednisolone	6	6.52
Clobetasone	5	6.58	Miconazole/Hydrocortisone	5	5.43
Prednisolone	4	5.26	Hydrocortisone	5	5.43
Clobetasol	3	3.95	Chloramphenicol	4	4.35

Diprosalic®	2	2.63	Alendronic acid	3	3.26
Etodolac	2	2.63	Clobetasol	3	3.26
Furosemide	2	2.63	Betamethasone Valerate	2	2.17
Gliclazide	2	2.63	Bisoprolol Fumarate	2	2.17
Hydrocortisone	2	2.63	Co-codamol 30/500	2	2.17
Indometacin	2	2.63	Ibuprofen	2	2.17
Hydrocortisone butyrate (Locoid®)	2	2.63	Atorvastatin	2	2.17
Paracetamol	2	2.63	Ramipril	2	2.17
Simvastatin	2	2.63	Simvastatin	2	2.17
Spironolactone	2	2.63	Timodine®	2	2.17
Total	49	**64.47**		60	**65.22**

7.4.2 Therapeutic classes of drugs commonly associated with potential errors in older patients

When the drugs associated with errors in older patients were grouped into their therapeutic classes, topical corticosteroids were topmost on the list as shown in Table 41 below. The top 12 therapeutic drug classes associated with a prescribing error accounted for over two thirds of all errors in older patients.

Table 41: Therapeutic drug classes associated with a prescribing error in older patients ≥65 years

Therapeutic drug class	Frequency	Percentage
Corticosteroid-topical	37	22
NSAID	26	15
Corticosteroid-topical + antimicrobials and anti-inflammatory	15	9
Corticosteroid-oral	10	6
Diuretic	7	4
Thyroid and antithyroid hormone	7	4
Statin	6	4
ACE-I/Angiotensin II blocker	5	3
Antibacterial	5	3
Antidepressant	4	2
Bisphosphonate	4	2
Opioid	4	2
Total	130	77

The top 8 therapeutic classes associated with a prescribing error in older patients in L1 and B1 are shown in Table 42 below. It can be seen that topical corticosteroids and NSAIDS were the two topmost drug classes mostly associated with prescribing errors in both practices.

Table 42: Comparison of the therapeutic drug classes associated with a prescribing error in older patients ≥65 years old

Therapeutic drug class	Frequency L1	% L1	Therapeutic drug class	Frequency B1	% B1
Corticosteroid-topical	18	23.68	Corticosteroid-topical	19	20.65
NSAID	13	17.11	NSAID	14	15.22
Diuretic	6	7.89	Corticosteroid-topical with antimicrobial	10	10.87
Thyroid/Anti-thyroid hormone	6	7.89	Corticosteroid-oral	6	6.52
Corticosteroid-topical with antimicrobial	5	6.58	Antibacterial	5	5.43
Corticosteroid-oral	4	5.26	ACE-I/Angiotensin II blocker	4	4.35
Antidepressant	3	3.95	Bisphosphonate	4	4.35
NSAID-topical	3	3.95	Statin	4	4.35
Total	58	76.32		66	71.74

7.4.3 BNF chapters of the drugs commonly associated with prescribing errors in older patients

Table 43 below outlines the proportion of prescribing errors by their BNF chapters. It can be observed that the top BNF chapters associated with prescribing errors were those that also accounted for the highest numbers of prescriptions in Table 16 above.

Table 43: Proportion of prescribing errors from different BNF chapter

BNF Chapter	British National Formulary chapter	Frequency	Percentage
13	Skin	55	32.74
10	Musculoskeletal and joint diseases	30	17.86
6	Endocrine system	25	14.88
2	Cardiovascular system	24	14.29
4	Central nervous system	18	10.71
11	Eye	7	4.17
1	Gastro-intestinal system	2	1.19
3	Respiratory system	2	1.19
5	Infections	2	1.19
9	Nutrition and blood	2	1.19
7	Obstetrics, gynaecology, and urinary-tract disorders	1	0.60
	Total	168	100.00

At practice level, the top five BNF chapters associated with prescribing errors were identical in L1 and B1, and included Skin, Cardiovascular system, Endocrine system, Central Nervous System, and Musculoskeletal and joint diseases.

7.4.4 Drugs commonly associated with monitoring errors in older patients

Table 44 shows the drug preparations associated with monitoring errors. It can be seen that Bendroflumethiazide, Lisinopril, Levothyroxine, and Losartan accounted for 60% of the errors.

Table 44: Drugs associated with monitoring errors

Preparation name	Formulation	Frequency	Percentage
Bendroflumethiazide	Tablets	5	20.00
Lisinopril	Tablets,	5	20.00
Levothyroxine	Tablets	4	16.00
Losartan Potassium	Tablets	2	8.00
Simvastatin	Tablets	2	8.00
Amias® (Candesartan)	Tablets	1	4.00
Amiodarone	Tablets	1	4.00
Carbimazole	Tablets	1	4.00
Co-amilozide	Tablets	1	4.00
Furosemide	Tablets	1	4.00
Priadel®	Tablets	1	4.00
Total		25	100

7.4.5 BNF Chapters of drugs commonly associated with monitoring errors

Table 45 shows the proportion of monitoring errors by their BNF chapters. Most of the drugs, which were associated with a monitoring error, were from the cardiovascular chapter.

Table 45: Proportion of monitoring errors by the different BNF Chapters

BNF chapter	BNF chapter name	Frequency	Percentage
2	Cardiovascular system	19	76
6	Endocrine system	5	20
4	Central nervous system	1	4
	Total	25	100

7.5 Information on different types of prescribing errors in older patients

Additional information is provided below on the drug preparations, which were most commonly associated with the different types of potential prescribing errors discussed in (Table 36) above.

7.5.1 Incomplete information on prescription

62 incomplete information errors in older patients involved 23 different preparations as shown in Table 46. Some of the prescriptions were associated with directions such as "as directed," and "as advised by hospital prescriber." The other categories of incomplete prescription information related to the use of topical steroid or steroid-containing preparations in patients ≥65 years old, without specifying either the duration of use or part being treated, when the quantity prescribed and patient's mental health state had been assessed from the medical notes.

Table 46:Drug preparations most commonly associated with incomplete information on the prescription in older patients

Preparation name	Frequency	Percentage
Betacap*, Betamthasone Valerate, Betnovate®	6	10
Canesten HC ®	1	2
Daktacort ®	5	8
Dermovate ®	5	8
Diprosalic ®	2	3
Dovobet®	1	2
Elocon®	1	2
Etopan XL ®	1	2
Eumovate®	10	16
Fucibet®	2	3
Fucidin H®	2	3
Furosemide	2	3
Gliclazide	2	3
Hydrocortisone	7	11
Indometacin	1	2
Locoid®	1	2
Lumigan®	1	2
Metformin	1	2
NovoMix®	1	2
Prednisolone	2	3
Spironolactone	1	2
Synalar®	1	2
Timodine®	2	3
Trimovate®	2	3
Xalatan®	2	3
Total	62	100

The therapeutic classes of the drugs most commonly associated with incomplete information on the prescription from Table 46 are shown in Table 47 below. It can be observed that topical steroids accounted for over 75% of all prescriptions with this type of prescribing error.

Table 47: Therapeutic drug classes most commonly associated with incomplete information on the prescription in older patients

Therapeutic class	Frequency	Percentage
Topical steroid	31	50
Topical steroid containing	17	27
NSAID	2	3
Diuretic	3	5
Anti-diabetic	3	5
Anti-glaucoma	3	5
Insulin	1	2
Oral steroid	2	3
Total	62	100

The BNF chapters most commonly associated with incomplete prescription information in older patients are shown in Table 48 below. It can be seen that skin preparations made up over 75% of this type of error.

Table 48: BNF chapters associated with incomplete information on prescriptions in older patients

Chapter name	Chapter number	Frequency	Percentage
Skin	13	48	77
Musculoskeletal and joint disease	10	2	3
Cardiovascular system	2	3	5
Endocrine system	6	6	10
Eye	11	3	5
Total		62	100

7.5.2 Duplication

The 21 duplication errors involved 19 different drug preparations. Of these, 5 (24%) were associated with co-prescription of two oral (or oral and topical) non-steroidal anti-inflammatory drugs (NSAIDs) without information to avoid concomitant use; 5 (24%) were associated with co-prescription of two paracetamol-containing opioid analgesic, or one alongside paracetamol, with no advice to avoid concomitant use; 4 (19%) scenarios were related to continued prescription of beta-blockers and diuretics, when a prescriber had noted their discontinuation while prescribing alternative preparations or strengths.

7.5.3 Omission error relating to failure to prescribe concomitant medication

Of the 22 omission errors relating to failure to prescribe concomitant treatment, 19 (85%) involved the use of oral non-steroidal anti-inflammatory drugs, NSAIDS in older patients ≥65 years, without co-prescription of gastro-protective agents to protect against gastrointestinal bleeding. One omission error related to failure to prescribe a Bisphosphonate as an adjunct treatment to a patient with osteoporosis despite previous recommendation from their hospital consultant as detailed in a discharge note. Another omission error related to a 79-year old female on long-term Prednisolone daily without concomitant regular administration of a bisphosphonate (in this case, Zoledronic acid), although a plan for annual administration of Zoledronic acid was specified by a different GP in the patient's medical record.

7.5.4 Inadequate review

The 11 inadequate review errors involved 10 different drug preparations. Three of these (27%) were associated with Angiotensin receptor inhibitors namely Ramipril, Lisinopril and Enalapril. In all three cases, the prescriber had noted in patients' record to discontinue the medications for various reasons. However, they continued to be prescribed, in one case, up to 3 repeats before being discontinued. Two (18%) were related to discontinuation of Simvastatin on account of side effects, by the prescriber or patient, without attempting a switch to other suitable statins with better side effect profiles even though patients' cardiovascular risks suggested potential therapeutic benefits with cholesterol-regulating agents.

7.5.5 Dose/strength error

The 8 dose or strength errors involved 7 different drug preparations. Two of this error type related to Simvastatin. In one case, Simvastatin 40mg daily at night was prescribed to a 70-year old female on repeat prescription alongside Amlodipine 5mg daily against the Medicines and Healthcare Regulatory Agency (MHRA) advice to limit the dose of Simvastatin to 20mg daily when co-prescribed with Amlodipine to reduce the incidence of side effects. The second Simvastatin error was, a random strength reduction from 20mg to 10mg for three months and then back up to 20mg, with no notes in the medical record to explain the sudden change suggesting a strength selection error.

One error was associated with the prescription of Etodolac 600mg modified-release tablets daily, for pain and inflammation, to an 89-year old female patient with reduced renal function (GFR at last test was 39ml/min (low; normal = >60ml/min) with elevated serum creatinine from previous biochemistry results.

One error was associated with the prescription of Naproxen at a high starting daily dose of 500mg twice daily to a 67-year old male for sciatica.

The other preparations associated with this error type further included one each for Gaviscon advance, Atorvastatin, Spironolactone and Zopiclone.

7.5.6 Quantity error

The 8 quantity errors involved 6 different drug preparations. Of these, 2 were associated with consecutive and overlapping supply of paracetamol to 82- and 98-year old female patients. In one case, it was documented in the medical record that the patient had made suicidal threats a month after the supplies were made.

2 quantity errors were associated with the prescription of Prednisolone for acute exacerbations of respiratory disease. In both cases, the numbers of tablets supplied to the patients were each 34 tablets short of the quantity required as per the directions on the prescription i.e. 40 tablets of 30mg (6 tablets) of Prednisolone 5mg daily for 14 days.

2 quantity errors were associated with consecutive and overlapping supply of the Schedule 2 controlled drugs, OxyContin® and OxyNorm®.

7.5.7 Timing error

Only two drug preparations associated with 7 timing errors were identified. 6 of these were due to Levothyroxine being prescribed with advice to take at bedtime for underactive thyroid. The BNF currently advises that Levothyroxine is taken preferably 30 minutes before breakfast and caffeine-containing liquids (e.g. coffee, tea), or other medication. Another potential timing error was associated with oral Prednisolone prescribed to an 84-year old female patient for acute exacerbation of respiratory disease, with the directions “take 6 daily,” and no advice to take as a single dose in the morning after breakfast as recommended by the BNF.

7.5.8 Frequency error

The 6 frequency errors involved 3 different drug preparations. Of these, 4 (67%) were associated with Chloramphenicol eye drops and ointment, which appeared to have a default direction in one practice's clinical computer system as "apply 4 times a day for 2 days and continue for 48 hours after resolution." The BNF recommends that Chloramphenicol is administered "1 drop at least every 2 hours then reduce frequency as infection is controlled and continue for 48 hours after healing." Moreover, most over-the-counter preparations contain similar directions to the BNF. Another frequency error related to Locoid ointment, a potent steroid, which is recommended for once or twice daily application but had been prescribed irregularly over 2 years to an older patient for three times daily application. The last frequency error related to a repeat prescription for Gabapentin 300mg capsules issued over three months to a 69-year old patient with unclear frequency of use – one to three times daily or three times daily.

7.5.9 Interaction error

There were 5 drug combinations, which were classed as potential interaction errors from information obtained from the BNF online and drug information on SystmOne GP clinical computer system. They included

- Clomipramine (tricyclic and related antidepressant) with Sodium Valproate (antiepileptic) – tricyclic and related antidepressants antagonize anticonvulsant effect of antiepileptics lowering the convulsive threshold
- Clomipramine with Amitriptyline (both tricyclic antidepressants) to an older patient
- 84-year old female patient on Digoxin (cardiac glycoside) 125mcg daily with Furosemide (loop diuretic) 80mg daily – increased cardiac toxicity with cardiac glycosides if hypokalemia occurs with loop diuretics. Patient had shortness of breath and exercise intolerance with resulting hospital investigations for most of the year
- Fluoxetine (a selective serotonin reuptake inhibitor, SSRI) with Warfarin (a coumarin), to an 82-year old female patient – anticoagulant effect of coumarins possibly enhanced by SSRIs, leading to increased risk of bleeding. Patient has been prescribed iron supplements though it was unclear if this was linked to this potential error

- 67-year old female prescribed oral fluconazole (enzyme inhibitor) 50mg daily for 14 days alongside repeat Simvastatin 20mg at night, with no advice to temporarily discontinue Simvastatin.

7.5.10 Other errors in older patients

Important points from the analyses of the other types of error are highlighted below:

- Of the 5 inadequate documentation errors, three related to medications for long-term conditions (Alendronate, Ramipril and Atorvastatin), which were not necessarily discontinued by the GP at any point, but which were not regularly issued thereby raising questions during routine medicines' reviews at the surgery. One case related to Citalopram at a dose of 10mg daily, which was changed to 'alternate days' on two consecutive prescriptions, following which a surgery reception staff re-printed the original 10mg daily prescription. There was no documentation in the record to indicate if these dose variations were intentional. The last scenario was associated with a patient on repeat Levothyroxine tablets whose medical notes indicated that they were *"not on any thyroid treatment as euthyroid."*
- Of the 4 allergy errors, three were associated with prescriptions for Risedronate, Amoxicillin and Clopidogrel, despite there been clear documentation of previous allergies or sensitivities. There were no details with respect to the severity or nature of their sensitivities in the cases involved Risedronate and Clopidogrel. The last case was associated with a 66-year old female patient with a history of uncontrolled asthma (and two oral prednisolone courses in the 12-months review period) who was also prescribed Naproxen at a high daily dose of 1000mg twice in the review period.
- Of the 4 formulation errors, three involved Prednisolone prescriptions to a patient diagnosed with oesophagitis, gastritis and bile reflux, at three different strengths with a missed opportunity to prescribe the enteric-coated formulation to alleviate gastric symptoms. The 4th potential formulation error was also related to Prednisolone: 70-year old male on long-term Prednisolone 40mg daily on repeat with documented gastric acid problems.
- All the duration errors related to topical steroids at quantities, which could result in extended use without corresponding advice on duration of use.

7.6 Information on different types of monitoring errors in older patients

Additional information is provided below on the drug preparations, which were most commonly associated with the different types of monitoring errors discussed in

Table 37.

Monitoring not requested: The 23 monitoring-not-requested errors were associated with 12 medications: Candesartan, Amiodarone, Bendroflumethiazide, Carbimazole, Co-amilozide, Furosemide, Levothyroxine, Lisinopril, Losartan, Lithium, Ramipril and Simvastatin. In all the instances, laboratory tests were not ordered when due.

Results not acted upon: The two results-not-acted-upon, were both associated with Levothyroxine doses not adjusted according to endocrinology results.

7.7 Analysis of omission errors related to failure to prescribe a drug for an existing clinical condition in older patients ≥65 years old

The reviewer identified 20 older patients with 23 possible omission errors relating to failure to prescribe for an existing clinical condition, from the review of 364 case notes. These scenarios were those there were no notes in the medical records to suggest a decision not to supply had been made by the GP or in accordance with a patient's preference. They were separate from those errors associated with failure to prescribe concomitant treatment. These cases included the following:

Drug implicated	Description of Omission error
Statin	4 possible cases of failure to prescribe in patients who may benefit from the primary or secondary prevention of cardiovascular events
Aspirin	5 possible cases of failure to prescribe aspirin in patients with coronary heart disease
Bisphosphonate and/or calcium	6 possible cases of failure to prescribe a bisphosphonate and/or calcium to maintain bone mineral density in confirmed cases of osteoporosis or long-term oral steroid treatment
Colchicine and Allopurinol	For acute and chronic gout treatments as opposed to continued use of NSAIDs to manage inflammation
Brufen M/R ®	Dose-reduction of long-term 800mg of Brufen M/R up to twice daily (patient was adamant he did not require PPI)
Addition of diuretic (or dose optimisation	Diuretic, or dose optimization of Losartan in a 71-year old female with uncontrolled hypertension who was on Losartan 25mg daily

of Losartan)	
Anti-diabetic agent	Anti-diabetic drugs not prescribed to a patient who was referred to the DESMOND diabetes structured programme but who did not attend, with sustained elevated Plasma Fasting Glucose level
Vitamin D supplement	Vitamin D supplement not prescribed to an 85-year old male with low levels of Vitamin D – 29.9nmol/L (reference range 80-150nmol/L) and documented limited or restricted movement, on-going tiredness and weight-loss
Metformin	Metformin to a patient following an elevated HbA1c level – the GP had suggested that Metformin would "*give patient better CV protection than Gliclazide."* Metformin was subsequently prescribed but not issued due to "*repeat inactivation."*
Iron supplements	Two cases of failure to prescribe iron supplements when haematology tests showed low iron levels.

7.8 Severity assessment of medication errors

207 case summaries representing a total of 216 prescribing and monitoring errors identified in older patients were presented to the judges (to reduce the judges' workload, some errors were summarised as one if they were for the same patient since some of the errors were identical). The distribution of severity scores amongst the judges was sometimes skewed, though most of the errors were judged as having lower severity scores. Descriptive statistics were therefore presented using median scores and IQR. Mean scores were also calculated to provide comparison with the median and the existing literature.

For older patients, the mean severity score was 3.1, and the median was 3.0 (IQR 2.5, 4.0). The minimum severity score was 0 (no harm), and the maximum score was 9. Monitoring errors had a median score of 3.5 (IQR 3.5, 4.0). Overall, 104 (~50%) errors had scores of less than 3 (minor), 102 (~50%) had scores of 3 to 7 (moderate). Although there were isolated cases of 'severe' category by each individual judge, no two judges classed the same error as severe. Most monitoring errors were judged as being of moderate severity. Appendix 21 provides examples of judgments made by the panel.

Examples of minor and moderate errors, and some errors judged as severe by individual judges is shown below:

Table 49: Examples of errors and their severities

Minor errors	Moderate errors	Severe (individual judges)
Diprosalic® ointment and	76-year old male taking	67-year old female prescribed

Dovobet® gel prescribed to 76-year old male at the same time. Both the ointment and gel contain Betamethasone 0.05% (as dipropionate), a potent steroid. Duration of use not specified. Also on other steroids Patient's mental difficulties documented.	Priadel 400mg at night. Lithium requires 12-monthly Thyroid Function Tests (TFTs). TFTs last ordered in 2011 (2 missed opportunities from date of review for testing thyroid function)	Prednisolone tablets 5mg (Acute) with the directions 'COPD: Take six daily as a single dose for 14 days. Steroid.' At the stated dose, a 14-day course will require a total of 84 tablets. Only 40 tablets were prescribed
83-year old female prescribed 30 Cetirizine tablets (acute) for hayfever. Two weeks after, 30 tablets of Loratadine (repeat) 10mg tablets were prescribed for 'itch.'	An 81-year old female prescribed Ketoprofen gel 2.5%, (Acute) Ketoprofen capsules 50mg (Repeat) and Diclofenac gel 1% (Repeat) on the same day	81-year old female prescribed Naproxen 250mg three times daily on acute prescription without gastro-protection in Dec 2013. Patient presented with "…small blood after wiping and epigastric pain in Jan 2014
77-year old male on Losartan 12.5mg daily on repeat prescription. Angiotensin II receptor antagonists require 12 monthly urea and electrolytes test, which was last ordered for the patient in May 2013 (record was reviewed Aug 2014)	40mg Simvastatin tablets issued to 70-year old female on repeat with Amlodipine 5mg. MHRA advice is to limit dose of Simvastatin to 20mg when co-prescribed with Amlodipine	79-year old female prescribed acute Amoxicillin capsules 500mg three times daily for 7 days despite recorded sensitivity to Amoxicillin in 2010. Details of the sensitivity was not recorded in patient's record
65-year old female prescribed HRT Estradiol® pessaries 10micrograms daily for two weeks then twice weekly. Patient's last recorded blood pressure reading was 180/90mmHg	Acute 112 Naproxen 250mg tablets issued to 67-year old male at a dose of two twice daily for Sciatica. No gastro-protective agent for 28-day course of Naproxen tablets	79-year old female on repeat Ramipril capsules 10mg daily. In Sep 2013, a prescriber recorded in patient's record "needs to stop Ramipril see comment re renal artery." However, Ramipril continued to be issued till May 2014

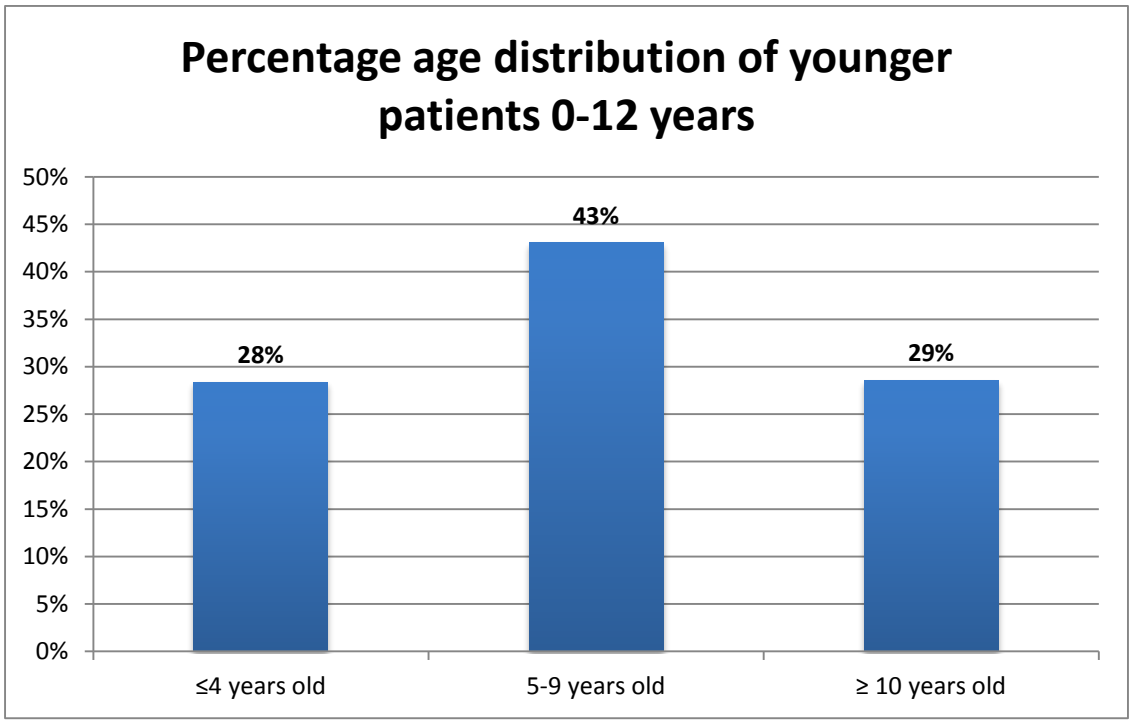
Chapter 8. Results of the investigations on the prevalence and nature of prescribing errors in children

8.0 Characteristics of paediatric patients 0-12 years old

The study involved the retrospective review of the records of 525 younger patients 0-12 years old. These younger patients had a mean age of 6.49 years (SD=3.54), and 254 (48.38%) were female. Of the 12-months retrospective record review period, these patients were registered for an average of 11.40 months. Of the 525 younger patients 0-12 years reviewed, 282 (53.71%) had had at least one prescription during the 12-months retrospective examination of their records.

The percentage age distribution of older patients whose records were examined is shown in Figure 18.

Figure 18: Age distribution of younger patients 0-12 years old



At practice level, the study involved the examination of 237 (18.76%) of 1263 registered patients aged 0-12 years old in L1; the number of records reviewed in B1 was 288 (16.28%) of 1769 registered patients aged 0-12 years. The mean ages of these patients were 5.92 years (SD = 3.35) and 6.96 years (SD = 3.62) in L1 and B1 respectively. The proportion of younger male patients reviewed in L1 was higher than that of female patients at 54.85%. In B1 however, the proportion of younger male and female patients reviewed were comparable at 48.96% and 51.04% respectively. Of the 12-months retrospective record review period, these younger patients were registered for an average of 11.00- and 11.72-months in L1 and B1 respectively.

The proportion of younger patients who had had at least one medication in the 12-months record review period in L1 and B1 were comparable at 56.96% and 51.04%% respectively.

Age distribution of patients whose records were reviewed was comparable for patients 5-9 years old in both practices; this patient age group accounted for over 40% of all younger patients reviewed. However, the proportion of younger patients ≤4 years old reviewed was higher in L1 than in B1. Conversely, the proportion of younger patients ≥10 years old was higher in B1 than in L1.

The percentage age distribution of younger patients in L1 and B1 are compared below in Table 50:

Table 50: Comparison of age distribution of younger patients 0-12 years old in L1 and B1

Age range	Number of patients L1	Percentage age frequency L1 (%)	Number of patients B1	Percentage age frequency B1 (%)
≤4 years old	76.00	32.07	73.00	25.35
5-9 years old	110	46.41	116	40.28
≥ 10 years old	51	21.52	99	34.38
All 0-12 years	237.00	100.00	288.00	100.00

8.1 Characteristics of prescriptions reviewed for younger patients 0-12 years old

In total, 755 unique prescription items for 282 younger patients 0-12 years were reviewed. Of these, 188 (24.90%) were repeat prescriptions, and 567 (75.10%) were acute prescriptions. Only one item (Epilim Chronosphere®) prescribed to a child was an item, which was considered as requiring blood test monitoring.

Including those patients without a prescription item issued in the 12-months record review period, the median number of prescriptions per younger patient was 1 (IQR 2); excluding patients without a prescription item, the median number of prescriptions per younger patient was 2 (IQR 2). The highest number of prescription items issued to any younger patient 0-12 years during the review period was 14.

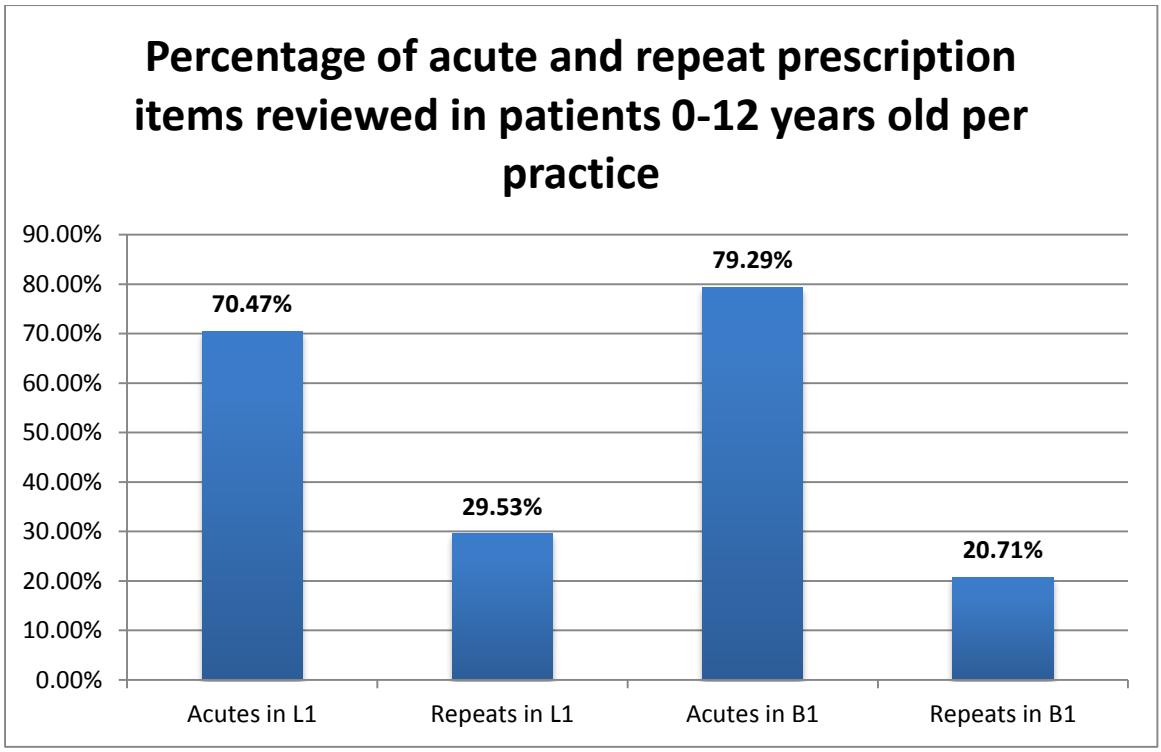
Of the 755 prescriptions items, male patients received the majority at 437 (57.88%). Table 51 below provides information on how the number of prescription items varied with younger patients' age ranges. It can be seen that the average numbers of prescriptions per patient were comparable across the three age ranges.

Table 51: How prescription items varied with age for younger patients 0-12 years

Age range (years)	Number of prescriptions	Number of patients with at least one prescription item	Average number of prescription items per patient
0-4.99	344	124	2.77
5.00-6.99	311	113	2.75
≥10.00	100	45	2.22
All 0-12 years	755	282	2.68

At practice level, 359 unique prescription items for 135 younger patients were reviewed in L1. Of these, 106 (29.53%) were repeat prescriptions and 253 (70.47%) were acute prescriptions. In B1, 396 unique prescription items for 147 younger patients were reviewed. The proportions of repeat and acute prescriptions for younger patients in B1 were 82 (20.71%) and 314 (79.29%) respectively as shown in **Figure 19** below.

Figure 19: Percentage of acute and repeat prescription items reviewed in younger patients in L1 and B1



Including and excluding patients without a prescription item issued in the 12-months review period, the median number of prescriptions per younger patient in both L1 and B1 were comparable at 1 (IQR 2) and 2 (IQR 2) respectively.

Of the 359 and 396 unique prescription items reviewed in L1 and B1 younger male patients received the majority in both L1 and B1 at 234 (65.18%), and 203 (51.26%) respectively. Table 52 below compares how the number of prescription items varied with older patients' age ranges in L1 and B1. It can be seen that average number of prescription items per patient were comparable across the three age ranges in both practices.

Table 52: How prescription items varied with age in younger patients between L1 and B1

Age range (years)	Number of Rx items L1	Patients with at least one Rx item L1	Average number of prescription items per patient L1	Number of Rx items B1	Patients with at least one Rx item B1	Average number of prescription items per patient B1
0-4.99	155	58	**2.67**	189	66	**2.86**
5.00-6.99	158	57	**2.77**	153	56	**2.73**
≥10.00	46	20	**2.30**	54	25	**2.16**
All 0-12 years	359	135	**2.66**	396	147	**2.69**

8.1.1 Characteristics of acute and repeat prescription items reviewed in younger patients

Acute prescription items were recorded for 257 younger patients, and the median number of unique acute prescription items per younger patient was 2 (IQR 2), with the highest number prescribed to any patient being 9.

Repeat prescriptions were recorded for 86 younger patients, and the median number of unique repeat prescription item per younger patient was 2 (IQR 1.25), with the highest number prescribed to any patient being 12.

Table 53 below shows the number of younger patients, who were prescribed a range of acute and repeat prescriptions. It can be seen that over three quarters of younger patients had three or less acute and repeat prescription items.

Table 53: Number of younger patients with ranges of acute and repeat prescription items

Number of acute prescription items	Number of younger patients 0-12 yrs. (%)	Number of repeat prescription items	Number of younger patients 0-12 yrs. (%)
≤3	213 (82.88)	≤3	78 (90.70)
4-7	39 (15.18)	4-7	6 (6.98)
8-11	5 (1.95)	8-11	1 (1.16)
12-15	0 (0)	12-15	1 (1.16)
≥16	0 (0)	≥16	0 (0)
567	**257 (100)**	**188**	**86 (100)**

At practice level, acute prescription items were recorded for 121 younger patients in L1, and the median number of unique acute prescription items per younger patient was 2 (IQR 2), with the highest number of acute prescriptions issued to any patient being 8. Acute prescription items were recorded for 136 older patients in B1, and the median number of unique acute prescription items per younger patient was comparable with L1 at 2 (IQR 2), with a maximum of 9 acute prescriptions issued to any patient.

In L1, repeat prescription items were recorded for 44 younger patients, and the median number of unique repeat prescription items per younger patient was 2 (IQR 2) with the highest number prescribed to any patient being 12. Repeat prescription items were recorded for 42 younger patients in B1, and the median number of unique repeat prescription items per older patient was 2 (IQR 1), the maximum number of repeat prescription items issued to any patient being 8.

Table 54 below compared the number of younger patients who were prescribed a range of acute and repeat prescriptions in L1 and B1. It can be seen that over 80% of patients had three or less acute and repeat prescription items in both practices.

Table 54: How the number of younger patients with ranges of acute and repeat prescription items varied

Number of acute prescription items	**Number of younger patients 0-12 years**		**Number of repeat prescription items**	**Number of younger patients 0-12 years**	
	L1 (%)	B1 (%)		L1 (%)	B1 (%)
≤3	103 (85.12)	110 (80.88)	≤3	38 (86.36)	40 (95.24)
4-7	17 (14.05)	22 (16.18)	4-7	5 (11.36)	1 (2.38)
8-11	1 (0.83)	4 (2.94)	8-11	0 (0)	1 (2.38)
12-15	0	0	12-15	1 (2.27)	0
≥16	0	0	≥16	0	0
All 0-12 years	121	136		44	42

Results on how the number of acute and repeat prescription items varied with younger patients' age is provided in Table 55 below. It can be seen that the average numbers of acute and repeat prescriptions per patient were comparable across the three age ranges. This is similar at practice level as shown in Table 56 below.

Table 55: How acute and repeat prescription items varied with younger patients' age

Age range (years)	Total Acute items	Number of patients	Average number of acute prescriptions per patient	Total Repeat items	Number of patients	Average number of repeat prescriptions per patient
0-4.99	271	114	**2.38**	73	37	**1.97**
5.00-6.99	222	105	**2.11**	89	34	**2.62**
≥10.00	74	38	**1.95**	26	15	**1.73**
All 0-12 years	567	257	**2.21**	188	86	**2.19**

Table 56: Comparison of acute and repeat prescription items varied with younger patients' age between L1 and B1

Age range (years)	Total Acute items	Number of patients	Average number of acute prescriptions per patient	Total Repeat items	Number of patients	Average number of repeat prescriptions per patient
L1						
0-4.99	116	52	2.23	39	16	2.44
5.00-6.99	103	53	1.94	55	20	2.75
≥10.00	34	16	2.13	12	8	1.50
All 0-12 years	253	121	2.09	106	44	2.41
B1						
0-4.99	155	62	2.50	34	21	1.62
5.00-6.99	119	52	2.29	34	14	2.43
≥10.00	40	22	1.82	14	7	2.00
All 0-12 years	314	136	2.31	82	42	1.95

8.1.2 Characteristics of drugs commonly prescribed to younger patients

8.1.2.1 BNF chapters

The different groups of drugs prescribed to younger patients by British National Formulary, BNF chapter are shown in Table 57 below. It can be observed that the most commonly prescribed drugs for younger patients were those for skin, infections, and respiratory system; these drugs made up almost two thirds of prescriptions.

Table 57: Distribution of prescription items reviewed by BNF Chapter for younger patients 0-12 years

Chapter	Chapter name	Frequency	Percentage
13	Skin	235	31.13%
5	Infections	188	24.90%
3	Respiratory system	139	18.41%
11	Eye	52	6.89%
1	Gastro-intestinal system	40	5.30%
12	Ear, nose and oropharynx	24	3.18%
9	Nutrition and blood	19	2.52%
4	Central nervous system	18	2.38%
6	Endocrine system	15	1.99%
7	Obstetrics, gynaecology, and urinary-tract	12	1.59%
15	Anaesthesia	5	0.66%
Appendix 2	Borderline substances	5	0.66%
10	Musculoskeletal and joint diseases	2	0.26%
2	Cardiovascular system	0	0.00%
8	Malignant disease and immunosuppression	0	0.00%
14	Immunological products and vaccines	0	0.00%
	Total	755	100.00%

At practice level, drugs for skin, infections, respiratory system, eye and gastro-intestinal system were the top five BNF chapters most commonly prescribed for younger patients in both L1 and B1 Table 58. These drug classes made up over 80% of all prescriptions in both practices.

Table 58: Comparison of drug distribution by BNF chapter in L1 and B1

BNF chapter name	Frequency L1	% L1	BNF chapter name	Frequency B1	% B1
Skin	**132**	**36.77**	**Infections**	**114**	**28.79**
Infections	**74**	**20.61**	**Skin**	**103**	**26.01**
Respiratory system	**56**	**15.60**	**Respiratory system**	**83**	**20.96**
Gastro-intestinal system	**19**	**5.29**	**Eye**	**33**	**8.33**
Eye	**19**	**5.29**	**Gastro-intestinal system**	**21**	**5.30**
Ear, nose and oropharynx	15	4.18	Nutrition and blood	10	2.53
Central nervous system	10	2.79	Ear, nose and oropharynx	9	2.27
Obstetrics, gynaecology, and urinary-tract disorders	10	2.79	Central nervous system	8	2.02
Nutrition and blood	9	2.51	Endocrine system	7	1.77

Endocrine system	8	2.23	Borderline substances	4	1.01
Anaesthesia	3	0.84	Obstetrics, gynaecology, and urinary-tract disorders	2	0.51
Musculoskeletal and joint diseases	2	0.56	Anaesthesia	2	0.51
Borderline substances	1	0.28			
Unclassified (Eqe Q capsules)	1	0.28			
Total	359	100		396	100

8.1.2.2 Drugs commonly prescribed in younger patients

The top 20 drugs most frequently prescribed to younger patients are shown in Table 59 below. It can be observed that these drugs made up almost two thirds of prescriptions.

Table 59: Top 20 drugs most commonly prescribed in younger patients 0-12 years

Preparation name	Frequency	Percentage
Amoxicillin	106	14.04
Salbutamol	61	8.08
Chloramphenicol	30	3.97
Hydrocortisone	29	3.84
Fusidin®	26	3.44
Clenil Modulite®	26	3.44
Flucloxacillin	21	2.78
Cetirizine	19	2.52
Oilatum®	19	2.52
Clotrimazole	15	1.99
Fucithalmic®	14	1.85
Phenoxymethylpenicillin	14	1.85
Doublebase®	13	1.72
Movicol® Paediatric Plain	12	1.59
Miconazole	11	1.46
Trimethoprim	11	1.46
Zerobase®	11	1.46
Dioralyte®	10	1.32
Chlorphenamine	9	1.19
Co-amoxiclav	8	1.06
Total	465	61.59

At practice level, Amoxicillin and Salbutamol were the top two most frequently prescribed drugs to younger patients in both L1 and B1. Most of the drugs in this list were comparable,

and made up approximately 65% of all drugs prescribed to younger patients in both practices as shown in Table 60 below.

Table 60: Comparison of the top 20 drugs most commonly prescribed to younger patients in L1 and B1

L1			B1		
Preparation name	**Frequency**	**%**	**Preparation name**	**Frequency**	**%**
Amoxicillin	44	12.26	**Amoxicillin**	62	15.66
Salbutamol	25	6.96	**Salbutamol**	36	9.09
Fusidic acid	16	4.46	**Chloramphenicol**	18	4.55
Hydrocortisone	15	4.18	**Clenil Modulite®**	17	4.29
Cetirizine	13	3.62	**Hydrocortisone**	14	3.54
Oilatum®	13	3.62	Fucithalmic®	13	3.28
Chloramphenicol	12	3.34	Flucloxacillin	11	2.78
Flucloxacillin	10	2.79	**Fusidic acid**	10	2.53
Clenil Modulite®	9	2.51	Zerobase®	9	2.27
Miconazole	9	2.51	Chlorphenamine	8	2.02
Clotrimazole	8	2.23	Phenoxymethylpenicillin	8	2.02
Doublebase®	8	2.23	Clotrimazole	7	1.77
Movicol	7	1.95	Cetirizine	6	1.52
Aveeno®	6	1.67	Miconazole HC	6	1.52
Dioralyte®	6	1.67	Erythromycin Ethyl Succinate	6	1.52
Diprobase®	6	1.67	Gaviscon	6	1.52
Hydrous Ointment	6	1.67	Oilatum®	6	1.52
Phenoxymethylpenicillin	6	1.67	Trimethoprim	6	1.52
Prednisolone	6	1.67	Clarithromycin	5	1.26
Clotrimazole HC	5	1.39	Co-amoxiclav	5	1.26
Total	230	64.07		259	65.40

8.1.2.3 Therapeutic classes of commonly prescribed drugs in younger patients

When the drugs prescribed to younger patients were grouped into their therapeutic classes, antibacterial drugs were topmost on the list, similar to older patients. This was also true in both L1 and B1. The top 20 drug classes most commonly prescribed to younger patients are shown in Table 61 below. It can be seen that these drug classes made up over 90% of the prescriptions.

Table 61: Top 20 therapeutic drug classes most commonly prescribed in younger patients 0-12 years

Drug class	Frequency	Percentage
Antibacterial	251	33.25%
Corticosteroid/corticosteroid-containing	112	14.83%
Emollient	104	13.77%
Bronchodilator	62	8.21%
Antihistamine	32	4.24%
Laxative	25	3.31%
Antifungal	24	3.18%
Anti-infective	13	1.72%
Antacid	10	1.32%
Electrolyte replacement	10	1.32%
Anthelmintic	8	1.06%
Leukotriene receptor antagonist	8	1.06%
Anti-warts	7	0.93%
Sodium Chloride	7	0.93%
Anaphylaxis treatment	6	0.79%
Multivitamin	6	0.79%
Non-opioid	6	0.79%
ADHD management	5	0.66%
Anaesthetic	5	0.66%
Anti-inflammatory	5	0.66%
Total	706	93.50%

At practice level, antibacterial drugs were also topmost on the list of the therapeutic drug classes prescribed to younger patients, comparable with older patients (see Table 21). Corticosteroids and corticosteroid combinations, Emollients, Bronchodilators, and Antihistamines, and Anti-infective agents, were the topmost therapeutic drug classes most commonly prescribed to younger patients in both practices as shown in Table 62, It can be observed that these top therapeutic classes made up approximately 94% of all prescriptions in younger patients.

Table 62: Comparison of the top 20 therapeutic drug classes commonly prescribed to younger patients 0-12 years in L1 and B1

L1			**B1**		
Therapeutic Drug class	**Frequency**	**%**	**Therapeutic Drug class**	**Frequency**	**%**
Antibacterial	101	28.13	Antibacterial	144	36.36
Emollient	62	17.27	Corticosteroid/corticosteroid-containing	67	16.92
Corticosteroid/cortic	48	13.37	Emollient	42	10.61

osteroid-containing					
Bronchodilator	25	6.96	Bronchodilator	37	9.34
Antifungal	22	6.13	Antihistamine	15	3.79
Antihistamine	17	4.74	Laxative	9	2.27
Laxative	16	4.46	Antacid	8	2.02
Anti-infective	7	1.95	Anti-infective	6	1.52
Electrolyte replacement	6	1.67	Anaphylaxis treatment	5	1.26
Sodium Chloride	5	1.39	Anthelmintic	5	1.26
Anti-inflammatory	4	1.11	Cough suppressant	5	1.26
Non-opioid analgesic	4	1.11	Leukotriene receptor antagonist	5	1.26
Anaesthetic	3	0.84	ADHD management	4	1.01
Anthelmintic	3	0.84	Anti-warts	4	1.01
Anti-warts	3	0.84	Antifungal	4	1.01
Leukotriene receptor antagonist	3	0.84	Electrolyte replacement	4	1.01
Lubricant	3	0.84	Specialised formula	4	1.01
Multivitamin	3	0.84	Multivitamin	3	0.76
Shampoo	3	0.84	Anaesthetic	2	0.51
Antacid	2	0.56	Antisecretory and mucosal protectant	2	0.51
Total	340	94.71		375	94.70

8.1.2.4 Characteristics of drug formulations commonly prescribed in younger patients

Table 63 shows the distribution of different formulations for the 755 prescription items issued to younger patients. It can be seen that oral and topical medications made up over 70% of prescriptions for this age group.

Table 63: Distribution of different types of formulation prescribed to younger patients 0-12 years

Formulation	Frequency	Percentage
Liquid oral	255	33.77%
Topical	254	33.64%
Inhalers	92	12.19%
Solid oral	72	9.54%
Eye/ear/nose/ointment or drops/sprays	70	9.27%
Injection	10	1.32%
Mouthwash	1	0.13%
Suppositories/Pessaries	1	0.13%
Total	755	100.00%

In L1 and B1, the distributions of the different formulations for the prescription items issued to younger patients were comparable as shown below in Table 64.

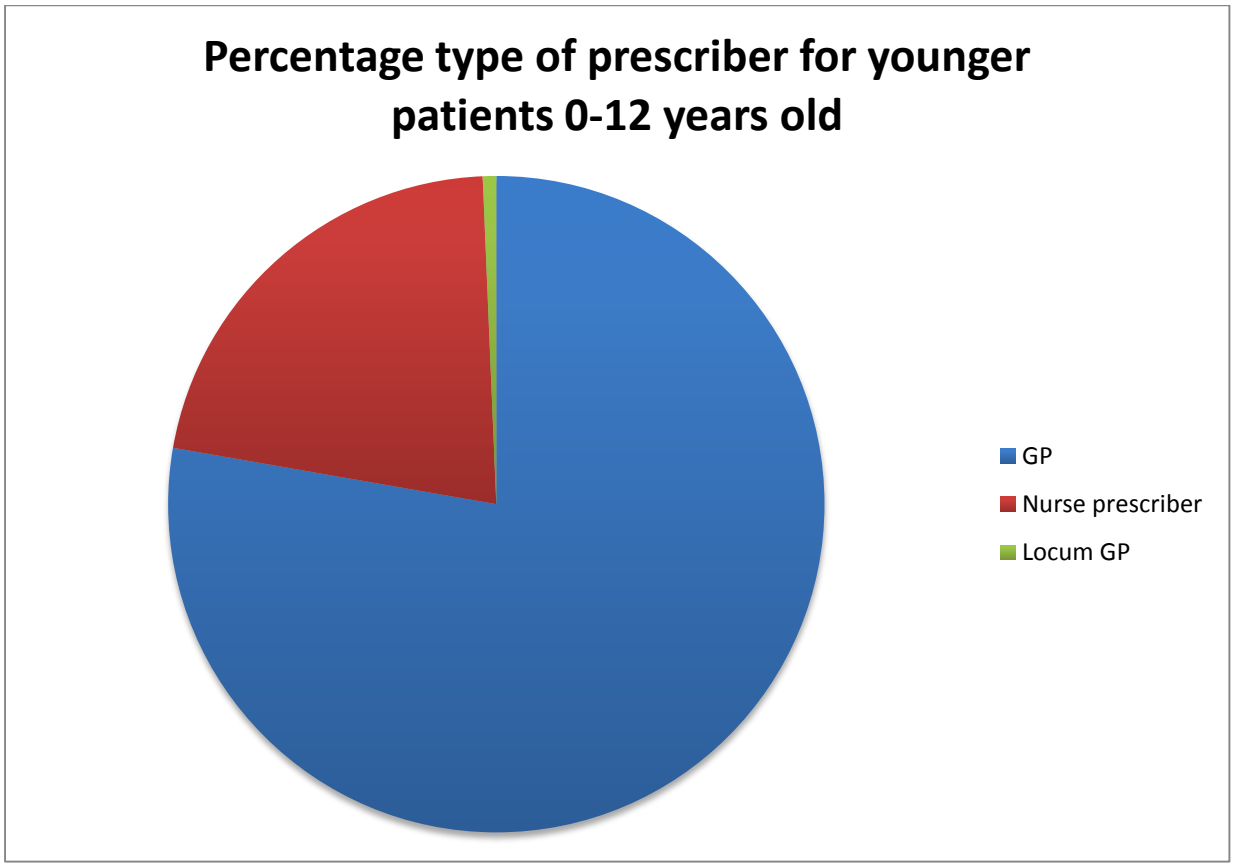
Table 64: Comparison of the different types of formulation prescribed to younger patients 0-12 years in L1 and B1

Formulation	Frequency L1	Percentage L1	Frequency B1	Percentage B1
Eye/ear/nose/ointment or drops/sprays	33	9.19	37	9.34
Inhalers	36	10.03	56	14.14
Injection	1	0.28	9	2.27
Liquid oral	109	30.36	148	37.37
Mouthwash	1	0.28	0	0.00
Solid oral	36	10.03	36	9.09
Suppositories/Pessaries	0	0.00	1	0.25
Topical	143	39.83	109	27.53
Total	359	100.00	396	100.00

8.1.3 Types of prescriber

The distributions of different types of prescriber for the prescription items are shown in Figure 20. It can be seen that the vast majority of prescription items were issued by the surgery's GPs. The percentage of prescriptions issued by nurse prescriber was higher than for older patients (see **Error! Reference source not found.**)

Figure 20: Types of prescribers that issued the prescription items in the study to younger patients 0-12 years old



8.2 Prevalence of prescribing errors for younger patients 0-12 years old

From the review of the 755 prescription items in younger patients 0-12 years, the following numbers of medication problems were identified:

1. 70 prescribing errors and 3 omission errors relating to failure to prescribe for an existing condition (73 in total).
2. No monitoring errors were identified in children 0-12 years old.

8.2.1 Prescribing and monitoring error rates in younger patients

8.2.1.1 Error rate per patient

- 57 of 282 younger patients 0-12 years, (20.21%, 95% CI 15.94%-25.28%) with at least one prescription item in the review period, had at least one prescribing error. There was a mean of 1.23 errors per patient.
- When prescribing and omission errors (relating to failure to prescribe for an existing condition) were combined, 59 of 282 younger patients, (20.92%, 95% CI 16.58%-26.04%) with at least one prescription in the record review period had at least one error.

The prevalence of prescribing errors in younger patients grouped into three age bands is shown in Table 65 below:

Table 65: Prevalence of prescribing errors in younger patients

Age (yrs.)	Number of patients with errors	Number of patients with at least one prescription item	Prevalence of all errors (95% CI)
≤4.99	23	124	18.55 (12.69-26.30)
5.00-≤9.99	31	113	27.43 (20.05-36.30)
≥10.00	5	45	11.11 (4.84-23.50)
Total	59	282	20.92 (16.58-26.04)

It can be observed that patients 5.00-9.99 years old were more likely to have an error though this did not reach statistical significance at $p<0.05$ (Chi-square test, $p=0.051$).

The Chi-square two-tailed statistic test demonstrated that paediatric patients in B1 were significantly more likely to have a potential error when compared with paediatric patients in L1. (P-Value=0.033).

8.2.1.2 Error rate per item

- Of 755 prescription items reviewed in younger patients 0-12 years old, 70 prescribing errors were identified with a prevalence rate of prescribing errors per item being 9.27% (95% CI 7.4%-11.55%).
- When prescribing and omission errors (relating to failure to prescribe for an existing condition) were combined, 73 errors were identified. This gave a prevalence of prescribing errors per item of 9.67% (95% CI 7.76%-11.99%).

At practice level, paediatric patients in B1 (12.12%) were significantly more likely to have an error compared with L1 (6.96%) (P-value = 0.017; Two-tailed Z-test for two population proportions).

Summarily, the prevalence of prescribing and monitoring errors per item and per patient, in the 12-months record review period is shown Table 66 below.

Table 66: The prevalence of prescribing errors in younger patients 0-12 years old

Age (years)	Prescribing error rate (and omission) per item	Prescribing error rate per patient with at least one prescription
0-4.99	8.43%	18.55%
5.00-6.99	**12.22%**	**27.43%**
≥10.00	6.00%	11.11%
All 0-12 years	**9.67%**	**20.92%**

The error rates per patient shown above did not reflect that one patient could have had more than one error. When the error rate was determined by expressing the total number of errors as a percentage of patients with at least one prescription item, a higher prevalence of 25.89% (95% CI 21.13%-31.30%) was obtained (see Figure 21 below); the figures were 18.52% (95% CI 12.87%-25.91%) and 32.65% (95% CI 25.60%-40.59%), in L1 and B1respectively (a two-tailed Z test for 2 population proportions demonstrated that the difference was significant, P-value=0.0067;). The prevalence of errors in younger patients for the three age groups was consistently higher in B1 than in L1 (see Figure 22 below).

Figure 21: Prevalence of errors per patient 0-12 years old

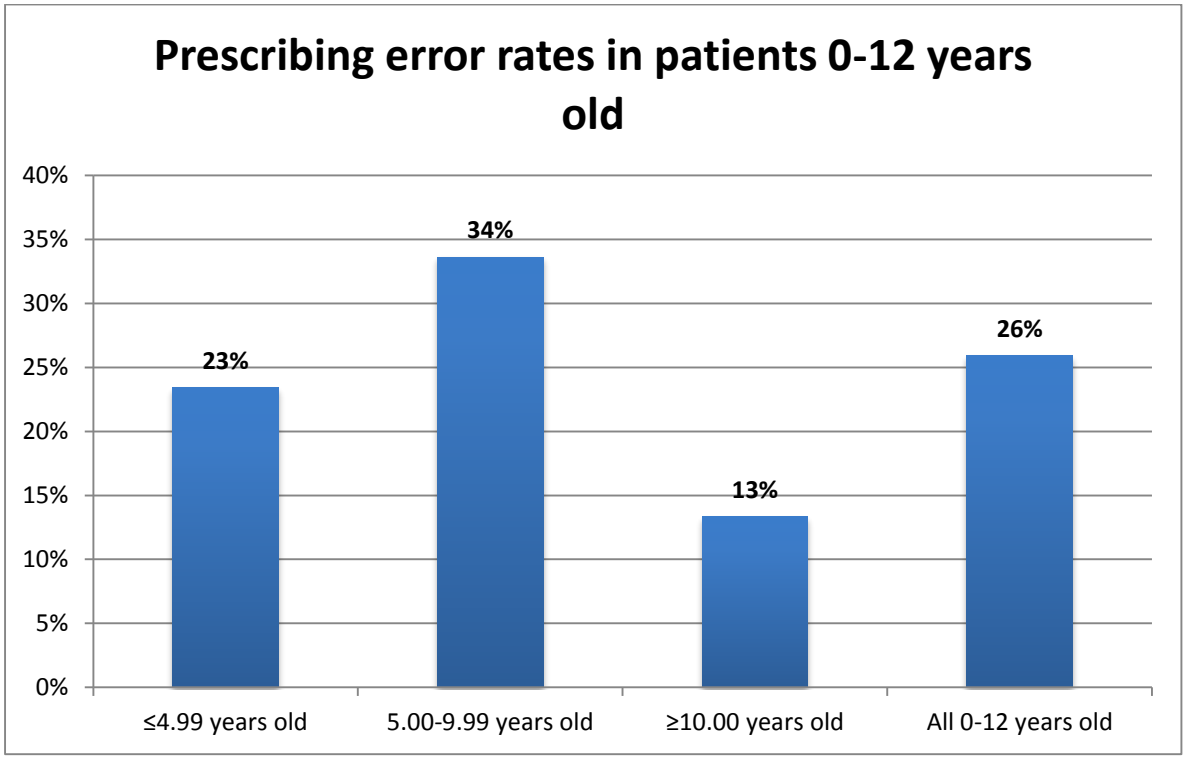
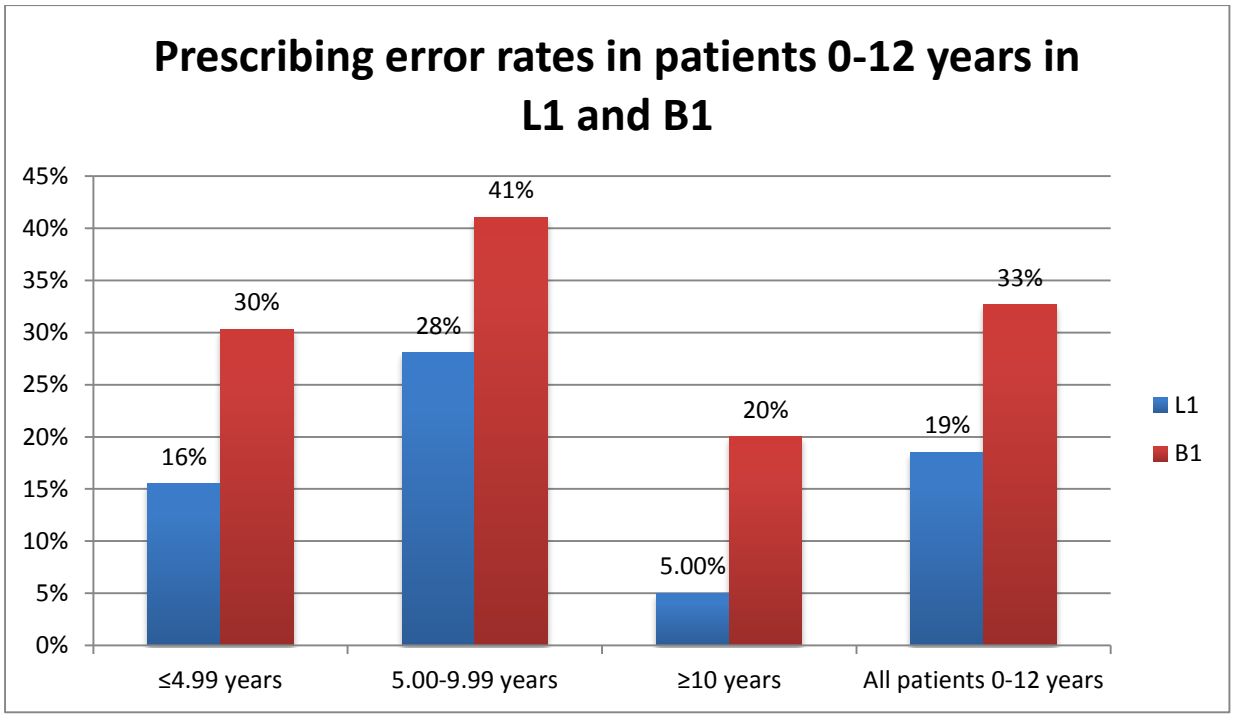


Figure 22: Comparison of prevalence of errors per patients 0-12 years old in L1 and B1



8.2.2 How prescribing and monitoring error rates varied with younger patients' sex

The prevalence of errors per patients' sex is presented in Table 67 below. It can be observed that comparable proportions of female and male patients had a potential error though more items prescribed to female patients were associated with errors.

Table 67: Prevalence of prescribing errors for male and female younger patients 0-12 years

	Number of prescription errors	Total prescription items	Prescription error rate per item	Patients with at least one prescription item	Prescription error rate per patient
Female	36	318	11.32%	133	27.07%
Male	37	437	8.47%	149	24.83%
Total	73	755	**9.67%**	282	**25.89%**

When the prevalence of errors was determined by expressing the number of patients who had at least one error as a percentage of patients with at least one prescription item, error rate per patient 0-12 years were 20.30% (95% CI 14.34%-27.92%) for female patients, and 21.48% (95% CI 15.65%-28.75%) for male patients. It can be observed that comparable proportions of female and male patients had at least one error. Two-tailed Chi-square statistical test showed that there was no statistical difference between male and female younger patients (P-Value=0.808).

Female patients in B1 were however significantly more likely to experience an error when compared with L1 (P-value=0.02); errors in male patients were comparable in both practices (P-Value=0.45).

8.2.3 How prescribing errors varied with acute and repeat prescriptions in younger patients 0-12 years

The prevalence of prescribing errors for acute and repeat prescriptions over the 12-months record review period is presented in Table 68 below. It can be seen that acute prescription items were associated with significantly more errors than repeat prescription items in younger patients (two tailed Chi-square test at 0 $p<0.05$; P-Value=0.00031). Acute prescriptions in B1 were more likely to have an error when compared with acute prescriptions in L1; this reached statistical significance.

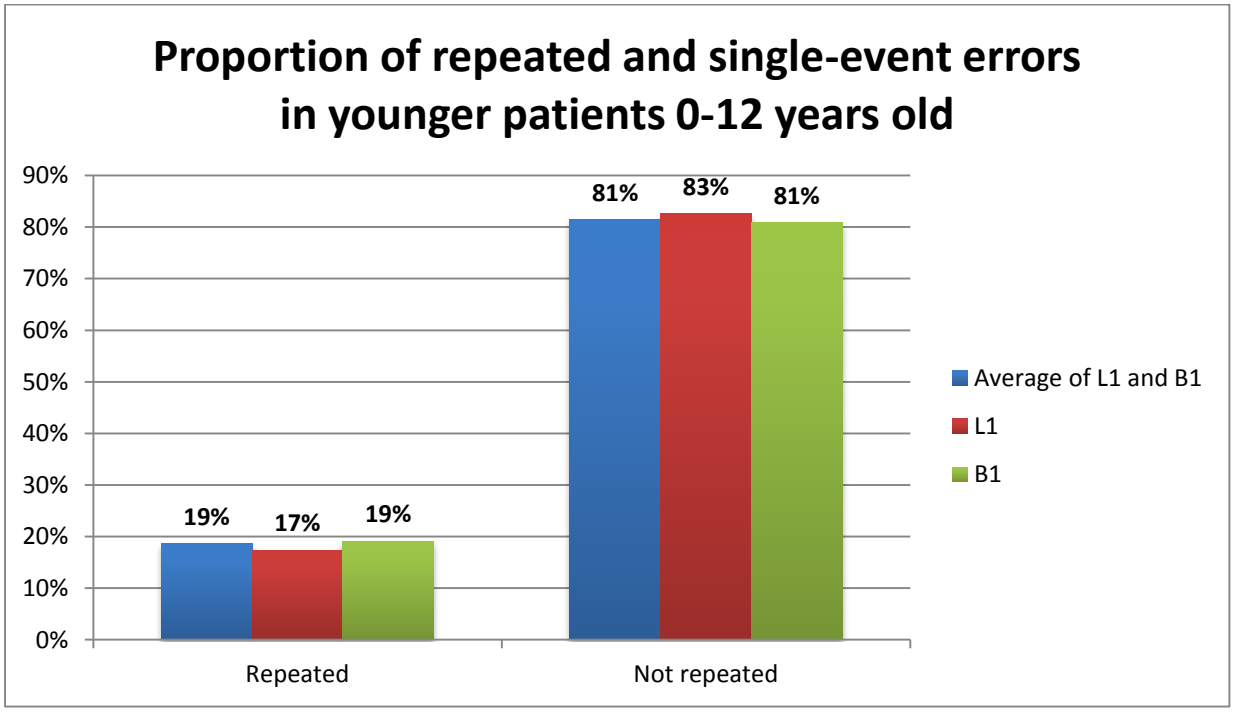
Table 68: Prevalence of prescribing errors for acute and repeat prescription items prescribed to younger patients 0-12 years

Type of prescription	Frequency of errors on prescription items	Percentage (95% CI)
Acute prescription items	65	92.86% (8.44%-9.69%)
Repeat prescription items	5	7.14% (3.09%-15.65%)
Total	70	100%

8.2.4 Reoccurrences of prescribing errors in younger patients 0-12 years

During data collection, potential errors were reviewed as to whether they had occurred as a single event or had been repeated one or more times. Figure 23 below shows that most errors in younger patients had not been repeated, and approximately 20% errors had been repeated in younger patient.

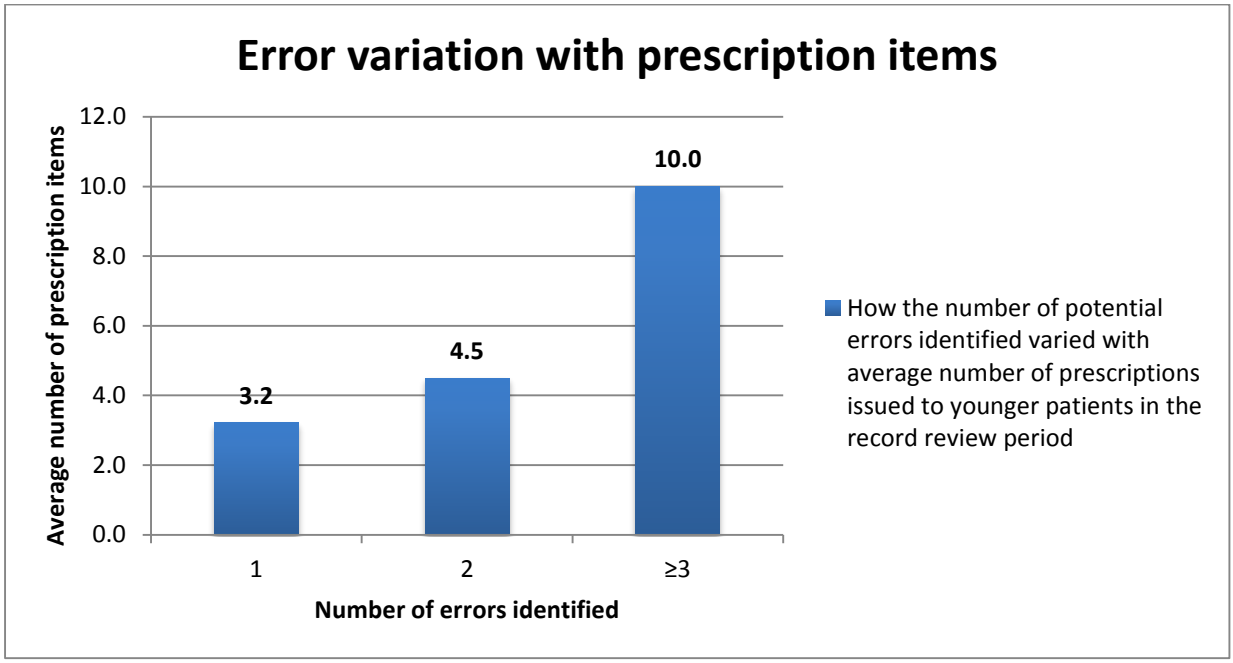
Figure 23: Reoccurrences of potential prescribing errors in younger patients



8.2.5 How prescribing error rates varied with the number of prescriptions in younger patients

Figure 24 below showed that the number of errors identified in the younger patient group increased with the average number of prescriptions.

Figure 24: Error variation with prescription items in younger patients



8.3 Types of prescribing errors in younger patients 0-12 years old

The distributions of the different types of prescribing errors for younger patients are shown in Table 69. It can be observed that more than a third of prescription errors were associated with information being incomplete on the prescription. Over three quarters of prescribing errors were associated with the top three categories of prescribing errors as shown in below.

Table 69: Distribution of different types of prescribing errors for younger patients 0-12 years old

Types of prescribing error	Frequency	Percentage
Incomplete information on prescription	32	45.71
Dose/strength error	17	24.29
Frequency error	8	11.43
Inadequate documentation on medical records	3	4.29
Quantity error	3	4.29
Inadequate Review	3	4.29
Unnecessary drug	2	2.86
Formulation error	2	2.86
Total	70	100

At practice level, incomplete information on prescription remained the most frequently occurring type of prescribing error in younger patients, representing 52.17% and 42.55% of all categories in L1 and B1 respectively as shown in Table 70 below.

Table 70: Comparison of distribution of different types of prescribing errors for younger patients 0-12 years old in L1 and B1

Types of prescribing error	Frequency L1	%, L1	Types of prescribing error	Frequency L1	%, L1
Incomplete information on prescription	12	52.17	Incomplete information on prescription	20	42.55
Dose/strength error	5	21.74	Dose/strength error	12	25.53
Quantity error	3	13.04	Frequency error	8	17.02
Formulation error	2	8.70	Inadequate documentation on medical records	3	6.38
Inadequate Review	1	4.35	Unnecessary drug	2	4.26
			Inadequate Review	2	4.26
Total	23	100.00		47	100

8.3.1 Drugs commonly associated with potential errors in younger patients

Table 71 below shows the drugs most commonly associated with prescribing errors in younger patients. There were 20 different drugs associated with prescribing errors in younger patients in total, and the 7 shown in the table below accounted for over 80% of the errors

Table 71: Drugs most commonly associated with prescribing errors in younger patients 0-12 years

Preparation name	Dosage form	Frequency	Percentage
Amoxicillin	Oral suspension	17	24.29
Hydrocortisone	Ointment and cream	10	14.29
Chloramphenicol	Eye drops	8	11.43
Daktacort®	Cream	8	11.43
Canesten HC®	Cream	7	10.00
Timodine®	Cream	4	5.71
Fucidin H®	Cream	3	4.29
Total		57	81.43

Table 72 below shows the drugs most commonly associated with prescribing errors in younger patients in L1 and B1. In total, there were 11 and 13 drugs associated with prescribing errors in L1 and B1 respectively. In both practices, Amoxicillin topped the list.

Table 72: Comparison of drugs most commonly associated with prescribing errors in younger patients 0-12 years old in L1 and B1

Preparation name	Frequency L1	% L1	Preparation name	Frequency B1	% B1
Amoxicillin	6	26.09	Amoxicillin	11	23.40
Canesten HC®	5	21.74	Chloramphenicol	8	17.02
Hydrocortisone	3	13.04	Hydrocortisone	7	14.89
Daktacort®	2	8.70	Daktacort®	6	12.77
Cetirizine	1	4.35	Timodine®	4	8.51
Clenil Modulite	1	4.35	Fucidin H®	3	6.38
Eumovate®	1	4.35	Canesten HC®	2	4.26
Eurax-HC	1	4.35	Clarithromycin	1	2.13
Ketoconazole	1	4.35	Erythromycin Ethyl Succinate	1	2.13
Movicol	1	4.35	Kolanticon®	1	2.13
Qvar®	1	4.35	Mebeverine	1	2.13
			Salbutamol	1	2.13
			Trimethoprim	1	2.13
Total	23	100		47	100

8.3.2 Therapeutic classes of drugs commonly associated with potential errors in younger patients

When the drugs associated with errors in younger patients were grouped into their therapeutic classes, antibacterial drugs were topmost on the list as shown in Table 73 below.

Table 73: Therapeutic drug classes associated with prescribing errors in younger patients 0-12 years old

Therapeutic drug class	Frequency	Percentage
Antibacterial	28	40.00
Corticosteroid-topical with antimicrobial	22	31.43
Corticosteroid-topical	11	15.71
Bronchodilator	3	4.29
Antifungal	1	1.43
Antihistamine	1	1.43
Antisecretory and mucosal protectants	1	1.43
Antispasmodic	1	1.43
Corticosteroid-topical with antipruritic	1	1.43
Laxative	1	1.43
Total	70	100

The topmost therapeutic drug class associated with prescribing errors in L1 and B1 were Corticosteroid (with antimicrobial agents) and antibacterial drugs respectively as shown in Table 74 below.

Table 74: Comparison of the therapeutic drug classes associated with prescribing errors in younger patients 0-12 years old

Therapeutic drug class	Frequency L1	% L1	Therapeutic drug class	Frequency B1	% B1
Corticosteroid-topical with antimicrobial	7	30.43	Antibacterial	20	42.55
Antibacterial	6	26.09	Corticosteroid-topical with antimicrobial	15	31.91
Corticosteroid-topical	4	17.39	Corticosteroid-topical	6	12.77
Bronchodilator	2	8.70	Bronchodilator	4	8.51
Antifungal	1	4.35	Antihistamine	1	2.1
Antihistamine	1	4.35	Corticosteroid-topical with antipruritic	1	2.13
Corticosteroid-topical with antipruritic	1	4.35			
Laxative	1	4.35			
Total	23	100		47	100

8.3.3 BNF chapters of the drugs commonly associated with prescribing errors in younger patients

Table 75 below outlines the proportion of prescribing errors in younger patients by their BNF chapters. It can be observed that the five BNF chapters associated with prescribing errors were those that also accounted for the highest numbers of prescriptions in Table 57 above.

Table 75: Proportion of prescribing errors in younger patients 0-12 years from different BNF chapters

BNF Chapter	British National Formulary chapter	Frequency	Percentage
13	Skin	35	50.00
5	Infections	20	28.57
11	Eye	8	11.43
3	Respiratory system	4	5.71
1	Gastro-intestinal system	3	4.29
	Total	70	100

At practice level, the proportions of prescribing errors in younger patients by their BNF chapters were comparable with Table 76 below.

Table 76: Errors in younger patients by BNF chapters

BNF chapter number	BNF chapter name	Frequency	%	BNF chapter number	BNF chapter name	Frequency	%
13	Skin	13	56.52	13	Skin	22	46.81
5	Infections	6	26.09	5	Infections	14	29.79
3	Respiratory system	3	13.04	11	Eye	8	17.02
1	Gastro-intestinal system	1	4.35	1	Gastro-intestinal system	2	4.26
				3	Respiratory system	1	2.13
Total		23	100			47	100

8.4 Information on different types of prescribing errors in younger patients

Additional information is provided below on the drug preparations, which were most commonly associated with the different types of prescribing errors in younger patients discussed in (Table 69) above.

8.4.1 Incomplete information on prescription

32 incomplete information errors involved 7 different skin preparations as shown in Table 77 below. The most common form of incomplete information related to the use of topical steroid or steroid and antimicrobial-containing preparations in young patients, with no specific advice on either duration of use or part being treated, when the quantity prescribed had been taken into consideration. It can be observed that hydrocortisone only, and in combination with Clotrimazole and Miconazole, were mostly associated with this error type. Quantities prescribed ranged mostly from 30grams to 60grams.

Table 77: Drug preparations most commonly associated with incomplete information on the prescription in younger patients

Preparation name	Frequency	Percentage
Canesten HC® (Clotrimazole and hydrocortisone)	6	19
Daktacort® (Miconazole and hydrocortisone)	7	22
Eumovate® (Clobetasone)	1	3
Eurax-Hydrocortisone®	1	3
Fucidin H® (Fusidic acid and hydrocortisone)	3	9
Hydrocortisone	10	31
Timodine®	4	13
Total	32	100

8.4.2 Dose/strength error

The 17 dose or strength errors involved 4 different drug preparations. Fourteen of this error type related to the prescription of incorrect doses of Amoxicillin to younger patients ≥5 years. For example, a 9-year old female patient was prescribed 100mls of Amoxicillin 125mg/5ml oral suspension three times daily, twice in seven days, following suspected treatment failure. (The BNF recommends a dose of 250mg three times daily for children ≥5 years old). The patient later presented at a NHS walk in centre with "yellowish discharge and eardrum perforation," and was later discharged with co-amoxiclav 250mg/5ml three times daily. One

dose error was also identified in a prescription of Erythromycin Ethyl Succinate 125mg/5ml every 6 hours to an 8year 2months old female.

8.4.3 Other errors in younger patients 0-12 years

Important points from the analyses of the other types of error in younger patients are highlighted below:

- **Frequency error:** the eight frequency errors related to unclear directions on Chloramphenicol eye drops or ointment, which were judged to have the potential to result in treatment failure.
- **Inadequate documentation in medical notes:** involved three scenarios: a 37 weeks old male child presented in June with a suspected penicillin allergy. As at August when the record was reviewed, there was still no annotation in the allergy and sensitivities section of the patient's notes; an almost 7-year old male prescribed Salbutamol inhaler twice in one week with no notes to suggest worsening symptoms or the possibility of storage in a 2nd place or school; lastly, a 9-year old female child prescribed two steroid-containing cream (with Clotrimazole and Fusidic acid) when patient presented with suspected 'eczema and fungal infection,' with no notes to suggest why an antibacterial-containing cream had been supplied in addition to a antifungal-containing cream.
- **Quantity error:** this error type involved only Amoxicillin where the quantity prescribed was short by a dose to complete the stated week's dosage.
- **Inadequate review:** Of the three inadequate review errors, two were associated with prescription of Kolanticon® gel and Mebeverine oral suspension to a 10 year old child with on-going stomach problems, despite a documented plan for hospital referral one month prior to both prescriptions. The third case was associated with non-optimization of asthma therapy in a 7-year old child with worsening asthma symptoms.
- **Unnecessary drug:** This error type was associated with the prescription of *Trimethoprim with* Gaviscon infant oral powder for a 51 week old baby for acid reflux, and Daktacort ® cream to a 2-year old child following a history of "*hurt on passing faeces… which on examination showed a degree of phimosis and marginal discomfort*."
- **Formulation error:** The two scenarios were prescription of Ketoconazole shampoo for suspected generalized rash on skin, and a switch from Clenil Modulite® to Qvar®, with no notes suggesting these were intended by GP.

8.5 Analysis of omission errors related to failure to prescribe a drug for an existing clinical condition in younger patients 0-12 years

The reviewer identified 3 younger patients with 3 possible omission errors relating to failure to prescribe for an existing clinical condition, from the review of 525 case notes. These scenarios were those, where there were no notes in the medical records to suggest a decision not to supply had been made by the GP or in accordance with a patient's preference. They were separate from those errors associated with failure to prescribe concomitant treatment. These cases were all related to failure to prescribe a "preventer" medication in accordance with the step-wise management of asthma in children.

8.6 Severity assessment of errors

71 case summaries representing a total of 72 prescribing errors identified in younger patients were presented to the judges (to reduce the judges' workload, some errors were summarised as one if they were for the same patient since some of the errors were identical). Similar to older patients, the distribution of severity scores amongst the judges was sometimes skewed, though most of the errors were judged as having lower severity scores. Descriptive statistics were therefore presented using median scores and IQR. Mean scores were also calculated to provide comparison with the median and the existing literature.

For younger patients, the mean severity score was 2.8, and the median was 3.0 (IQR 2, 3.5). The minimum severity score was 0 (no harm), and the maximum score was 8. Overall, 48 (~68%) errors had scores of less than 3 (minor), 23 (~32%) had scores of 3 to 7 (moderate). Although there were isolated cases of 'severe' category by each individual judge, no two judges classed the same error as severe.

Examples of minor and moderate errors, and some errors judged as severe by individual judges is shown **below:**

Table 78: Examples of error severities in paediatrics

Minor	Moderate	Severe
2-year 1month old child prescribed 30grams of Hydrocortisone/Miconazole 1%/2% cream acute prescription for twice daily application	7-year 1month old male prescribed 150mls of Amoxicillin 125mg/5ml with the dosage instructions "5ml three times daily for 7 days." BNF recommended dose	37-week old male child: In June 2014, patient presented with "rash, which was widespread, chest clear, bilateral tonsil inflammation, no photophobia, no neck sickness," following administration of an antibiotic given from hospital. The GP diagnosed "likely penicillin

to nappy area. Duration of use not stated	for children over 5years old require Amoxicillin 250mg/5ml three times daily	allergy." This information was however not completed in the "sensitivities/allergy" section of the patient's record till date (Aug 2014)

Chapter 9. Discussions on the findings of the investigation on prescribing and monitoring errors in older patients and children in general practice

9.0 Discussion

9.1 Summary of findings

From a 12-month retrospective review of the electronic medical records of a random sample of older patients ≥65 years from two purposively selected English general practices, prescribing and monitoring errors were identified in approximately 1 in 12 prescriptions, with 1 in 3 patients being exposed to a prescribing or monitoring errors. Most of the errors identified were of mild to moderate severity as judged by a multi-disciplinary group of clinical pharmacists. The factors associated with increased risk of prescribing or monitoring errors included: prescription of an increasing number of medications, being prescribed medications required laboratory blood testing, being ≥75 years old, being prescribed medication from the following therapeutic areas: corticosteroid (oral, topical, and topical in combination with antimicrobial agents), NSAID, diuretic, thyroid and antithyroid hormones, statins and ACE-I/ARB, and being prescribed medications from the following BNF chapters: Skin, Musculoskeletal and joint diseases, endocrine, cardiovascular, and central nervous systems, and eye.

For younger patients 0-12 years old who were also studied during the same period, approximately 1 in 10 prescriptions and 1 in 5 patients were exposed to a prescribing error. Most of the errors identified for this age group were also of mild to moderate severity. The factors associated with increased risk of prescribing errors included: being aged ≤10 years old, being prescribed three or more medications, being prescribed medication from the following therapeutic areas: topical corticosteroids, and when in combination with antimicrobial agents, bronchodilator, antibacterial, and being prescribed medication from the following BNF chapters: skin, infections, eye, respiratory and gastrointestinal systems.

This study was a small but pragmatic study undertaken to identify the prevalence and nature of prescribing and monitoring errors in general practices among older patients ≥65 years old, and children 0-12 years, following suggestions in the literature that these patient groups are more susceptible to significant errors compared with the rest of the population. One of the main strengths of the study is that it is the first study in England to estimate the prevalence and nature of prescribing and monitoring errors in the study populations of older patients in children in primary care. This section discusses the methods used, and the results of the investigation.

9.2 The methods used in the study

9.2.1 Recruitment of CCGs (formerly PCTs) and general practices

During recruitment of local authorities and general practices, Primary Care Trusts, PCTs, were abolished to form the current Clinical Commissioning Groups, CCGs, structure. This change posed many challenges for the study, some of which are highlighted below:

- Researchers observed that using a multi-faceted approach to recruit healthcare professionals to participate in error studies was very useful (Howard et al., 2006). This was true under the PCT structure. The CCG structure has general practices as its member organizations, and as such, unlike PCTs, CCGs have little regulatory authority/role over practices. This meant that although the CCGs' medicines management teams welcomed the study and desired that general practices would seize the opportunity to review their medication safety practices, it was really down to the practices to decide to participate or otherwise. If the medicines management team under the old PCT structure knew a general practice, which may really benefit from the study, they could encourage and support them as necessary. With CCGs, however, the medicines management team became 'employed' by the general practices' body, the CCG, and may not have felt equipped to provide the encouragement and support to general practices to participate.
- The formation of the CCGs at the time meant many changes in staff roles and organizational structures. This meant, in many instances, starting the approval and consent to participate procedures all over again. Furthermore, the CCG boards were quite tied up with ensuring as smooth a transition as possible, meaning further delays for approvals and meetings. Obtaining consent from the Caldicott guardians of each organisation was challenging due to temporary overlap of staff roles.
- One example of the challenges experienced with the changeover: a PCT had previously given their consent to participate under the old structure. When the PCT was abolished, changes in local research governance resulted in unprecedented delays with uncovering the needs of the board with elements of the study.
- Due to these unprecedented delays, and time pressures on the project, two purposively selected general practices from two purposively selected CCG were used as the study sites for this aspect of the doctoral research.

During recruitment, it was also observed that PCTs and subsequently CCGs operated differently with respect to obtaining approval for research. For example, NHS South London wanted the study to identify practices and obtain some form of consent from them prior to the R and D's consent. Most of the other CCGs however, were happy to provide consent at the CCG level, and serve as a communication channel to the practices. One CCG, which was eventually lost, had given consent; however, certain members of the board requested further information, which the study provided but they were unable to reach a conclusion. Therefore, although the British healthcare system is meant to be a national health system, practices vary significantly across governance levels. Some standardisation of roles and procedures would be gainful for research, the findings and inferences of which could be potentially improve patient outcomes.

9.2.2 Sampling of general practices

The two general practices recruited to the study were moderately representative of general practices in England, with respect to their average list size, number of general practitioners/other prescribers, age profile and QOF points. The practices were both located in more deprived LSOAs, although L1 more than B1. As healthcare is one of the domains reflected by the IMD score, these results of these findings may be more generalizable to other English LSOAs in the top 20%-50% most deprived areas. The sampling strategy however did not give the study the opportunity to cover a range of locations (urban, rural, suburban and city) as originally intended. It is therefore possible that both practices had special interest in the safety and quality of prescribing when compared with other practices, and may have had a bias to the review of their records to identify potential prescribing errors.

9.3 Evaluating the prevalence and nature of prescribing and monitoring errors

Medication error rates reported in the literature vary with the methods and definitions used (Olaniyan et al., 2014).

This study used a retrospective quantitative review of electronic medical records to investigate the prevalence and nature of prescribing and monitoring errors in older patients and children in primary care. This approach involved the step-wise application of clinical judgement by a clinical pharmacist to review the patient, their diagnosis, and the therapeutic or drug intervention during a consultation, its effectiveness, and progress of the condition(s) being

managed (Barber et al., 2009; Zermansky et al., 2001). For each patient, the pharmacist provided a summary of the medicines prescribed, and described what was considered a prescribing or monitoring error. The literature on medication errors described this as a practical and reliable method for obtaining information on errors in prescribing as it consistently detected more errors when compared with other methods (Avery, Barber, et al., 2012; Olaniyan et al., 2014).

The other methods, which are commonly used to detect prescribing errors, include prospective observation of consultation or real-time data collection, which is cost- and labour-intensive and invasive, retrospective review of prescriptions, which potentially lacks vital and relevant patient information, incident reporting or analyses of other forms of databases, which is challenged by under-reporting, and patient and prescriber interviews, which is time- and interviewee(s) memory-dependent (Avery, Barber, et al., 2012). As observed by (Franklin et al., 2009) and (Tam et al., 2008), these methods have different strengths and weaknesses, and usually detect different types of errors.

Researchers investigated the methodological variability in detecting prescribing errors for the evaluation of interventions and found that, of four different methods namely prospective detection by ward pharmacist, retrospective health record review, retrospective use of a trigger tool, and spontaneous reporting, the most sensitive tool was retrospective health record review (Franklin et al., 2009). This tool picked up 69% and 83% pre- and post-intervention compared with very low figures for the other tools. In addition, there was little overlap in error detected by these different methods. Other researchers also found that, chart review determined the highest yield for detecting overall ‘medication misadventures’ or preventable adverse drug events of three methods, the other two being patient survey and voluntary reporting (Tam et al., 2008). In primary care, many relevant studies have also used record review in successful and consistent detection of prescribing and other medication-related errors (Abramson, Bates, et al., 2011; Avery, Barber, et al., 2012; Barber et al., 2009; Chen, Avery, et al., 2005).

As noted by Avery et al (2012), this method particularly relies on computerised general practices, such as those used in the current study, as patient demographic information, consultation notes, information on allergies or sensitivities, co-morbidities, laboratory test results, hospital correspondence or discharge notes, etc. are readily available in electronic format in one place to aid review. It was however observed during data collection, that inaccuracies and incompleteness could challenge this otherwise robust method. In one instance,

a hospital discharge note for a patient was inadvertently stored under a different patient's record. Although incidents like this may be rare, they could still pose a risk for retrospective review of records where data collection relies solely on accuracy of medical records. Furthermore, it was not always practical to read a prescriber's intention through the notes they had made. In their study, Avery et al included an element to detect the causes of prescribing errors by interviewing prescribers. However, this was outside the scope of the current study.

The results of any investigation into any quantitative estimation of medication errors may also be dependent on the definition used. The current study had intended, much earlier at the research conception stage, to develop and validate a general practitioner-led definition of prescribing error in primary care. However, following a literature review, it was assessed that adopting an existing definition would have been sufficient and suitable for the study. This was in part due to limited resources, and the increasing use and adoption of Dean et al's definition in the UK NHS.

Prescribing errors were identified using the definition developed and validated by Dean et al (Dean et al., 2000). This definition has been previously used in a DH report "Building a safer NHS for patients – improving medication safety (Department of Health, 2004). It has also been successfully operationalized in secondary and primary care studies on medication error (Avery, Barber, et al., 2012; Barber et al., 2009; Dean Franklin et al., 2007). This definition included omissions, overlooking patient's clinical status, transcription errors etc. Failures to adhere to prescribing guidelines were however, not considered as an error.

The monitoring error definition and criteria used in this study was developed and validated by (Alldred et al., 2008; Barber et al., 2009), and recently adapted for use in general practice by (Avery, Barber, et al., 2012). These definitions were practitioner-developed, clinically useful, and internally and externally validated. They were further deemed suitable to this study following the professional and media attention given to the GMC study by Avery et al (2012). The results of Avery et al's primary care study of medication errors in primary care provided a baseline to compare the results of the current study with.

Patients, whose medical records were examined, were randomly selected using computer-generated random numbers. This ensured that study population sampling bias was mainly eliminated.

The doctoral degree student, a clinical pharmacist, conducted all record reviews, which meant data collection was fairly consistent, when compared with those studies that use different pharmacists for different sites.

The research degree student also collected data on omission errors related to failure to prescribe for an existing condition. Dean et al's definition included omissions, as decision not to prescribe a medication, which other prescribers may, would be considered an error. However, as these errors were not directly related to prescribed medications, it is possible that some may have been overlooked during reviews (Avery, Barber, et al., 2012). 23 and 3 omission errors were identified in older patients and children respectively.

A validated method was used for severity assessment of potential prescribing and monitoring errors (Dean & Barber, 1999). As a judging panel reviewed each error, it is hoped that consistency in severity assessment has been achieved.

An MSc student did most of the data entry. All data entered, including patient demographics, prescriptions, and information of potential errors were checked for errors and corrected as necessary by the research degree student prior to data extraction and analyses.

9.4 The prevalence and nature or prescribing and monitoring errors

The percentage prevalence of prescriptions with prescribing and monitoring errors in older patients ≥65 years old was 7.89% (95% CI 6.94%-8.96%). One in three or 40.87% of all older patients were exposed to a prescribing or monitoring error during the 12-mnonth data collection period. Most of the errors were however of mild to moderate severity.

The percentage prevalence of prescriptions with prescribing and monitoring errors in children 0-12 years old was higher than that of older patients at 9.67% (95% CI 7.76%-11.99%). 1 in 5 or 20.92% of all children were exposed to a prescribing or monitoring error during the 12-months record review period. There were more errors of moderate severity than mild in younger patients than in older patients.

Although the absolute number of prescriptions and patients' records reviewed per practice and overall were sizeable, the small number of practices studied may preclude generalizability. However, this is a pragmatic study, which can be successfully adapted by practice pharmacists, to review the safety of prescribing during any specified time period (Zermansky et al., 2001).

General practices can also review the prescribing safety and quality associated with specific therapeutic classes, co-morbidities or age groups, by retrospectively reviewing a sample of their patients' records to identify potential risks for harm. This can lead them to identify and implement practical interventions to improve patient health outcomes.

A wide range of types of errors associated with different drugs and therapeutic groups were identified. Some of the specific ones, which require attention in the care of the older patient in primary care may include but not limited to

- Evaluating prescriptions of corticosteroids – oral – to ensure that the patients who may benefit from enteric-coated tablets are offered this, and for topical, to specify duration of use as required or prescribe small pack sizes, especially for potent steroids
- Identifying older patients who are regularly prescribed oral non-steroidal anti-inflammatory drugs to offer them gastro-protective agents, and to introduce checks on repeat issues of these items
- Identifying patients taking drugs, which require laboratory blood test monitoring to see to it that such tests are regularly ordered and acted upon as necessary
- Identifying those older patients who may benefit from more regular review of their medications – patients with increasing number of prescriptions or doctor's visits, frail patients who may increasingly become unable to demonstrate concordance, patients who are not regularly ordering their medication for long-term management of chronic diseases etc.

For children, these may include:

- Reviewing the doses of commonly prescribed antibiotics and possibly providing a chart, which summarizes these doses in every consultation room. It may be useful to perform periodic audits to review the prescription of antibiotics in the younger patient population as antibacterial prescriptions, mostly oral, made up a third or 33.25% of all prescriptions issued to children. It is therefore pertinent to get it right
- Topical steroids – the volume and quantity of steroids issued to younger patients was large 112 prescriptions accounting for 14.83% of all prescriptions. When it came to the errors however, 110 prescriptions, which accounted for 47.14% of all errors, were associated with

topical steroid-containing medications. It can be safely said that some standardization is required on prescriptions of topical steroids, particularly in the younger and older patient populations

- Identifying prescriptions for respiratory disease and ensuring adherence to the step management of asthma in children.

There is a dearth of studies, which have investigated the prevalence of prescribing and monitoring errors in older patients and children in primary care. The results of the current study are compared with those of other medication error studies in primary care.

The methods adopted in the current study were comparable to those of the recently published GMC-funded study, the PRACtISE Study (Avery, Barber, et al., 2012). This was in part due to the likelihood that the findings of that study would have influenced general practices' prescribing behaviour and sensitised them to some of the issues raised in the report. Furthermore, it was important to be able to compare the findings of the current study with another UK study, as this would hopefully highlight key areas of need in the care of the vulnerable patient populations.

Avery et al, found that older patients are more likely to have a medication error In keeping with this finding, the current study consistently showed a higher prevalence of prescriptions with prescribing and monitoring errors, when compared with the findings of the PRACtISE study, which investigated prevalence of medication errors across the whole population:

- The prevalence of prescriptions with prescribing or monitoring errors was 4.9%; in the current study, this was 7.89% confirming that older patients are at increased risk of medication errors
- All patients (n=1,777: the researchers found a prevalence of 12%; in the current study, in all older patients (n=364), the prevalence of errors was 36.23%
- Patients who had received at least one medication (n=1,200), the prevalence was 17.8%; in the current study, for older patients who had received at least one medication, prevalence was 40.87% (n=323)
- Patients aged 75 years and older who had received at least one medication (n=129) the prevalence was 38%; in the current study, the prevalence was 43.60% (n=133).

The error rate per patient, who had had at least one prescription item in the review period, increased with age and with the number of prescription items, in keeping with the findings of the GMC study. It was particularly of interest to find that the number of prescription errors increased with increase in the average number of prescription items in older patients Figure 17.

There were other similarities between the current study and the GMC study: incomplete information on the prescription was the most common category of errors; the bulk of errors, which comprised the 'omission to prescribe concomitant medication' were associated with the prescription of NSAIDs without gastro-protection; the most common monitoring error category was 'monitoring not requested;' drugs, therapeutic classes and BNF chapters associated with both prescribing and monitoring errors were mostly comparable.

Another UK study, conducted in 256 residents across 55 nursing or residential homes using record review, estimated the prescribing error rate as 8.3% of opportunities for error, with a mean harm of 2.6 (mild) (Barber et al., 2009). The result of the current study is in keeping with their findings that error rates are higher in older patients with co-morbidities and polypharmacy. The denominator used in Barber and colleagues' study, number of opportunities for error, was the number of prescription items written, plus any omissions. The denominator used in the current study was the number of prescription items written, without any omissions. Including the 23 omission errors identified in older patients, the prescribing error rate in the current study was approximately 7%, which was still higher than Avery and colleagues' prescribing error rate of 4.5% prescriptions across the population. It should however be born in mind that Barber and colleagues' study was done in possibly more vulnerable and high-risk patients who resided in nursing or residential homes, with an average age of 85.2 years (SD 8.6), higher than the average age of 73.68 years (SD = 7.75) recorded in the current study. Furthermore, Barber et colleagues' study was not limited to record review but also included other methods including patient interviews and direct observations, which may have led to the identification of more errors.

Another UK study, which used retrospective record review to identify potential prescribing errors from four general practices, found a comparatively lower error rate of 1.9 incidents per 1,000 patients or 4.3 per 1,000 patients on 2 or more medications (Chen, Avery, et al., 2005). This study however, focused on potential for *serious* drug-drug interactions or drug-disease interactions (contraindications), and was not limited to older patients. The proportion of errors, which were drug interactions identified in the current study was 3% of all errors, translating to

approximately 1.8 incidents per 1,000 prescriptions or 16.6 incidents per 1,000 patients with 2 or more medications. This loosely shows the higher prevalence of drug interactions in older patients, whose median number of prescriptions was much higher than Chen et al's study at 7 (IQR 7).

A USA study of 1,879 prescriptions of 1,202 patients at four adult primary care practices found a prescribing error rate of 7.6% prescriptions (95% CI 6.4%-8.8%) in a prospective cohort study using prescription review, patient survey and chart review (Gandhi et al., 2005). This study was conducted in outpatients 18 years and over. Errors in frequency and dose were common. The prescribing error rate in Gandhi et al's study interestingly compares with the results of the current study. The computerized prescribing systems used at the study sites in Gandhi et al's study were basic, and paralleled with handwritten prescriptions by the researchers. The GP clinical computer systems used at the practice sites of the current study were more advanced with dose and frequency checks, which may have been responsible for the relatively fewer numbers of these types of errors in older patients.

Abramson et al (2011) found a much higher error rate of 36.7% prescriptions (95% CI 30.7-44.0) when they conducted a non-randomised retrospective record review of 78 community-based primary care providers across two US states. The higher error rate reported in this study might be due to the use of paper prescriptions, which are generally associated with increased errors, when compared with electronic medical records. As concluded by Gandhi et al (2005), electronic prescribing could have prevented up to 95% of the potential ADEs (prescribing errors) identified in their study due to the advanced checks performed by these systems.

In Bahrain, researchers found a prescribing error rate of 90.5% prescriptions when they conducted a retrospective clinical prescription review (Al Khaja et al., 2007). This study differed from the current study because it did not include any element of record review. Prescribing errors included omission, commission and integration errors. It was very inclusive, and this may explain the high error rate reported. Also, paper prescriptions were used.

In the USA, researchers evaluated medication errors in 1,788 patients from six paediatric (<21 years) outpatient practices in Massachusetts in a prospective cohort study (Kaushal et al., 2010). Data was collected using duplicate prescription review, parental surveys and chart

review. The authors found a prescribing error rate of 68% of patients, and 53% of prescriptions for medication errors with minimal potential for harm, and 26% patients and 21% of prescriptions, for potentially harmful medication errors (near misses). In both of these instances, 90% and 60% errors occurred at the prescribing stage. Again, this study evaluated paper prescriptions. Although it is difficult to compare the findings of this study to the current study, it is evident that the prescribing stage was associated with more errors, and that fewer errors were associated with the potential for harms in the paediatric outpatient setting.

9.5 Factors associated with prescribing and monitoring errors

From the analyses of the results of the current study, factors, which may be associated with prescribing and monitoring errors, are highlighted below:

Older patients and children are at risk of more significant errors as suggested in the literature (Rees et al., 2015). Interventions such as tailored medication reviews can significantly reduce the risk of harm in this patient group in primary care. The problem of the use of incorrect doses in children has been documented (Ghaleb et al., 2010). This was also true in Avery et al's study. Urgent attention needs to be given to optimal paediatric doses to reduce the risk of harm associated especially with under dosing of antibiotics in children.

This study observed that female patients might be at a greater risk of error than male patients though Avery et al (2012) found that men seemed to be at higher risk of prescribing and monitoring errors than women. The literature suggests that women are more susceptible to adverse drug reactions (Zopf et al., 2008).

9.6 Study limitations

The number of general practices studied is a limitation of this study, although the absolute number of patients reviewed in this study was high when compared to other studies to compensate for this In the PRACtISE study, Avery and colleagues studied a 2% sample in each general practice (Avery, Barber, et al., 2012). The current study included a minimum of 10% sample per practice. Nevertheless, the results of the current study should be interpreted with caution, as findings may not be generalizable to all practices or patient groups studied. Furthermore, a relevant enquiry from the findings of the study may be to construct some form

of logistic regression to explore the relationships between the variables associated with prescribing errors.

The general practices, which participated in the study, were conveniently sampled. It is therefore possible that practices that were more open to discussing medication safety and having their records reviewed consented to study. This may have further introduced bias into the study.

Although review of electronic health records provide information on error, which may not be possible to obtain through routine reporting, it relies heavily on completeness and correctness of patient electronic medical records held in GP practices. Research has however suggested that some of these records may not be accurate or complete. Where the available information made it impossible to judge a situation, such cases were not included in the data. It is therefore possible that relevant information may have been missing. Furthermore, the psychological and social dimensions of medication error occurrence could not be explored through retrospective reviews of health records, as these records do not convey an information or meaning to the interactions between a patient and the GP. However, this was also out of the scope of the current study. Incorporating interviews with GPs and patients and other practice members and carers may have provided further insight into the causes of the errors identified in the current study. The researcher has attempted to provide some insight into the causes of errors by mapping the findings onto Vincent and colleagues' Patient Safety Framework in the final discussion.

For use of their error severity assessment scale, Dean and Barber recommended a 5-member multidisciplinary judging panel (Dean & Barber, 1999). Three judges and the researcher participated in assessing the severity of errors using Dean and Barber's scale. This may have been a source of bias. However, severity assessment of errors is a value judgement, which is not completely free from the influences of the professional and other background and experiences of the members of the judging panel. This was reflected in the current study where opinions of potential outcome of errors were subject to variation between judges.

Chapter 10. Medicines-related problems in community pharmacies

10.0 Introduction

Reason's accident causation model adopts a systems approach to human error (Reason, 1990). This model has been used to analyse the systems failures that underlie medication errors leading to adverse drug events (ADE) and potential ADEs (Leape et al., 1995). The model has also been used to analyse the causes of prescribing and administration errors in primary and secondary care (Barber et al., 2009; Dean, 2002; Dean et al., 2002; Slight et al., 2013). Reason's accident causation model describes an interaction between the 'latent' failures within the medication management system, and error-producing conditions within the environment, as factors, which lead to active failures by the individual who eventually makes an error. Active failures may be mistakes (wrong plan to achieve a desired objective), slips (doing another thing other than that intended), lapses (forgetting to do) or violations (not following guidelines or rules).

Defences within the system identify error, and rectify it before harm results. When these defences break down, errors and harm occur. Within primary care, defences may include those within general practices, community pharmacies, and patients.

Although the pharmacist's role has shifted from the traditional compounding duties, the role of the clinical pharmacist has developed significantly over the past two decades (Hepler & Strand, 1990).

Community pharmacists have been the first point of advice to members of the public about their health, and are strategically placed to tackling Medicines Related Problems (MRPs). Pharmacists use their professional qualifications and knowledge for "counter-prescribing" or "responding to symptoms." This traditional role of a community pharmacist underwent a decline following the inception of the NHS, and a decline in drug manufacturing and compounding of medicines. This was due to free access to doctors, no cost to medicines prescribed on a prescription, and a decline in the number of pharmacies. The practice of pharmacy has however come back to its roots.

Expansion of the roles and responsibilities of community pharmacists have led to the concepts of pharmaceutical care and medicines optimisation. Hepler and Strand (1990) describe pharmaceutical care as a system where practitioners are held accountable for a patient's medicines-related need. Pharmacists play a vital role in designing, implementing and monitoring the plan by liaising with other healthcare professionals in secondary and primary care, and the admission-discharge interphase (Nazar et al., 2015). The provision of

pharmaceutical care that considers medication appropriateness, patient compliance as well as alternative treatment plan leads to specific or desired therapeutic outcome. Medicines optimisation ensures that patients get the best possible use from their medicines, and that treatment is cost-effective, as £150 million of the NHS budget is spent of avoidable medication wastage (Trueman et al., 2010).

The community pharmacist therefore has a fundamental role as a 'defence' within the system of medicines management, and this has been strengthened over the past decade. In the UK, pharmacists perform clinical checks on prescriptions before they are dispensed and handed to the patient or carer in both secondary and primary care. The new NHS reforms have identified the move to integrated health care systems, and a shift in patients from secondary to primary care, as well as better chronic disease prevention and admission avoidance (Nazar et al., 2015).

The role of the pharmacist in community practice is therefore increasingly relevant to patient safety. The Pharmaceutical Services Negotiating Committee (PSNC) estimated that community pharmacists provide services to some 1.6million patients daily in England. Establishment of the Community Pharmacy Contractual Framework (CPCF) in 2005 means services provided by community pharmacists are now greater than ever. These services have been broadly categorised into three namely essential, enhanced and advanced services: essential services include dispensing of medication and provision of over-the-counter advice (counter prescribing). Enhanced services include smoking cessation advice, minor ailments, needle exchange etc. Advanced services include conducting Medicines Use Reviews (MUR) and the New Medicine Service (NMS) (Noyce, 2007). The main additions of the CPCF were the advanced services, which utilise the clinical expertise of pharmacists to provide patient focused service to ensure effective medicines usage and improve patient safety. For example, MURs involve pharmacists completing consultations with patients regarding their medications, identifying any problems they have and providing appropriate interventions.

Community pharmacists are strategically placed to provide legal and clinical appropriateness checks on prescriptions, and to identify and intervene on medicines-related problems including prescription errors, as they represent the last healthcare-professional 'defence,' prior to patient administration. The Pharmaceutical Care Network Europe (PCNE) defines medicines related problems (MRP) as circumstances involving medication therapy that does or has the potential to interfere with the desired health outcome (Pharmaceutical Care Network Europe, 2006).

This includes medication errors occurring at every stage of the medicines use system, and adverse drug reactions.

In the systematic review underpinning this thesis, studies that identified prescription errors through a prospective observational or retrospective review of prescriptions in general practice and community pharmacies were identified (Al Khaja et al., 2007; Al Khaja et al., 2005; Hämmerlein et al., 2007; Knudsen et al., 2007a; Martínez Sánchez & Campos, 2011; Sayers et al., 2009; Shah et al., 2001; Warholak & Rupp, 2009). Those studies, where a researcher observed and documented pharmacist interventions on prescription errors consistently recorded higher error rates when compared with those studies where the pharmacist was expected to document their own interventions.

Shah et al (2001) retrospectively analysed prescriptions from 23 doctors (from three general practices in the UK) in three community pharmacies over a two-month period. The researchers found a prescribing error rate of 7.5 per 100 items. Errors were found on 140 of the 1,373 handwritten items (10.2%) compared with 1,233 of the 33,772 computer-generated items (7.9%).

With an ageing population, increased use of high-risk drugs in community or general practice, electronic prescribing, increase in the number of prescriptions dispensed in community practice, it is important to explore the defences within the medicines management system in primary care, not just from general practice but also within community pharmacy.

10.1 Aim and objectives

Therefore, the aim of this study was to explore the role the community pharmacist plays, identifying the nature of MRPs in community pharmacies and other roles that could contribute to medication safety. The objectives were

- Estimate the prevalence of MRPS, with particular focus on prescriber-related problems (prescribing errors), in community pharmacies
- Describe the nature MRPs in community pharmacies
- Describe the drugs commonly associated with MRPs in community pharmacies
- Identify if particular patient groups were at risk of getting specific MRPs
- Identify and describe the actual and potential severity of MRPs identified in community pharmacies

- Describe pharmacists' intervention and resolution of medicines-related problems
- To establish the role of the pharmacist in identifying medicines-related problems through categorization of the activities they perform most frequently and the time taken to complete them.

10.2 Setting

The study was carried out in three conveniently selected community pharmacies, CP1, CP2, and CP3 over three week periods. CP1 and CP3 were part of a nationwide multiple pharmacy chain in Luton and Leighton Buzzard respectively, both in Bedfordshire, England. CP2 was an independent pharmacy also located in Luton located in close proximity to a GP surgery, a dental practice, and Luton and Dunstable University Hospital. CP3 was also located in close proximity to neighbouring general practices, dental practices, and was in the town centre. The indices of deprivation for Luton and Bedford have been described in Chapter 6 above. The three pharmacies were opened for business during similar hours, between 9am and 6.00pm or 6.30pm, in the case of CP1. The three pharmacies provided NHS essential, enhanced and advanced services. Additional services performed at CP3 included diabetes screening and administration of flu vaccinations. All three pharmacies were located on high streets with easy access to train stations or public transport.

10.3 Methods

A prospective observational study of pharmacists' interventions on medicines-related problems was conducted in three community pharmacies, CP1, CP2 and CP3, located in Luton and Bedford, within a 2-mile radius of the general practices that participated in the record review study, with support for data collection from final year MPharm students. This study involved the students observing the pharmacists' interventions on prescriptions and interventions on medicines-related problems in community pharmacies. Data collection was not restricted to vulnerable age groups because of the small number of MRPs intervened upon in community pharmacies as reported in the existing literature above (systematic review chapter). The principal supervisor and doctoral degree student trained the MPharm students on observation and identification of MRPs in community pharmacies. Each MPharm student was then observed by the doctoral degree student during the pilot study at each site to ensure that they were recording relevant information and identifying MRPs. In order to ensure the MPharm student completed data collection forms and categorised medicines-related problems

appropriately, the doctoral degree student validated a small sample of completed data collection forms by reviewing relevant information relating to medicines-related problems chosen for validation.

A data collection form, which had been previously used in other studies for documenting pharmacists' interventions, was used Appendix 22. Pilot studies were conducted at each site on the first two days of the study, mainly to test accessibility to information, and the practicality of having extra persons within the usually small dispensaries, as this was the main concern of participating pharmacies. Following the pilot study, no amendments were necessary to the data collection form; therefore the data collected were included in the overall analyses.

All prescriptions presented by patients/carers, or collected by individual pharmacies were screened for MRPs. MRPs identified by individual responsible pharmacists were also included in the study. The investigator documented relevant information on patient demographics, details of the drug associated with MRP, and the actions taken to resolve the problem. The number of items and prescriptions dispensed during the study period were recorded. MRPs were grouped as prescriber-related, drug-related, delivery-related, patient-related problems, and other (near misses and other pharmacy-related interventions such as advanced services, including MURs etc.). The responsible pharmacists and investigator judged actual or potential severity of errors as mild, moderate or severe as defined below, based on their therapeutic knowledge and experience.

For the purposes of this study, the following definitions and severity classification were used:

A medicines-related problem was defined as an event or circumstance involving drug therapy that actually or potentially interferes with the desired health outcomes (Pharmaceutical Care Network Europe, 2006). A DRP is said to exist when a patient experiences or is likely to experience either a disease or symptom having an actual or suspected relationship with drug therapy (Strand et al., 1990). A 'near miss' was defined as any incident, which was detected up to and including the point at which the medication was handed over to the patient or their representative; any incidents, detected after the patient or their representative had taken possession of the medication were recorded as dispensing errors (Ashcroft, Quinlan, et al., 2005). The prescribing error definition used was that of Dean et al (2000), as stated above. Levels of severity were assigned as mild, moderate and severe, based on the studies of Pirmohamed et al (2004) and Zed et al (2008): Mild – laboratory parameters may be disturbed/appear abnormal of tested, or the presentation of a symptom not requiring treatment

may occur. MRPs regarded to have a minor potential inconvenience to the patient, thus not harming the patient were classed as mild. Moderate - laboratory parameters may be disturbed/appear abnormal, or the presentation of a symptom requiring treatment/admission to hospital, or a problem resulting in non-permanent disability (low degree of harm meaning it can be corrected). Severe – disturbed or abnormal laboratory parameters, or the presentation of a symptom that was considered to be life threatening or that resulted in permanent disability (led to patient harm to the extent of intensive treatment) (Pirmohamed et al., 2004; Zed et al., 2008).

A secondary objective of this study was to observe and document the activities undertaken by the responsible pharmacist through a timed-activity log during the three-week data collection period. Pharmacists' activities were categorised into essential, enhanced, advanced and 'other' services. The activity log for the pharmacist was completed during the study period during ten- to 20-minute intervals.

10.4 Results

10.4.1 Prevalence and nature of MRPs in community pharmacies

In CP1, 99 interventions were identified for 88 patients, with some patients requiring multiple interventions. The median age of patients who required at least one intervention was 66 years, with over 80% of patients being ≥21 years old. The age group, which required the most interventions, were patients, ≥65 years old at 53%. There was no statistically significant difference in the proportions of male and female patients receiving interventions (50% and 49% respectively). The numbers of prescription and items filled during the study period were 2,098 and 4210 respectively. The mean intervention rate was therefore 4.72% of prescriptions. Most interventions were carried out for newly initiated drugs (40%) and prescription items, which patients had had previously (39%), with repeat prescriptions accounting for 22% of all problems. Prescriber-related problems in CP1 accounted for just over 17% of all MRPS (n=17), and 47% of all prescription-related MRPs originated from local practices.

The top five problems, which accounted for over 75% of all problems identified in CP1 were associated insufficient patient knowledge (27%), dispensing near misses (20%), insufficient dispensary stock (11%), advanced services-related problems (9%), and legal problems (7%). In CP1, 67% of all problems identified were due to prescriber- and patient-related problems. The top six BNF drug classes requiring interventions in CP1 were Central Nervous System, CNS

(17%), Cardiovascular drugs, CVS (14%), ENT agents (14%), Skin (10%), gastrointestinal drugs, GI (9%), and Anti-infective agents (9%).

The most frequently taken actions to resolve MRPs in CP1 were practical instruction to patient, patient counselling, and change in quantity, strength, form or dosage (following clarification and approval by the prescriber in most cases). The responsible pharmacist spent an average of 8.10 (range = 2 to 30) minutes to resolve MRPS. Over 75% of all MRPs were considered mild, with only over 2% classified as severe. Prescriber-related problems identified in CP1 were inappropriate quantity, inappropriate dosage, regular item missing, incomplete prescription, wrong drug, inappropriate instruction and formulation.

In CP2, a total of 37 MRPs were identified for 36 patients during the study period. The MRPs identified in CP2 were on prescriptions from general practices (FP10), with only one MRP identified on a hospital prescription. As no MRPs were identified on dental, nurse and private prescriptions, it can be said that 100% of all prescriber-related problems were from prescriptions from doctors, mostly in GP surgeries. During the study period, 1460 prescriptions or 3173 prescription items were dispensed in CP2. This gave a prescribing error prevalence of 1.17%, or 12 errors in every 1,000 items.

Prescriber-related problems accounted for 38% of all MRPs, identified in CP1. The other categories of MRPs identified in CP2 were delivery-related problems (2.7%), and patient – related problems (5.4%), and other problems (54%). Therefore, other problems and prescriber-related problems accounted for the highest categories of MRPs in CP2.

The most commonly prescribed medication, which were associated with an MRP according to their BNF chapters in CP2 were, CNS drugs, CVD drugs, endocrine system, drugs for musculoskeletal and joint diseases, and GI drugs. Incomparably with CP1, more patients under 60 experienced an MRP in CP2.

95% of all MRPs requiring pharmacists' interventions in CP2 were associated with contacting the prescriber since most of the MRPs identified were prescriber-related problems. Such interventions included patient counselling (5%), pharmacist to dispense temporarily, while prescriber will forward an 'updated' prescription (38%), pharmacist looked into patient medication history and made a new request to GP surgery for a missing item (16%), pharmacist made own decision (11%), pharmacist referral to GP (16%), and interventions proposed by pharmacist and approved by GP (14%). Approximately 60% of all MRPs were considered

mild in CP2, with 13.5% errors classed as severe. The average intervention time in CP2 was 9.33 minutes (range = 4 to 30 minutes). This was comparable to CP1 above.

In CP3, 256 MRPs were detected from 1831 prescriptions (or 3632 items) dispensed for 254 (of 1356 seen) patients. This gave an MRP incidence rate of 7.05% items. The numbers of female and male patients with MRPs were comparable at 52% and 48% respectively. Similar to CP2, prescriber-related problems accounted for the highest proportion of MRPs (52%, n=132). In CP3, the majority of MRPs were considered as of moderate severity (51%, with 47% and 2% accounting for 'mild' and 'severe' categories respectively. BNF chapters of medications associated with an MRP in CP3 were CVS (39%), musculoskeletal (19%), Anti-infective (12%), respiratory (8%), Endocrine system (7%), CNS (6%) and GI (5%). A significant number of MRPs (50%, n=127, p=0.034) were identified in patients, ≥65 years old. Patients who took an average of 7 medicines in CP3 were at risk of experiencing an MRP (n=102, p=0.041). Paediatric patients were not significantly at risk of MRPs in CP3. 55% of all MRPs in CP3 were prescriber-related MRPs. Newly issued items and repeat prescriptions were associated with the most MRPs in CP3. Although MRPs from general practices accounted for 48% of all prescriber-related MRPs in CP3, more MRPs per prescriptions were recorded for hospital prescriptions (9 MRPs on 21 hospital prescriptions). Prescriber-related problems identified in CP3 were mostly duplication, regular item missing, and unsigned prescriptions. 63 dispensing errors and near misses were identified in CP3.

In summary, the MRPs detected in the community pharmacies are shown in Table 79 below.

Table 79: MRPs detected in community pharmacies

Pharmacy	Number of patients	Number of prescriptions	Number of items	MRPs	% MRPS per items
CP1	88	2,098	4210	99	2.4
CP2	36	1460	3173	37	1.2
CP3	254	1831	3632	256	7.1

Prescriber-related problems identified in each community pharmacy were related to inappropriate quantities, inappropriate dosage, regular prescription item missing, incomplete/missing data and illegible prescription, inappropriate drug, inappropriate direction or instruction, inappropriate strength, drug duplication, inappropriate duration of use, and wrong data. Of these, inappropriate quantity, dosage, regular item missing and incomplete

information were most commonly identified in CP1. In CP2, regular item missing, inappropriate strength, wrong duration of use, and inappropriate dosage, direction and quantity, were the prescriber-related problems identified. Prescriber-related problems identified in CP3 were missing data or incomplete information, inappropriate dosage, inappropriate directions, inappropriate formulation, incorrect quantity, regular item missing, inappropriate strength, drug duplication, inappropriate duration of use, inappropriate drug, and illegible prescription. It can therefore be seen that regular item missing, inappropriate strength, duration of use, dosage, direction and quantity, were commonly identified in all three pharmacies.

Delivery-related problem identified in CP1 included insufficient stock in the dispensary, unavailability of product (not on the market), and items out on delivery. In CP2, unavailability of drug (not on the market) was the only delivery-related problem identified. This was also the case in CP3.

Patient-related problems identified in CP1 included insufficient knowledge, for example, about administration, and compliance issues (patient cannot swallow capsules/tablets or cannot open drug container). Patient-related problems in CP2 included difficulty opening container and non-adherence. In CP3, patient-related problems identified were also administration problems; for example, patient was unable to use their Salamol® (Salbutamol) CFC free inhaler.

Other problems identified in CP1 were dispensary near misses, dispensing error, over-the-counter-related problems, and legal problems. These were also identified in CP2, and in CP3, other problems identified were drug-food interaction and adverse drug reactions.

Examples of prescriber-related MRPs in each of these severity categories are provided in Table 80 below. Examples of interventions performed by pharmacists on prescriber-related problems (prescribing errors) are shown below in Table 81.

Table 80: Examples of interventions performed by pharmacists on prescriber-related problems (prescribing errors) in community pharmacies

Type of prescriber-related problems	Example
Missing data	Total quantity in words and figures was missing on a prescription for Tramadol Hydrochloride
Inappropriate dosage	Child weighing 9kg prescribed 500mg Amoxicillin three times daily for moderate Otitis Media, leading to overdose (Recommended dosage is 360mg three times daily)
Incorrect	Patient prescribed Simvastatin 40mg every morning, instead of at

directions/information	night; Patient address was incorrect
Inappropriate formulation	Ibuprofen 200mg tablets prescribed to a 4-year old patient but oral suspension required
Incorrect quantity	28 tablets of Lisinopril 10mg prescribed to a patient, instead of the normal 2x28 (or 56)
Regular item missing	Aspirin 300mg dispersible tablets missing on repeat prescription
Wrong duration of use	Patient prescribed Colchicine 500mg twice daily for three weeks instead of for no more than three days

Table 81: Examples of mild, moderate and severe prescriber-related MRPs detected in community pharmacies

Severity	Example
Mild	67-year-old patient prescribed a Salbutamol aerosol inhaler. The patient had insufficient knowledge about medication administration and the New Medicines Service (NMS). Practical instruction was given to the patient regarding administration of her medication, alongside information regarding the NMS follow-up procedure
Moderate	3-year-old patient prescribed Flucloxacillin 250mg capsules. The formulation was inappropriate due to the patient's age and inability to swallow capsules. The pharmacist changed the formulation from capsules to suspension. The prescriber was not contacted to elicit the change, but was contacted in order to obtain a corrected prescription; Simvastatin 10mg twice daily prescribed rather than once daily
Severe	Amoxicillin prescribed to a patient with severe penicillin allergy

10.4.2 Activities of community pharmacists

The top five activities performed by the responsible pharmacist in CP1 included clinical and accuracy checking of prescriptions (29%), dispensing or filling of prescriptions (20%), labelling of prescriptions (11%), attending to telephone enquiries or queries (11%), and other administrative work (9%). This meant 60% of the activities undertaken by the pharmacist involved checking, labelling and dispensing of prescriptions.

Similar to CP1, pharmacist mostly engaged in clinical and accuracy checking of prescriptions and dispensing activities (62%), with only 10% and 9% of their time spent on MURs/NMS and patient counselling respectively. 20 dispensing errors and near misses were identified in CP1.

Pharmacists in CP3 spent most of their time clinically checking and dispensing prescription (40%). 6% of pharmacists' time was spent on advanced services (MURs and NMS). Enhanced services, which included minor ailments scheme, supervised administration, flu vaccination, blood pressure checks and diabetes screening, occupied 18% of pharmacists' time.

Table 82: Summary of findings on MRPs in community pharmacies

Site	Prescriber-related	Delivery-related	Drug-related	Patient-related	Other	Proportion of prescriber-related problems	Total MRP	Total prescriptions	Total items	Prevalence of prescriber-related problems	
										% Rx	% Items
CP1	17	14	1	26	41	17.17%	99	2098	4210	0.8	0.40
CP2	14	1	0	2	20	37.84%	37	1460	3173	1.0	0.44
CP3	140	32	0	21	63	54.67%	256	1831	3632	7.6	3.85

The table above shows the proportion and prevalence of MRPs, which were prescriber-related.

10.5 Discussion

The community pharmacist acts as the last line of defence for minimising prescribing and medicines-related problems. The study showed the types of MRPs pick up and the degree of harm prevented.

This study has described the prevalence of medicines-related problems in community pharmacies, with particular focus on prescriber-related problems (prescribing errors) intervened upon by community pharmacists. The findings in the three studies were comparable and are summarised below.

10.5.1 Summary of findings

- Over 50% of all prescriptions requiring a pharmacist intervention originated from local general practices in all three pharmacies
- Drugs, which were most commonly associated with MRPs in the pharmacies, belonged to the following BNF classes: CVs CNS, Skin, Gastrointestinal drugs (GI), Anti-infective, and musculoskeletal and joint disease agents.
- The actions most frequently taken by the pharmacist to resolve problems included practical instructions to the patient, medication counseling, contacting prescribers for alteration of quantity, strength, form, or dosage of the medication. More interventions were associated with new prescriptions and repeat prescriptions.
- Majority of prescriber-related MRPs were of 'mild' severity, while a small proportion were considered 'severe.'
- Older patients were more at risk of MRPs, notably prescriber-related MRPs
- Responsible pharmacists spent more than 60% of their time on the physical aspects of dispensing, involving clinical assessment of prescriptions labeling and dispensing, and leaving little time for advanced services such as MURs and NMS.

The findings in the current study are in keeping with other studies of interventions performed by community pharmacists as discussed below.

Incomplete information was identified in this study as one of the problems associated with prescribing errors in keeping with Chen et al, who found that most prescriber-related errors arose from prescriptions with incomplete or incorrect information (Chen, Neil, et al., 2005). Young et al found that over three-quarters of the interventions were on new prescriptions, and that dosage information and missing prescription information were two common prescriber-related problems (Young et al., 2012). The researchers further found that the prescriber was

contacted for most of the interventions, which resulted in most prescriptions being changed, and led to limiting the time pharmacists can spend on patient-focussed activities. In keeping with the study by Young et al, the current study also found that when an intervention on a prescription was necessary, it was based on more technical issues, for example, signature missing on prescriptions quantity-related problems, rather than on clinical issues such as interactions and contra-indications.

In addition to new prescriptions, interventions were also commonly documented for repeat prescriptions, consistent with other studies (Hämmerlein et al., 2007; Rupp et al., 1992; Young et al., 2012). The New Medicines Service (NMS) was commissioned in 2011 to deal with this problem, particularly to empower patients who may be prescribed medication for long-term management of chronic diseases for the first time. This promotes engagement with the expertise and experience of healthcare professionals, such as pharmacists, to enable patients to get the most from their new medicines. However, this study consistently demonstrated that less than 10% of pharmacists' time was actually available for these advanced services. For repeat prescriptions, adequate monitoring of chronic diseases and medicines optimization can often prevent ADEs in community care, which often lead to hospital admission (Pirmohamed et al., 2004). As such, pharmacists need to spend more of their time on clinical and patient-facing roles and less on technical roles, to ensure that patients are truly benefitting from the services. With an ageing population, and continued increase in primary care management of chronic conditions and complex medications, pharmacy regulatory bodies, and NHSE need to work together to ensure protected quality time for clinical community pharmacy services if they are to be successful in improving patient outcomes.

This study found that the top categories of problems identified were either related to the patient of the prescriber (prescription). In CP1 for example, insufficient patient knowledge was identified as the most prevalent type of medicines-related problem. This could reflect a lack of understanding of their conditions and management, or even problems with interpretation of dosage or monitoring instructions on patients' part as observed by researchers (Wolf et al., 2007). As Vincent (2010) pointed out, patient safety is all about putting the 'patient' back into the art of clinical and therapeutic management. Vincent pointed that patients are not passive victims of errors and safety failures, but can be actively involved in making sure that their care is effective, fitting and safe. It is right to include patients in their care by seeing them as partners, rather than nuisances. Patients can be actively involved in the safety of healthcare in many diverse ways – by contributing to safe medication use, making informed choices about

who treats or manages them, providing information to make accurate diagnoses, being involved in infection control initiatives, checking the accuracy of medical records, observing and checking care processes, identifying and reporting complications from their management and adverse events, effectively managing their own medication and condition (including helping with drug or other treatment monitoring), and contributing immensely to healthcare service design and improvements (Coulter & Ellins, 2007). Therefore, patients should be empowered by being informed and carried along as partners in their therapeutic knowledge.

This study has also demonstrated that pharmacists are traditionally providers of medicine, although they are increasingly involved in clinical roles (enhanced and advanced NHS services), in keeping with other studies (Gidman & Cowley, 2013; Kheir et al., 2014). Gidman and Cowley (2013) found, from their qualitative study of the public's opinions and experiences of pharmacy services, that although participants made positive comments about pharmacy services, many preferred to see a GP. The public in Gidman and Cowley's study viewed community pharmacy services as "incomplete," and "which did not co-ordinate well with other primary-care services." The researchers commented that the public considered pharmacy environments and retail area as being less than ideal for private healthcare conversations. Consultation rooms in community pharmacies usually look like, and come across as "after-thoughts." Some consultation rooms are indeed very small, and offer no privacy for consultation with patients, many of whom are unwilling to be cramped in such small spaces for ten to fifteen minutes, particularly when they have a choice of seeing their GP and practice nurses in more practical spaces. Should those services, requiring private clinical conversations with pharmacists, not have been commissioned in GP surgeries for clinical pharmacists in the first instance?

The current study also identified that older patients with chronic medications and polypharmacy are also at risk of MRPs. This is in keeping with the findings of the records review section of this thesis, and other studies, which have been extensively cited in this work. Medicines optimisation and successful reviews of chronic drug use by pharmacists have been documented (Avery, Rodgers, et al., 2012; Zermansky et al., 2001). There is copious evidence to support the current debate around the potential benefit of clinical pharmacists' presence in general practice. The Royal Pharmaceutical Society (RPS) believes that similar to what currently exists in hospital, primary care patients should have the benefit of a pharmacist's clinical expertise. The RPS made three recommendations: to general practitioners to welcome the innovation that pharmacist can bring to the care of their patients; to local commissioners to

include the expertise of pharmacists in all care path ways that use medicines; and to NHS England to publish evidence showing the benefits of pharmacists in GP surgeries (Royal Pharmaceutical Society, 2014). The RPS has highlighted the role of pharmacists working with GP surgeries: resolving problems with medicines, prescribing, and audits and processes-related work. This provides a more robust safety net before the patient gets the prescription, and can enable them to get the most from their medication. Policy and research must collaborate on the model of care as a study found that some pharmacists may require additional relevant training, though perhaps their mode of remuneration for clinical services is a contributing factor to why pharmacists may appear reluctant to increase their roles (Morton et al., 2015)

Perhaps the current skill-mix in community pharmacy further poses a challenge to really freeing up the pharmacist's time for clinical services. The current study has demonstrated that when pharmacists undertake activities that can be performed by other members of the dispensary, the time available for providing enhanced and advanced services and patient engagement dramatically decreases. Most pharmacy contractors in the UK employ dispensing assistants and healthcare assistants fresh from secondary education, and then provide training on the job. Community pharmacists are expected to provide the necessary training support to these entrants. There is therefore enormous pressure on the community pharmacist, leading to inadequate training of these dispensing assistants, and the continuous need for pharmacists to be deeply involved in technical aspects of dispensary functions such as stock and retail management. Is the business of medication safety not too risky to allow this mediocre entry and training requirement? The GPhC and Royal Pharmaceutical Society, RPS, along with the other stakeholders need to urgently review this arrangement, particularly with the imminent introduction of clinical pharmacists in GP surgeries. Until clarification and establishment of the pharmacist's roles in medicines management and medicines optimisation, the general public's confusion and limited use of the pharmacist's expertise will remain.

Although community pharmacists are one of the defences in primary care medicines management system, this study shows that this system can sometimes break down leading to dispensing errors and near misses. Innovative ways to then improve and strengthen the defences in GP practices and pharmacies need to be researched and integrated in practice to improve patient safety.

10.6 Study limitations

Although this study was relatively smaller than those conducted previously in the UK and elsewhere with consequently less representative results, the methods and definitions used remained robust, and produced results comparable with other findings.

The pharmacies that participated in this study were not selected at random. They were selected based on their willingness to participate. As such, pharmacist(s) were aware that any MRPs, which occurred in the pharmacy, during data collection, would be observed and documented. Moreover, the opportunities to screen and selectively identify problems to be recorded by the principal investigator were therefore provided. Consequently, the results may not provide an accurate representation of the frequency, type, origin and resolution of MORS that occurred in the selected pharmacies. It is therefore possible that the true rate of MRPs may have been underestimated. The effect of the principal investigator's observation may also help to explain why very few MRPs, and in some instances none at al, were identified following the investigator's work at 16.00pm, even though pharmacies opened till 6.00pm or 6.30pm.

It is possible that a different investigator may have interpreted, and therefore applied the methods and definitions differently. The principal supervisor reviewed a small sample of the MRPs documented in an attempt to account for this individual interpretation, and to ensure consistent application of definitions used by the MPharm students. However, the act of observation was not validated.

The doctoral researcher, MPharm student and responsible pharmacists were not given any formal training in the identification of MRPs requiring intervention for the purposes of this study. Competence in this task was therefore assumed based on the training and education received in identification and documentation of problems and interventions by the investigators and pharmacists during their education (Young et al., 2012). It is therefore possible that these individuals varied in their ability to detect potential MRPs. This is evident in the disparity in the numbers of MRPs detected in each of these pharmacies.

Nevertheless, it is important to note that the responsible pharmacists had their inputs in the severity rating of MRPs, and standardised forms and definitions were used when categorising MRPs. Moreover, direct observation as opposed to incident reporting by community pharmacists was a robust method used to study MRPs in community pharmacies.

Chapter 11. **Final discussion**

11.0 Summary of the doctoral research

The overall aim of this PhD research was to explore the safety of medication use in primary care through the determination of the prevalence and nature of prescribing errors in two vulnerable age groups, older patients and children, and to provide some insight into the locals systems for managing medication errors in primary care. The key findings from the research highlight the following:

- Guidance on local arrangements and pathways for clinical governance may be less defined and therefore lead to loss of important learning from adverse prescribing events and near misses locally. This has raised significant issues around the culture of patient safety in primary care. The literature on medication safety in primary care is very sparse with respect to evaluating local arrangements for management of medication errors
- Older patients 65 years and over and children 0-12 years old are at increased risk of prescribing and monitoring errors
- Older patients experience an unacceptable level of monitoring errors for routinely prescribed drugs including Angiotensin Converting Enzyme inhibitors (ACE-I) and Angiotensin II receptor antagonists or blockers (ARB), diuretics, statins, and Thyroid hormones. Older patients may experience more monitoring errors since these drugs are commonly prescribed, as people get older. However, considering the routine use of most these drugs to manage cardiovascular problems in primary care and prevent hospital admissions, this level of failure in the monitoring system has enormous potential to increase the burden of disease on patients, healthcare practitioners and the healthcare system
- Specific drug classes, which need to be the focus of continued professional development (CPD) for general practitioners include non-steroidal anti-inflammatory drugs (NSAIDs), and topical and oral steroids and anti-infectives
- Antibiotic dosing in children is a major source of prescribing errors, considering they were most commonly prescribed in this age groups (Table 61 above)
- Community pharmacists are the last healthcare professional ‘defense’ within the medication management system in primary care prior to medication use by patients. The role of the community pharmacist in interventions on prescription errors and other MRPs was evident from this study. The healthcare system needs to urgently review the role of pharmacists to strengthen this defense.

- Patients and their carers are not just ‘casualties’ of medication errors. Their role as active members of the prescribing process needs to be explored to prevent medication errors in primary care.

11.1 Discussions of findings against models of causes of error

Although the current study did not set out to explore the causes of prescribing errors experimentally, the findings outlined above have been mapped onto the conclusions of the qualitative exploration of the causes of prescribing errors in general practice from the PRACtISE study and Reason’s model of human error (Reason, 1990).

Thorough analysis of incident often exposes a range of activities and deviations from safe practices though specific actions or inactions may have led to the immediate cause of an incident. These activities and deviations from safe practices, also known as ‘latent conditions,’ provide the bases for accidents in the first place. As Vincent (2010) surmised, some accidents in historical high profile accidents such as the Paddington Rail accident of October 1999, the loss of Space Shuttle Columbia in February 2003, the Piper Alpha oil disaster in July 1988 etc., often happened due to inadequate training, problems with scheduling, balancing safety and profit requirements, failures of communication, failure to solve already known safety issues and laid-back or reactive attitudes from management (Vincent, 2010). The problem with latent conditions is that almost no one makes a decision to allow ‘slips’ to happen. However, other decisions, which influence safety indirectly without anyone noticing, erode safety in a gradual but dangerous process. Recent example within the British healthcare system is the high-profile failings within the Mid-Staffordshire Hospitals, which attracted a lot of media attention.

Apart from the latent conditions within any organization, safety and organizational culture are related concepts used to explain accidents. The term safety culture is difficult to define, but it can be understood as the ambience, which describes an organisation with respect to conscientiousness and care. As Vincent points out, culture is an aggregate of good or bad habits that are largely malleable.

The psychology of error has underpinned analysis of errors. According to Reason, errors are divided into two broad categories namely slips and lapses, which are associated with actions, and mistakes, which are associated with knowledge. Slips and lapses are associated with using the wrong action to achieve the right plan: slips are external actions while lapses are internal events. Mistakes are associated with using the wrong plan in the first place to achieve the right

action. Mistakes may be rule-based or knowledge-based. Violations, on the other hand are intentional deviations from standards or rules. These concepts describe the active failures by those people at the 'sharp end' of the system who are working the system, in healthcare, the providers and users of the system. It is the interaction between the 'active and latent failures,' which lead to errors as shown in the Figure 25 below.

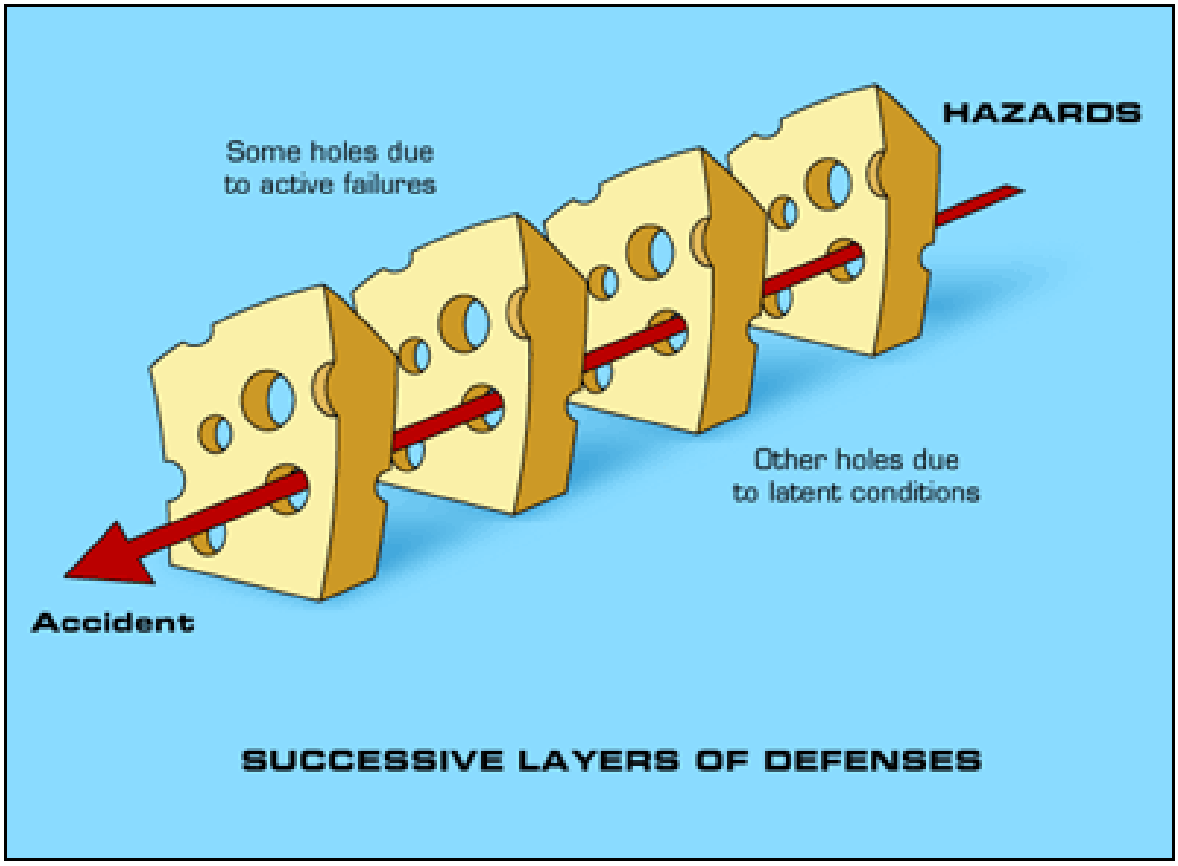


Figure 25: Reason's "Swiss Cheese" Model (image with permission from [www.patientsafety.duhs.duke.edu)](www.patientsafety.duhs.duke.edu)

To provide understanding, accidents in healthcare and other industries are to be reviewed from a wider systems view. Reason's model of organizational accident shows that although individual actions and failures are important in analysing accidents or errors, their working environment and organizational processes produce the latent conditions that lead to errors. As explained in Vincent (2010), the sequence of accident starts with the unfavourable and complex issues of organizational procedures, which include planning, design, maintenance, strategy and policy. The latent conditions created are then carried along different organizational and departmental systems to the workplace where local conditions created contribute to the

ideal environment for errors and violations. Some of the unsafe acts unfortunately penetrate the system defences to produce incidents. This model is represented in the figure below

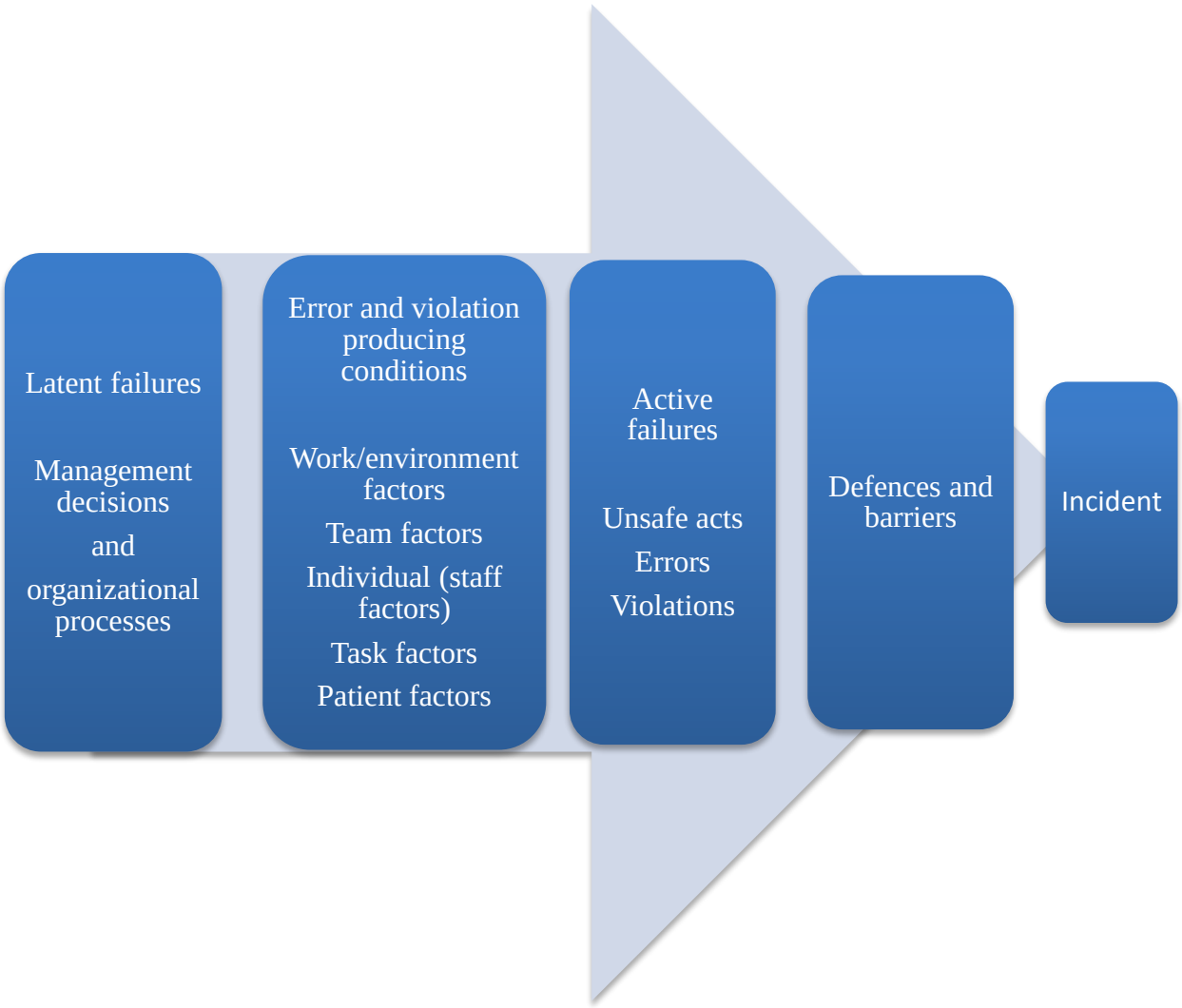


Figure 26: Organisational accident model (adapted from Reason, 1997)

Figure 26 above shows a simple visual representation of Reason's accident model. The latent failures describe the organisation and culture; the error and violation producing conditions describe contributory factors and active failures describe the care delivery problems (Vincent, 2010). Reason points out that this model does not seek to shift the responsibility from workers at the sharp end of the system to the managers, but that both levels have a shared responsibility when it comes to accidents. Vincent points out in addition that beyond the organization itself, regulatory and professional organizations, government institutions, etc. also impact patient safety.

Vincent and colleagues have therefore extended Reason's model as summarised in Table 83 below, and produced a single all-encompassing framework of factors impacting clinical practice by grouping the error producing conditions and organizational factors.

Table 83: Framework of contributory factors influencing clinical practice (Vincent et al., 1998)

Factor types	Contributory influencing factor
Patient factors	Condition (complexity and seriousness) Language and communication Personality and social factors
Task and Technology Factors	Task design and clarity of structure Availability and use of protocols Availability and accuracy of test results Decision-making aids
Individual (staff) Factors	Knowledge and skills Competence Physical and mental health
Team Factors	Verbal communication Written communication Supervision and seeking help Team leadership
Work and Environmental Factors	Staffing levels and skills mix Workload and shift patterns Design, availability and maintenance of equipment Administrative and managerial support Physical environment
Organizational and Management Factors	Financial resources and constraints Organizational structure Policy, standards and goals Safety culture and priorities
Institutional Context Factors	Economic and regulatory context National health service executive Links with external organizations

Error-producing conditions identified from the current research are summarised below using the framework highlighted above. It is however important to note that not every slip, lapse or violation needs to be explained in terms of Reason's organizational framework and Vincent and colleagues' framework. Some errors are very much related to the local context and specific characteristics of related tasks (Vincent, 2010). Moreover, the demarcation between the factor types outlined in Table 83 above is more blurred than distinct. All major incidents however mostly happen over time, involve many different people and influencing factors (Vincent, 2010).

11.1.1 Patient factors

At the top of the framework are patient factors. The patient's condition directly influence practice and outcome. In the current study, older patients were observed to have on-going co-morbidities, which needed to be managed as rationally as possible. This led to significant polypharmacy, with average number of acute and repeat prescriptions per older patient ≥65 years old recorded as approximately 4.0 and 6.0 respectively (Table 14). The total average item per older patient ≥65 years old was recorded as 8 (Table 10). With age-related diminishing pharmacokinetics, older patients were at increased risk of errors such as drug interactions, renal impairment affecting drug dosing, and potential adverse drug effects. Cognitive challenges were also observed as related to some of the error identified in these patient groups. For example, a patient with well-documented mental difficulties, who was prescribed a few different potencies of topical steroids, without specific advice on areas being treated or duration of use. Older patients were also observed to require more secondary-care related visits and investigations when compared with the rest of the population. Moreover, general practice management of older patients was not restricted to only their own GP. As such, an older patient with many on-going medical needs, could be seen by more than GP even for the same issue, thereby creating an error-producing opportunity. Age-related dosing has long-influenced clinical practice in children. This study has highlighted unprecedented levels of suboptimal antibiotic dosing in children. Assumptions about the age and appropriate dosing in children may also contribute to the errors identified.

The patient personality and social factors, which influence practice and patient outcome, were unfortunately not amenable to evaluation in the current study consultation room interactions could not be captured from patients' record reviews. However, factors such as patient personality, language and psychological issues may contribute no less to issues of quality identified in the current study. For example, a 67-year old patient had been prescribed Brufen Retard ® (modified-release Ibuprofen) regularly for six years at a dose of 800mg twice daily. Two GPs had documented patient's refusal of a gastro-protective agent, such as a PPI despite having had long chats with him. This example demonstrates how the personality of a patient can influence the quality of prescribing. The BNF clearly advises gastro-protection, particularly for NSAIDs use in patients, ≥65 years old. It is possible that the patient may be unaware of the risks associated with his treatment regime or the patient may have come across as demanding and assertive as observed in the patient characteristics from the PRACtISE study

11.1.2 Task and Technology Factors

The task design, adoption of protocols and test results were observed to influence the care process and the quality of care in the current study as outlined below:

1. The medicines management process – the medicines management process in primary care is currently not owned by any specific group of healthcare professional. Although advanced services provided by pharmacists, such as MURs and NMS were implemented to provide some form of link within the many arms of the primary healthcare system, the current model does not establish this link properly. This was observed to lead to poor communication and chaos within the system leading to increased risk of errors. For example, an older patient's dose is changed and they receive both the new dose and the erstwhile dose at the same time. This is a common observation in my practice as a community pharmacist. Someone somewhere should be bringing the loose ends together
2. New and repeat prescriptions – as observed in the community pharmacies studied, the responsible pharmacist intercepted more errors relating to newly issued items and repeat prescriptions. In the records review study, the current study demonstrated that repeat prescriptions were significantly more likely to be associated with an error when compared with acute prescriptions (P-Value=3.3E-05) and (Table 35). Avery et al have outlined the process of issuing repeat prescriptions in GP surgeries in the PRACtISE study. Sometimes, repeat prescriptions are printed by prescribing clerks and are in turn signed by GPs, sometimes without immediate access to the PMR. The system of repeat requests by a patient's pharmacy may sometimes complicate repeat dispensing. In a bid to increase their loyalty and lock-in, pharmacies offer free repeat management for many patients. With such a system, patient safety does not have patients at its heart anymore. The patient is eliminated from the process completely. Pharmacists should ideally have conversations with patients before dispensing the next repeat. In practice however, this seldom happens.

   Avery and colleagues recommended that new drugs should ideally not be placed on repeat prescriptions until at least after a 6-week review. This study has shown that new medications are added onto an existing repeat list even without taking out the drugs that have been discontinued. The question is who is ultimately responsible for repeat dispensing– the patient, GP, receptionist or pharmacist?
3. Availability and accuracy of test results – the current study found that 1 in 3 older patients experienced a monitoring error (Table 32). Ensuring timely and adequate blood

test for drug monitoring was a challenge. The most common monitoring errors were however for routinely used drugs. Perhaps the most challenging factor was the continued re-issuing of those drugs requiring monitoring even when such monitoring had not been done

4. GP clinical computer system – incompleteness of patient medical records posed a risk to increased harm. Information on allergies, referrals, blood test results and off-site prescribing (such as in patient's homes or for other hand-written prescriptions) were sometimes missing. Overriding alerts and relevant information due to the sheer volume of alerts also seems to be a potential problem. In an instance, a hospital discharge note and treatment regime was stored under a different patient's record. This was brought to the attention of the manager who then passed a comment that that situation would be rectified.

11.1.3 Individual (staff) Factors –

1. The prescriber-related factors – Although prescribers' views were not sought in the current study, the nature of some of the errors identified in the current study have highlighted a range of issues with GP prescribing in primary care namely their therapeutic training, experience with use of some drugs, and their knowledge of specific patient groups such as children and older patients, and their professional responsibilities to update their knowledge with advances in medical practice.
    a. From the interviews conducted in the PRACtISE study, Avery and colleagues mentioned that many GPs felt their therapeutic training received much less attention than they judged was required to enable them to safely conduct the art of prescribing. The types of errors summarized in the records review section above have also demonstrated this. For example, a patient with compromised renal function who continued to be prescribed Etodolac® (NSAID) at a high dose. The antibiotic dosing errors in children also demonstrates the problem with inadequate therapeutic training.
    b. These dose/strength errors identified in children and older patients in this study also demonstrate GPs' inadequate knowledge of the therapeutic needs of specific patient groups. Some potential errors identified in the current study emphasize the importance of keeping up to date with new evidence. For example, the MHRA has advised that the dose of Simvastatin is limited 20mg

when a patient is taking Amlodipine. In one dose/strength error described above, a 70-year old patient was receiving 40mg Simvastatin. Also, the BNF advises gastro-protection with NSAIDs in older patients. However, 19 of the 22 omission errors relating to failure to prescribe concomitant medication were related to the use of NSAIDs without gastro-protection, which has been documented to lead to preventable hospital admissions

2. The community pharmacist – this research has also suggested that while pharmacists are trained and equipped to provide clinical services (Al-Khani et al., 2014), the physical acts of dispensing often preclude the delivery of these services. Perhaps they are not located in the right environment where their skill and training could be harnessed. From the view of the pharmacists' who participated in the study, the physical barrier between GPs and hospital prescribers, and pharmacists with respect to location may be an source of error-producing condition

11.1.4 Team Factors

The need for multi-disciplinary co-working amongst community healthcare providers has been known to influence patient safety and the quality of care in primary care. Community pharmacists recounted how challenging it is to contact hospital prescribers by phone to obtain clarifications as necessary. Incomplete medical records or inadequate documentation were observed to contribute to written communication errors. For example, a patient with suspected antibiotic-allergic was asked to ring the name of the medication implicated through. Three months after this advice was given, the patient's record was still not annotated with this information creating an environment for this adverse reaction to re-occur

11.1.5 Work Environmental Factors

This study showed that the skill mix and staffing levels in community pharmacy practice might contribute to the inability of pharmacists to perform important clinical roles and patient advice. The current arrangement for remunerating the services conducted by community pharmacists supports a target-driven culture amongst owners and management of pharmacy chains. The retail environment has been documented to deter patients from wanting to benefit from consultations with community pharmacists

11.1.6 Organizational and Management Factors

1. Local arrangements for clinical governance – although primary care organizations are expected to have systems in place for reviewing their errors and near misses, it

would appear from this study that such systems are less well defined. Under the defunct PCTs, review, analysis and learning from near misses were not perceived as being important to prevent errors from reaching patients. Although this forms a part of contract monitoring, again no one appears to be responsible for this process. With the new structure of CCGs and NHS Area Teams, the process of local clinical governance is unclear. Overall, the culture within these local health organizations appears to be reactive (Ashcroft, Morecroft, et al., 2005; Parker et al., 2006). Particularly, investigating incidents, learning from incidents, team working, and communication with primary care organizations such as general practices and community pharmacies were dimensions, were not well defined.

11.1.7 Institutional Context Factors

The current economic and political climate may put additional pressures on healthcare professionals who may not want to challenge "management authorities" due to the fear of loosing their jobs. For example, the practice of clinical pharmacy in the community is challenged by targets to conduct specific numbers of advanced services; this pressure can lead to missing those patients who really need the service because it is more about numbers than about patient benefit.

11.2 Summary and recommendations

Following suggestions in the literature (from key landmark studies including the PRACtISE study by Avery et al, 2012 and the CHUMS study by Barber et al, 2009) that older patients and children may be more susceptible to medication errors, this work sought to establish the prevalence, types and nature of medication errors in these two population groups, estimating the ensuing harm, and proposing pragmatic interventions to reduce the prevalence of errors. In keeping with other UK studies on medication errors, most errors identified had the potential to cause minimal harm to these patient groups. This study found that approximately 1 in 3 older patients or 1 in 12 prescription items issued to older patients were exposed to a prescribing or monitoring errors. For monitoring errors only, this increased to 1 in 9 patients, being susceptible to a monitoring error. Factors influencing the occurrence of prescribing errors in older patients included taking multiple medications, being female, and being aged 75 years and over, being prescribed medication from the following groups: cardiovascular, corticosteroid (oral and topical), and musculoskeletal and joint disease agents.1 in 5 younger patients or 1 in 10 prescription items issued to patients aged 0-12 years experienced a prescribing error. Factors influencing the occurrence of prescribing errors in younger patients included being aged 5-10 years, being prescribed multiple medications, and being prescribed antibiotics.

The current study also sought to characterise community pharmacists' interventions on prescription errors and MRPs. The results showed that community pharmacists intervene on a diverse range of MRPs from general practice, and are therefore important and pragmatic points of 'defence' within the medicines management process, though this role is often challenged by the more technical aspects of dispensing. This study has therefore added evidence to the current discussions around the potential benefit of clinical pharmacists in GP surgeries.

This research used a mixed method approach to achieve the set objectives of this research. Established and tested quantitative methods were used to determine the prevalence of prescribing and monitoring errors in older patients and children, and to estimate pharmacists' interventions on prescription errors and other MRPs. The retrospective record review and prospective observation of pharmacists' intervention allowed a more in-depth review of events leading up to an error or MRP. Quantitative and qualitative methods were used to study and characterise the systems of error management at former PCTs, CCG and NHS England levels.

Researchers have investigated the prevalence of prescribing errors in secondary care, and more recently in primary care and in residential or nursing care homes, and made recommendations

with varied outcomes (Royal et al., 2006). This is however, the first study to estimate the prevalence and nature of prescribing errors in older patients and in children in primary care, and to estimate community pharmacists' intervention on MRPs, and based on the findings, to make recommendations to prevent errors.

The typology of errors on prescriptions for older patients however showed that patients were more likely to experience errors, not just as a consequence of their age (i.e. due to polypharmacy, pharmacokinetic/dynamic changes, etc.), but also as a consequence of being prescribed a medication. If experiencing an error was purely age-related, the types of errors one would have expected to see more of are dose/strength errors, allergy, intolerance and contraindication errors, incorrect drug errors, etc. However, the most common errors were incomplete information on prescription, omission errors relating to failure to prescribe for an existing condition, inadequate review errors, and an unacceptable level of monitoring-not-requested errors. This study has demonstrated that there is an unacceptable prevalence of medication errors primary care, affecting the most vulnerable patient groups. Interventions are urgently required to reduce patient morbidity and improve patient outcomes. This has immense implication for policy.

From the systematic literature review underpinning this study, researchers agree that GP training and continued educational development need to focus more on therapeutic drug use. Indeed, one of the key recommendations of the PRACtICe Study following identification of many errors that could have been prevented with greater attention to safe prescribing, was the professional development of GPs (Avery, Barber, et al., 2012). The researchers made recommendations to the General Medical Council to review the Royal College of General Practitioners (RCGP) curriculum to give more focus to therapeutic knowledge, and to develop an educational tool, which can be used by GPs to improve their skills of comprehensive medication reviews to identify and correct errors. The researchers also highlighted the importance of continued professional development (CPD), especially for established GPs who are already practicing. For instance, one of the common errors identified in younger patients 0-12 in the current study was the prescription of suboptimal strengths of antibiotics. Although the recommended dosages are stated in the BNF for children and other reference sources, physicians and other prescribers sometimes do not have 'the time' to refer to these, or even assume that they know it already. CPD portfolios for GPs must incorporate case studies from research findings to highlight common errors to doctors. While this is a very important step in

the right direction, the current debate about the role of pharmacists in GP practices aligns perfectly with this recommendation.

Pharmacists' current training gives therapeutic knowledge and skills the prominence it deserves. Pharmacists are already the final healthcare professional defense in Reason's Swiss Cheese Model, detecting medication errors before they reach patients (Brown et al., 2006). Many medication error studies have successfully employed pharmacists to conduct thorough medication reviews to identify potential errors from medical records, and from prescriber and patient interviews, and observation (Alldred et al., 2011; Avery, Barber, et al., 2012; Barber et al., 2009; Franklin et al., 2009). In their study to determine whether a pharmacist can effectively review repeat prescriptions through consultations with elderly patients in general practice, Zermansky et al (2001) found that patients in the intervention group (pharmacist reviewed) were more likely to have changes made to their repeat prescriptions, and that the drug costs were less in the intervention group (Zermansky et al., 2001). Other studies else where have underscored the strategic position of community pharmacists (Al-Khani et al., 2014; Mossialos et al., 2015; Odukoya et al.)

Another randomised controlled trial found that a pharmacist-led information technology intervention (PINCER) was an effective method for reducing a range of medication errors in general practices with computerised clinical records (Avery, Rodgers, et al., 2012). The PINCER intervention comprised feedback, education outreach and dedicated support. The primary outcomes were the proportion of patients who had had any of three clinically important errors: prescription of NSAID to patients without co-prescription of proton-pump inhibitor to patients with a history of ulcer, beta blockers to those with a history of asthma, and long-term ACE-I use in the elderly without urea and electrolytes check up. It is note-worthy to mention that these types of errors were identified in the current study. With such evidence on the role of pharmacists in conducting medication reviews and medication safety interventions, is the current debate about pharmacists' role in GP practices stating the obvious? Research and practice must collaborate urgently to establish policies and models to support pharmacists' roles in general practice. The cost of pharmacists' interventions cannot be compared with the cost of medication errors to the healthcare system, the practitioner and the patient.

In their study, Barber et al found that for each prescribing, dispensing or administration event, there was an 8-10% chance for an error to occur. This rose to 15% for a monitoring error to occur (Barber et al., 2009). Avery et al (2012) found an increased risk of error (odds ratio 3.18,

P<0.001) for drugs on the monitoring list. The current study found a monitoring error prevalence of 9.38% items among older patients Table 32. This figure was higher than the prevalence of prescribing errors only (~7.0% items), even though drugs requiring blood test monitoring accounted for only a fifth of all reviewed prescriptions. It can be concluded that monitoring errors are even more prevalent than prescribing errors in primary care management. During data collection, it was observed that one GP clinical computer system made it easier to see the last time a monitoring test was done. This could probably have contributed towards the higher percentage of monitoring errors identified in this surgery. Although general practices have different systems to ensure blood test monitoring is done on time, these defences slip sometimes (Avery, Barber, et al., 2012). Unlike Avery and colleagues' finding, very few of the monitoring errors identified in the current study were related to high-risk drugs such as anticoagulants (e.g. Warfarin) or drugs with narrow-therapeutic indices (e.g. Lithium). The most common monitoring errors were identified in 'regular' drugs such as Angiotensin Converting Enzyme Inhibitors (ACE-I) and angiotensin II receptor antagonists, Statins, Diuretics, Thyroid hormones, etc. (Table 44). This was in keeping with Barber and colleagues' study (2009), where the researchers found that the drugs most commonly involved in monitoring errors in care homes were diuretics (53.1%), ACE inhibitors (15.6%), Amiodarone (12.5%) and Levothyroxine (9.4%) (Barber et al., 2009). This raises the question of getting the 'basics' right. Interventions such as the use of monitoring 'books,' like Warfarin (Yellow) book, Lithium book, Steroid card, etc. have increased the safety of monitoring high-risk drugs, which is laudable. However, more patients take the drugs where monitoring was observed to have failed in this study, when compared with high-risk drugs, further emphasising the need for interventions to prevent monitoring errors. Avery et al suggested that alerts, which highlight the need for blood test monitoring for certain drugs, should be created on clinical computer systems. However, researchers have observed that such alerts are not sufficient in themselves to prevent errors due to prescribers overriding them (Tamblyn et al., 2008).

Perhaps the repeat prescribing system contributes to the problem of suboptimal monitoring in primary care. Often, messages are left on the repeat dispensing slips by GP practices, so that they are passed onto the patient by the dispensing pharmacy. With many pharmacies retaining repeat slips to increase loyalty and lock-in, the communication often breaks down. At the practice, the GP may not necessarily have access to patients' record at the time of signing. Therefore, it is easy for monitoring reminders to get overlooked.

This raises the same question, which was raised by Barber et al (2009) – who is responsible for ensuring adequate blood test monitoring for certain drugs in general practice – the GP who signs the prescription, the practice nurse who sends reminders for reviews, the practice receptionist who takes repeat orders, the pharmacist who fills the prescription, or the patient who should know when their blood test is due? Barber et al found that the lack of any one person taking responsibility for the 'whole system' was one of the factors, which led to the unacceptable prevalence of medication errors in care homes. This study will suggest that monthly-quarterly audits of drugs requiring monitoring within individual GP practices may help to highlight problems, with action taken as necessary. Perhaps a trigger tool like the NHS Safety Thermometer could be adapted for primary care drug monitoring system.

The NPSA 2007 report 'Safety in Doses: improving the use of medicines in the NHS,' recommends that healthcare organisations should assess whether current arrangements around medication incident reports received locally are enabling local learning and action to reduce the risk of harm to patients, by reviewing the numbers and completeness of those reports (National Patient Safety Agency, 2007). A national error learning system is very useful. However, local actions are still necessary to establish local improvements. This study has raised serious concerns about the current local arrangements for managing error reporting, reviews and learning. Under the now defunct PCTs, it would appear that protocols and action plans for managing error learning were suboptimal and hazy. Although CCGs referred the researcher to the NHSE Area Teams citing not being responsible for error reporting and learning, only 2 NHSE Area teams returned a completed questionnaire. This very low response rate may not be solely due to the limitations of the study, like using a postal survey, but may reflect the current safety climate within NHSE Teams. With the new CCG structure, urgent actions to clarify responsibilities and accountabilities for local error reporting and learning are needed. The roles and responsibilities of the medicines management teams of both the CCGs and NHSE Area teams need to be amalgamated in the interests of patient safety. Also, the idea of individual organisations, such as community pharmacy multiples having own incident reporting systems is commendable. However, this may lead to loss of vital information when these data are not pulled together and analysed locally for relevant actions and learning. Moreover, there is evidence that GPs and pharmacists may not necessarily report all errors and near misses (Ashcroft et al., 2006; Kingston et al., 2004). Toolkits such as the NHS Safety Thermometer, a local improvement tool for measuring, monitoring and analysing patient harms and 'harm free' care, are useful. However, it should be noted that this toolkit helps to analyse patient 'harm.'

Collating information on ‘near misses,’ and using them to inform local improvement strategies may prevent such harm in the first place.

This study has also raised important issues for policy with respect to managing older people with chronic co-morbidities and the resultant polypharmacy, and paediatric patients, with the associated dose titrations, in the community. In secondary care, specialists, by training and practice, have the skills and experience required to deal with the ‘same’ issue and same patient over and over again. Perhaps it sounds simplistic that this model could be replicated in primary care. However, looking at the types and nature of errors identified in UK primary care in the current study, and the studies by Avery et al (2012) and Barber et al (2009), the suggestion of some form of specialisation in primary care may be effective. For instance, the 17-dose/strength errors (25% of all errors) associated with paediatric dosing of antibiotics, may be prevented if GPs with special interests in paediatrics managed such patients. The same applies to older patients. Patients, whose conditions require medication switches and dose adjustments over time really need to see one GP during such periods at least, to ensure continuation of a care plan. One of the seven main error-producing conditions perceived to lead to an increased risk of errors was related to the Prescriber, when Avery et al qualitatively studied the causes of prescribing errors in primary care. The researchers noted that experience as well as training, were prescriber-related factors, which determined the likelihood of mismanagement (Slight et al., 2013). The more such GPs deal with such cases, the better they become at dealing with complex patient needs.

This research has also highlighted the role of the patient and/or care in patient and medication safety. The study found that the top categories of problems identified in community pharmacies were either related to the patient or the prescriber. As Vincent (2010) pointed out, patient safety is all about putting the ‘patient’ at the centre of safety. Unruh and Pratt (2007) describe the “invisible work of “patients” in a healthcare system – identifying errors of procedures, managing therapeutic and non-therapeutic treatment tasks, handing over to new staff and ensuring continuity of their care, and providing relevant information about their health and well-being (Unruh & Pratt, 2007) as cited in Vincent (2010). Although patients may decide to engage to various degrees, all patients should be treated as individuals and provided the opportunity to speak or comment on aspects of their care. Empowering patients to be involved in their care can help prevent medical errors. This can be achieved by patient education supported by health campaigns. Healthcare professionals need to encourage the participation and involvement of patients. Patients are increasingly represented in hospital groups, and this

needs to be brought into community practice. The next paragraph has attempted to pull together what the current study adds to the literature and the body of knowledge on medication safety in primary care.

11.3 Conclusion

Errors are common in older patients and in children in primary care. The majority of errors were of mild to moderate severity. Similar to secondary care, there is a gap for primary care healthcare professionals with special interest in geriatric and paediatric medicine. Furthermore, there is ample opportunity for pharmacist-led record review to identify potential errors and risk for harm, which in turn could potentially inform improvement in the safety and quality of prescribing in primary care.

11.4 What this study adds

- This study has provided important information on the prevalence of prescribing and monitoring errors in general practice in older patients ≥65 years old and in children 0-12 years old, and the nature of these errors
- The defenses in the medication management system in primary care that prevent errors – the prescriber-related defenses, community pharmacy-related defenses and patient-related defenses
- Local arrangements for error management and learning needs to be reviewed and clarified as the current system is relatively porous
- Underutilized roles of community pharmacists in primary care and an urgent review into the mode of delivery of NHS advanced services (MUR and NMS) in primary care
- This study has also highlighted the need for patient and carer involvement in healthcare to improve health outcomes. Campaigns and adverts related to improved safety in the use of medication need to be put out to patients.

11.5 Opportunities for further research

Opportunities exist for further research to explore factors, which contribute to medication mishaps in these vulnerable age groups by exploring the relationships between the variables identified. Patient and healthcare professional inputs can be pointers to potential interventions to improve the safety of medication use in primary care.

The models of pharmaceutical care provided by community pharmacists need to be further explored. If pharmacists are going to be successful in GP practices, a solid foundation needs to be laid. One of the challenges of interventions to prevent errors is that the similar interventions may be duplicated if existing systems are not thoroughly reviewed to draw out their drawbacks. Although there is evidence to support pharmacists' interventions, the proposed model needs to be thoroughly planned through rigorous research.

11.6 Outputs from this research

- Journal publication - ***Olaniyan, Janice****; Ghaleb, Maisoon; Dhillon, Soraya; Robinson, Paul (2015):* Safety of Medication Use in Primary Care – A systematic review – IJPP Vol. 23, pp. 3-20
- ***Olaniyan, Janice****; Ghaleb, Maisoon; Dhillon, Soraya; Robinson, Paul (2013): Medication Error Management System in Primary Care:* Royal College of General Practitioners Annual Primary Care Conference: Progressive Primary Care, Harrogate, Yorkshire, October 2013
- ***Olaniyan, Janice****; Ghaleb, Maisoon; Dhillon, Soraya; Robinson, Paul (2013): Safety of Medication Use in Primary Care: A systematic Review:* Royal College of General Practitioners Annual Primary Care Conference: Progressive Primary Care, Harrogate, Yorkshire, October 2013
- ***Olaniyan, Janice****; Ghaleb, Maisoon; Dhillon, Soraya; Robinson, Paul (2015): Prevalence and Nature of Medication Errors in Older Patients in Primary Care:* International Forum on Quality and Safety in Healthcare: Inspiring healthcare for 20 years London 2015
- Poster accepted for presentation at the upcoming Royal College of General Practitioners Annual Primary Care Conference, SECC, Glasgow, 2015: Prevalence of Prescribing and Monitoring Errors in Older Patients and Children in Primary Care
- Poster accepted for presentation at the upcoming British Hypertension Society meeting in Staffordshire, September, 2015: Assessment of Electronic Patient Records in Two Primary Care Centres for Quality of Prescribing and Monitoring.

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Appendices

Appendix 1: Approval Letter from NHS Bedfordshire

Unit 12, Doolittle Mill
Froghall Road, Ampthill
Bedfordshire
MK45 2NX

01525 636915
Fax: 01525 636976

PA: Ruth Sawford
Tel: 01525 636936

Mrs Carolyn Read
Chair,
NRES Committee East of England - Cambridge Central
Victoria House
Capital Park
Fulbourn
Cambridge.
CB21 5XB

RE: Consent to carry out the Safety of Medication Use in Primary Care, SAFECaRE Study in Bedfordshire Primary Care Trust (REC reference number 12/EE/0166)

I write with respect to the above-named study. The research team have been in contact with us, and NHS Bedfordshire has agreed to work with the researchers, and for the study to be done in those general practices and community pharmacies within our area that are willing to take part. The PCT will provide honorary contracts for the research team.

The research team have mentioned that this study aims to extend the work done by the recently published General Medical Council (GMC) commissioned-study, the PRACtiSE Study. The SAFECaRE Study aims to estimate the rates of prescribing errors in the elderly (aged 65 years and older), and in children (0 to 12 years) as the PRACtISe Study demonstrated that these patient groups experience more medication errors than the rest of the population.

Should you have any further questions, please do not hesitate to contact me.

Kind regards

A.D. Cooke

Andrew Cooke

Head of Medicines Management

Appendix 2: Primary Care Research Assurance Letter Bedfordshire

NHS
Cambridgeshire and Peterborough Clinical Commissioning Group

23 July 2013

Research Management Team
Hosted by NHS Cambridgeshire & Peterborough CCG
Lockton House
Clarendon Road
Cambridgeshire
CB2 8FH
Tel: 01223725466
Email:
Vivienne.shaw@cambridgeshire.nhs.uk
www.camstrad.nhs.uk

Mrs Janice Olaniyan
University of Hertfordshire
Department of Pharmacy, Practice and Public Health
School of Life and Medical Sciences
University of Hertfordshire
AL10 9AB

Dear Mrs Olaniyan

Letter of assurance for research project

Re: L01238 Safety of Medication Use in Primary Care
REC: 12/EE/0166

The Research Management Team is funded by the West Anglia Comprehensive Local Research Network and hosted by the NHS Cambridgeshire & Peterborough Clinical Commissioning Group.

This assurance letter confirms that the Research Management Team has reviewed your submission in accordance with Department of Health Research Governance Framework for Health and Social Care. This assurance letter relates to the following primary care localities: Bedfordshire and Luton primary care.

This assurance is subject to obtaining IG toolkit reference for practices and pharmacies and Caldicott Guardian confirmation. In addition, any group work and observations will need the appropriate consent and prior agreements in place.

Primary Care Sites/GP practices decide on their own accord to agree participation for a given study.

This assurance letter is subject to the Investigators meeting the following specific conditions:

Please ensure that any amendments are submitted to the research ethics committee and the Research Management Team for review as appropriate

Investigator responsibilities can be found on our website, please familiarise yourself with these and the site file instructions.

The project must follow the agreed protocol and be conducted in accordance with Primary Care Sites/GP practices policy and procedures in particular in regard to data protection, health & safety and information governance standards. The research team are required to follow the reasonable instructions of the Primary Care Site/GP practice manager and can contact the Research Management Team for research management advice.

The West Anglia Primary Care Research Management Team undertakes research management services for primary care in Bedfordshire, Cambridgeshire & Peterborough, Luton and Cambridgeshire Community Services

Assurance is subject to adherence to the Data Protection Act 1998, NHS Confidentiality Code of Practice, the Human Tissue Act 2004, the NHS Research Governance Framework for Health and Social Care, (2nd edition) April 2005, the Mental Capacity Act and any further legislation released during the time of this study. Approval for Clinical Trials is on the basis that they are also conducted in accordance with European Union Directive and the Medicines for Human Use (Clinical Trials) Regulations 2004 principles, guidelines and later revisions, and in accordance ICH Good Clinical Practice.

Members of the research team must, where instructed, have appropriate substantive or honorary research contracts or letters of assurance for research access in Primary Care prior to commencing work on the study, additional researchers who join the study must also hold a suitable contract or letter of assurance for research access in Primary Care before they start. Final access to primary care sites/GP practices is at the discretion of the site.

You will be required to complete basic monitoring information during the course of the research, as requested by the Research Management Team. Should any adverse incidents occur during the research, local Incident and Near Miss Reporting Policy should be adhered to and the sponsor, CI and RMG Team informed.

We welcome feedback about your experience of this assurance process to help us improve our systems. May I take this opportunity to wish you well with your research and we look forward to hearing the progress and outcomes for the study, please contact the RMG team should you be encountering any local difficulties.

Yours sincerely,

Vivienne Shaw
CLRN RMG Manager

cc: Dr Maisoon Ghaleb (*note: Sponsor responsibilities can be accessed via our **website***)
cc: Lynda Harris (Beds & Luton Information Governance Lead)

Appendix 3: Bedfordshire Non-NHS Letter for Assurance for Access to Research

NHS
Cambridgeshire and Peterborough Clinical Commissioning Group

24 July 2013

Mrs Janice Olaniyan
Department of Pharmacy
University of Hertfordshire
College Lane Campus
Hatfield
AL10 9AB

Research Governance Team
Hosted by NHS Cambridgeshire & Peterborough CCG
Lockton House
Clarendon Road
Cambridgeshire
CB2 8FH
Tel: 01223725466
Email: Vivienne.shaw@cambridgeshire.nhs.uk
www.camstrad.nhs.uk

Dear Mrs Olaniyan,

Letter of assurance for research access in Primary Care: Project-specific L01238 Safety of Medication use in Primary Care (SAFECaRE)

The Research Management & Governance (RMG) Team is funded by the West Anglia Comprehensive Local Research Network and hosted by the NHS Cambridgeshire & Peterborough Clinical Commissioning Group.

This assurance letter confirms that the RMG Team have checked your Research Passport and associated HR documents and that they are compliant with the NIHR 'Research in the NHS: Human Resource (HR) Good Practice Resource Pack'. This assurance letter relates to the following primary care localities: Bedfordshire and Luton Primary Care.

You need to take this assurance letter with you and present to Primary Care Sites/GP practices so that they have evidence of RMG checks.

Assurance for research access to primary care sites will be subject to having received Primary Care Sites/GP practices agreement to participate in a given study (Agreement is usually facilitated via the Primary Care Research Network).

Your assurance for research access in Primary Care is on the terms and conditions set out below. This assurance commences on **24/07/2013** and ends on **01/12/2015** unless terminated earlier in accordance with the clauses below.

You will be considered to be a legal visitor at any Primary Care Sites/GP practices that you are allowed to do your research in. You are not entitled to any form of payment or access to other benefits and this letter does not give rise to any other relationship between you and the Primary Care Sites/GP practice, in particular that of an employee.

While undertaking research through Bedfordshire and Luton Primary Care Sites/GP practices you will remain accountable to your employer, **University of Hertfordshire,** but you are required to follow the reasonable instructions of the Primary Care Sites/GP practice manager in relation to the terms of this assurance for research access.

Where any third party claim is made, whether or not legal proceedings are issued, arising out of or in connection with your assurance for research access, you are required to co-operate fully with any investigation in connection with any such claim and to give all such assistance as may reasonably be required regarding the conduct of any legal proceedings.

You must act in accordance with local policies and procedures, which are available to you upon request, and the Research Governance Framework.

You are required to co-operate with Primary Care Sites/GP practices in discharging their duties under the Health and Safety at Work etc. Act 1974 and other health and safety legislation and to take reasonable care for the health and safety of yourself and others while in Bedfordshire and Luton Primary Care Sites/GP practices premises. You must observe the same standards of care and propriety in dealing with patients, staff, visitors, equipment and premises as is expected of any other contract holder and you must act appropriately, responsibly and professionally at all times.

If you have a physical or mental health condition or disability which may affect your research role and which might require special adjustments to your role, if you have not already done so you must notify your employer and Primary Care Sites/GP practices prior to commencing your research role so that the Primary Care Sites/GP practices can make arrangements for you.

You are required to ensure that all information regarding patients or staff remains **secure and strictly confidential at all times**. You must ensure that you understand and comply with the requirements of the NHS Confidentiality Code of Practice (http://www.dh.gov.uk/assetRoot/04/06/92/54/04069254.pdf) and the Data Protection Act 1998. Furthermore you should be aware that under the Act, unauthorised disclosure of information is an offence and such disclosures may lead to prosecution.

You should ensure that, where you are issued with an identity or security card, a bleep number, email or library account, keys or protective clothing, these are returned upon termination of this arrangement. Please also ensure that while on the premises you wear your ID badge at all times, or are able to prove your identity if challenged. Please note that that Primary Care Sites/GP practices accept no responsibility for damage to or loss of personal property.

The Primary Care Sites/GP practices may terminate your right to attend at any time either by giving seven days' written notice to you via the R&D Team or immediately without any notice if you are in breach of any of the terms or conditions described in this assurance letter or if you commit any act that the Primary Care Sites/GP practices reasonably consider to amount to serious misconduct or to be disruptive and/or prejudicial to the interests and/or business of Bedfordshire and Luton Primary Care Sites/GP practices or if you are convicted of any criminal offence. You must not undertake regulated activity if you are barred from such work. If you are barred from working with adults or children this letter of assurance is immediately terminated. Your employer will immediately withdraw you from undertaking this or any other regulated activity and you **MUST** stop undertaking any regulated activity immediately.

Your substantive employer is responsible for your conduct during this research project and may in the circumstances described above instigate disciplinary action against you.

Bedfordshire and Luton Primary Care Sites/GP practices will not indemnify you against any liability incurred as a result of any breach of confidentiality or breach of the Data Protection Act 1998. Any breach of the Data Protection Act 1998 may result in legal action against you and/or your substantive employer.

If your current role or involvement in research changes, or any of the information provided in your Research Passport changes, you must inform your employer through their normal procedures and the RMG Team who will need to review and issue a new assurance for you to share with the Primary Care Sites/GP practices.

Yours sincerely,

Vivienne Shaw CLRN RMG Manager

cc: Danielle Coe, Head of Student Registration, University of Hertfordshire, College Lane, Hatfield AL10 9AB

Appendix 4: Caldicott Guardian Confirmation, Bedfordshire

NHS
Bedfordshire
Clinical Commissioning Group

24 September 2013

Suite 1
Capability House
Wrest Park
Silsoe
Bedfordshire
MK45 4HR

Telephone: 01525 864430
Email: Nicholas.curt@nhs.net
Website: www.bedfordshireccg.nhs.uk

Janice Gbemisoye Olaniyan
Division of Pharmacy, Practice and Public Health
Department of Pharmacy
School of Life and Medical Sciences
University of Hertfordshire
Hatfield
AL10 9AB

Dear Janice

Re: Safecare Project

I would like to confirm in writing that, as the Caldicott Guardian of Bedfordshire Clinical Commissioning Group, I am happy for the Safecare project to take place in Bedfordshire.

Yours sincerely

Dr Nick Curt
Caldicott Guardian
Bedfordshire Clinical Commissioning Group

better care, better value, better health

Appendix 5: NHS Luton Letter of Approval

Mrs Carolyn Read
Chair,
NRES Committee East of England - Cambridge Central
Victoria House
Capital Park
Fulbourn
Cambridge.
CB21 5XB

RE: Consent to carry out the Safety of Medication Use in Primary Care, SAFECaRE Study in Luton Primary Care Trust (REC reference number 12/EE/0166)

I write with respect to the above-named study. The research team have been in contact with us, and Luton Primary Care Trust has agreed to work with the researchers, and for the study to be done in general practices and community pharmacies within our area. The PCT will provide honorary contracts for the research team.

The research team have mentioned that this study aims to extend the work done by the recently published General Medical Council (GMC) commissioned-study, the PRACtiSE Study. The SAFECaRE Study aims to estimate the rates of prescribing errors in the elderly (aged 65 years and older), and in children (0 to 12 years) as the PRACtISe Study demonstrated that these patient groups experience more medication errors than the rest of the population.

Should you have any further questions, please do not hesitate to contact me.

Kind regards

Richard A Jones
Head of Medicines Management and Accountable Officer for Controlled Drugs
Luton Clinical Commissioning Group (LCCG)
The Lodge
4 George Street West
Luton

Tel:-01582 532114 (ext 2114)
Mobile: 0790 0980 606
Safe Haven Fax number (Medicines Management Office): 01582 511054
Email: richard.jones@luton-pct.nhs.uk or richard.jones15@nhs.net

Appendix 6: Luton CCG Caldicott Guardian Approval

NHS
Luton
Clinical Commissioning Group

The Lodge
4 George Street West
Luton LU1 2BJ
Telephone : 01582 532049
Fax : 01582 511001
Email: nina.pearson1@lutonccg.nhs.uk

12 September 2013

Janice Gbemisoye Olaniyan
Division of Pharmacy, Practice and Public Health
Department of Pharmacy
School of Life and Medical Sciences
University of Hertfordshire
Hatfield
AL10 9AB

Dear Janice,

I would like to confirm in writing that as the Caldicott Guardian of Luton Clinical commissioning Group I am happy for the Safecare project to take place in Luton.

Yours sincerely,

Dr Nina Pearson
Chair
Caldicott Guardian
Luton Clinical Commissioning Group

Together for a healthier Luton

Appendix 7: Consent Letter from Kingfisher Practice

Kingfisher Practice

Churchfield Medical Centre, 322 Crawley Green Rd, Luton LU2 9SB
Tel 0844 477 0958 www.kingfisherpractice.com Fax 0844 884 0138

11th October 2013

Dear

I would like to confirm in writing that as the Caldicott Guardian of Kingfisher Practice I am happy for the Safecare project to take place in the practice.

Yours sincerely

Ian Hill-Smith

Dr Ian Hill-Smith MD BSc MRCP FRCGP

Partners: Gina Johnson, Ian Hill-Smith, Sarah Burcombe, Manju Kappen

Appendix 8: NHS Harrow Letter of Approval

NHS Brent

Executive Office
Wembley Centre for Health & Care
116 Chaplin Road
Wembley
Middlesex HA0 4UZ
Tel:
Fax: 020 8795 6483

NHS Harrow

Executive Office
The Heights
59-65 Lowlands Road
Harrow on the Hill
Middlesex HA1 3AW
Tel:
Fax: 020 8426 8646

24th September 2012

Mrs Carolyn Read
Chair
NRES Committee East of England - Cambridge Central
Victoria House
Capital Park
Fulbourn
Cambridge
CB21 5XB

RE: Consent to carry out the Safety of Medication Use in Primary Care, SAFECaRE Study in Harrow Primary Care Trust (REC reference number 12/EE/0166)

I write with respect to the above-named study. The research team have been in contact with us, and Harrow Primary Care Trust has agreed to work with the researchers, and for the study to be done in general practices and community pharmacies within our area. The PCT will provide honorary contracts for the research team but NHS Harrow is not responsible for any financial contributions to support this pilot project.

The research team have mentioned that this study aims to extend the work done by the recently published General Medical Council (GMC) commissioned-study, the Practice Study. The SAFECaRE Study aims to estimate the rates of prescribing errors in the elderly (aged 65 years and older), and in children (0 to 12 years) as the Practice Study demonstrated that these patient groups experience more medication errors than the rest of the population.

Should you have any further questions, please do not hesitate to contact me.

Kind regards

Javina Sehgal
Borough Director, NHS Harrow

Rob Larkman: Accountable Officer (Designate)
Brent, Ealing, Harrow and Hillingdon Clinical Commissioning Groups

Chair: Jeff Zitron

Appendix 9: South London Primary Care Letter of Approval

St George's Healthcare NHS Trust

South London Primary Care
Research and Development Office

South London Primary Care R&D
Address:
St George's Healthcare NHS Trust
Clinical Research Facility, Room 65,
Corridor 3a, Jenner Wing, Cranmer Terrace,
Tooting, London SW17 0RE
Maggie Elliott
SL Research & Development Manager
Maggie.Elliott@stgeorges.nhs.uk
Tel: 020 8725 4075

Mrs Janice Olaniyan,
School of Pharmacy, University of Hertfordshire
Department of Practice and Policy
College Lane Campus AL10 9AB

16 September 2013

Dear Mrs Olaniyan,

Study title: SAFECaRE study: Investigating the safety of medication use in primary care.
R&D Reference:2012/492 C,K,R,SM,W
REC ref:12/EE/0166
CSP ref:N/A
CI name: Mrs Janice Olaniyan
PI name Mrs Janice Olaniyan:

The South London (SL) Primary Care Research & Development (R&D) Office is the lead R&D team for SL GP/Independent Practitioner sites.

NHS Research Governance (RG) assurance for the above research has been given on the basis described in the application form and supporting documentation approved by an NHS Research Ethics Committee (REC) and HRA-CAG (Health Research Authority- Confidentiality Advisory Group) subject to the conditions listed below and overleaf. RG assurance is given on the understanding that the study is conducted in accordance with the Research Governance Framework. **The Chief Investigator (CI) should provide IG toolkit references to the HRA-CAG for those sites along with confirmation from the Caldicott Guardian that this research is being undertaken in line with their IG toolkit return prior to accessing data at each site. This information is to be reviewed by the security review team at the HRA-CAG.**

RG assurance is only granted for the activities for which a favourable opinion has been given by the NHS REC and the HRA-CAG to cover **Croydon CCG; Kingston CCG; Richmond CCG; Sutton CCG; Merton CCG and Wandsworth CCG**. The end date of the project is listed on the R&D form as 03 September 2014.

Please find attached guidance on the Independent Practitioner/Practice research governance responsibilities which sets out the responsibilities of the primary care site. The study team must get written agreement from each GP site and Community Pharmacy site confirming their decision to take part in this study.

Please give a copy of this letter to each participating site. If you require any further information or advice, do not hesitate to contact Fran Mautadin in the first instance or Maggie Elliott (contact details above).

St George's Healthcare NHS
NHS Trust

South London Primary Care
Research and Development Office

South London Primary Care R&D
Address:
St George's Healthcare NHS Trust
Clinical Research Facility, Room 65,
Corridor 3a, Jenner Wing, Cranmer Terrace,
Tooting, London SW17 0RE
Maggie Elliott
SL Research & Development Manager
Maggie.Elliott@stgeorges.nhs.uk
Tel: 020 8725 4075

Yours sincerely,

SL Primary Care R&D Manager

c.c.
Dr Maisoon Ghaleb, University of Hertfordshire;
Dr Paul Robinson, University of Hertfordshire;
Ms Soraya Dhillon, University of Hertfordshire;
Mr John Senior, University of Hertfordshire;

Research Governance assurance is given subject to the following conditions:

There will be no call upon NHS resources other than any mentioned in the application and agreed with the R&D Office and the Primary Care sites.

The research must not start until letters of access have been issued and we will write to the study team separately about this.

The research sponsor or the CI or the local PI at the research site may take appropriate urgent safety measures in order to protect research participants against any immediate hazard to their health or safety. The R&D Office should be notified if any such measures have been taken. The notification should also include the reasons why the measures were taken and the plan for further action. The R&D office should be notified within the same time frame as the REC.

The Sponsor organisation must have in place procedures for detecting and dealing with misconduct and fraud. All researchers must be aware of these procedures and any instances must be reported to the R&D Team.

Unless the Study Team requests otherwise, we will include details of this project on the Primary Care database.

We will ask the Study Team to send us a copy of the final report and/or a summary of the findings.

Only members of the clinical care team can access patient identifiable information without the patient's consent. Researchers are not part of the clinical care team and therefore require a patient's consent for access to their confidential data unless the study has been approved by the HRA-CAG (Health Research Authority- Confidentiality Advisory Group) under the Health Service (Control of Patient Information) Regulations 2002 to process patient identifiable information without consent.

South London Primary Care R&D
Address:
St George's Healthcare NHS Trust
Clinical Research Facility, Room 65,
Corridor 3a, Jenner Wing, Cranmer Terrace,
Tooting, London SW17 0RE
Maggie Elliott
SL Research & Development Manager
Maggie.Elliott@stgeorges.nhs.uk
Tel: 020 8725 4075

You must comply with the site information governance (IG) requirements.

GP indemnity for routine clinical practice is covered by GP Medical Defence Union arrangements.

All primary care recruitment must be uploaded to the NIHR portfolio by the study team if this study is a NIHR portfolio study.

Appendix 10: Health Research Authority (HRA) NRES Approval Letter

Health Research Authority
NRES Committee East of England - Cambridge Central
Victoria House
Capital Park
Fulbourn
Cambridge
CB21 5XB

Telephone: 01223 597685
Facsimile: 01223 597645

27 September 2012

Mrs Janice Olaniyan
Department of Practice and Policy,
School of Pharmacy
University of Hertfordshire
AL10 9AB

Dear Mrs Olaniyan

Study title:	**Investigating the Safety of Medication Use in Primary Care**
REC reference:	**12/EE/0166**
Protocol number:	**1**

Thank you for your letter responding to the Committee's request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Ethical review of research sites

NHS sites

The favourable opinion applies to all NHS sites taking part in the study, subject to management permission being obtained from the NHS/HSC R&D office prior to the start of the study (see "Conditions of the favourable opinion" below).

Non-NHS sites

Conditions of the favourable opinion

The favourable opinion is subject to the following conditions being met prior to the start of the study.

Management permission or approval must be obtained from each host organisation prior to the start of the study at the site concerned.

Management permission ("R&D approval") should be sought from all NHS organisations involved in the study in accordance with NHS research governance arrangements.

Guidance on applying for NHS permission for research is available in the Integrated Research Application System or at http://www.rdforum.nhs.uk.

Where a NHS organisation's role in the study is limited to identifying and referring potential participants to research sites ("participant identification centre"), guidance should be sought from the R&D office on the information it requires to give permission for this activity.

For non-NHS sites, site management permission should be obtained in accordance with the procedures of the relevant host organisation.

Sponsors are not required to notify the Committee of approvals from host organisations

- Point 7 - confirmation is required that all members of the research team including as yet unnamed post graduate students will have honorary contracts. This is not clear from the comments regarding future post graduate students yet to be appointed

- Point 13 - on the consent form (point 6) the Committee would like clarification about the use of personal views in the study - will they be anonymised. If so this needs to be made clear in the consent form

It is the responsibility of the sponsor to ensure that all the conditions are complied with before the start of the study or its initiation at a particular site (as applicable).

You should notify the REC in writing once all conditions have been met (except for site approvals from host organisations) and provide copies of any revised documentation with updated version numbers. Confirmation should also be provided to host organisations together with relevant documentation.

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document	*Version*	*Date*
Evidence of insurance or indemnity		02 August 2011
Interview Schedules/Topic Guides	1.0	28 February 2012
Investigator CV		
Letter from Sponsor		22 March 2012
Other: Form for collecting demographic and prescription data on patients (adapted from PRACtICE Study)	1.0	28 February 2012
Other: Form for collecting detailed information on potential medication errors (adapted from PRACtICE Study)	1.0	28 February 2012
Other: Form for collecting data on potential omission errors related to not prescribing for an existing condition (adapted from PRACtICE Study)	1.0	28 February 2012
Other: Form to be used for collecting demographic, prescription data on patients, and pharmacist intervention or inception of error	1.0	28 February 2012
Other: Form to be used for collecting demographic, prescription data on patients and dispensing error	1.0	28 February 2012
Other: Covering Letter for PCT clinical governance (participants for PCT-level questionnaires)	1.0	28 February 2012
Other: C.V Dr Maisoon Ghaleb		

Other: C.V Prof Soraya Dhillon		14 March 2012
Other: C.V Dr Paul Robinson		14 March 2012
Other: GMC PRACtiSe Study Protocol	3	07 June 2010
Other: Peer review comments from Felicity Smith		25 September 2012
Other: Luton CCG Consent Letter		
Other: Bedfordshire CCG Consent Letter		
Other: Harrow CCG Consent Letter		
Other: Covering letter - face to face interviews (lead GP and PM)	2.0	01 September 2012
Other: Covering letter - face to face interviews (pharmacist)	2.0	01 September 2012
Other: Interview Schedule (interviewees: Lead GP, practice manager, responsible pharmacist)	2.0	01 September 2012
Participant Consent Form: interview participants	2.0	01 September 2012
Participant Information Sheet: for all practice invited to participate	2.0	01 September 2012
Participant Information Sheet: for all community pharmacies invited to participate	2.0	01 September 2012
Participant Information Sheet: for safety culture assessment (GP's, nurses and practice managers)	2.0	01 September 2012
Participant Information Sheet: for safety culture assessment (responsible pharmacist and qualified dispensers)	2.0	01 September 2012
Participant Information Sheet: General Practice Information sheet - for cluster samples	2.0	01 September 2012
Participant Information Sheet: Community Pharmacy Information Sheet - for cluster samples	2.0	01 September 2012
Participant Information Sheet: General practice information sheet (for interviewees: lead GP and Practice Manager)	2.0	01 September 2012
Participant Information Sheet: Community Pharmacy Information Sheet (for interviewees: responsible pharmacist)	2.0	01 September 2012
Protocol	2.0	01 September 2012
Questionnaire: Questionnaire for PCT clinical governance leads	1.0	28 February 2012
REC application		26 March 2012
Response to Request for Further Information	Janice Olaniyan	

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

After ethical review

Reporting requirements

The attached document *"After ethical review – guidance for researchers"* gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments
- Adding new sites and investigators
- Notification of serious breaches of the protocol
- Progress and safety reports
- Notifying the end of the study

The NRES website also provides guidance on these topics, which is updated in the light of

changes in reporting requirements or procedures.

Feedback

You are invited to give your view of the service that you have received from the National Research Ethics Service and the application procedure. If you wish to make your views known please use the feedback form available on the website.

Further information is available at National Research Ethics Service website > After Review

12/EE/0166	**Please quote this number on all correspondence**

With the Committee's best wishes for the success of this project

Yours sincerely

pp NStorey

Mrs Carolyn Read
Chair

Email: Nicky.Storey@eoe.nhs.uk

Enclosures: "After ethical review – guidance for researchers"

Copy to: *Dr Maisoon Ghaleb, University of Hertfordshire*
Professor Soraya Dhillon, University of Hertfordshire

Appendix 11: Health Research Authority (HRA) Confidentiality Advisory Group (CAG) Approval

NHS
Health Research Authority
Confidentiality Advisory Group

Mrs Janice Olaniyan
Department of Pharmacy
School of Life and Medical Sciences
University of Hertfordshire
AL10 9AB

Skipton House
80 London Road
London
SE1 6LH

Tel: 020 797 22557
Email: HRA.CAG@nhs.net

11 June 2013

Dear Mrs Olaniyan

Study title: Investigating the Safety of Medication Use in Primary Care
Project CAG reference: CAG 1-06 (FT5)/2013
IRAS ID number: 100051/406213/4/136

Thank you for your research application, submitted for approval under the Health Service (Control of Patient Information) Regulations 2002 to process patient identifiable information without consent. Approved applications enable the data controller to provide specified information to the applicant for the purposes of the relevant activity, without being in breach of the common law duty of confidentiality, although other relevant legislative provisions will still be applicable.

The role of the Confidentiality Advisory Group (CAG) is to review applications submitted under these Regulations and to provide advice to the Health Research Authority on whether an application should be approved, and if so, any relevant conditions.

Health Research Authority approval decision

The Health Research Authority, having considered the advice from the Confidentiality Advisory Group as set out below, has determined the following:

1. The application is conditionally approved, subject to compliance with the standard and specific conditions of approval.

This letter should be read in conjunction with the outcome letter dated 25 March 2013.

Context

This application from the University of Hertfordshire detailed a study which aimed to carry out a review of patient notes within six GP practices and pharmacies in order to review prescribing errors and meet the following objectives:

1) To characterise existing systems of error identification, reporting and recording at PCT and primary healthcare organisation (general practice and community pharmacy) levels,
2) to assess the safety culture of primary healthcare organisations,
3) to develop primary care definition of prescribing errors and their categories,
4) to determine prevalence and types of prescribing errors in general practice, and to assess dispensing accuracy in community pharmacies, and

5) to design, implement and evaluate a practical error preventing intervention for primary healthcare organisations, in the UK.

The applicant requested support to allow a researcher to access 600 patient records within GP practices and 2000 prescribing records from community pharmacies in order to extract de-identified data only.

Request for clarification

Members agreed that the minimum requirements of the Regulations appeared to have been met and agreed to provide a provisional recommendation of approval for this activity, subject to a satisfactory response to the following request for clarification. Responses to this request were submitted and are summarised below in italics:

1. Please could you confirm whether NHS number will be recorded by the researcher and if so for what purpose.

It was confirmed that last four digits only would be recorded, along with initials and year of birth in order to provide a unique reference number for patients; this information would be retained at GP practices.

2. Please could you provide details of how identification of pharmacy records will be carried out?

It was confirmed that records would be identified by the responsible pharmacist.

Members reviewed the further information provided and confirmed that this was satisfactory. It was agreed that approval could now be recommended, subject to the following conditions of support.

Specific conditions of support

1) Confirmation of a favourable REC opinion. **Received**

2) Confirmation of satisfactory security arrangements. Please note that as access is taking place on NHS sites it has been confirmed by the security review team that you should provide IG toolkit references for those sites along with confirmation from the Caldicott Guardian that your research is being undertaken in line with their IG toolkit return prior to accessing data at each site. This information will then be reviewed by the security review team who will confirm if this is satisfactory for the purposes of your application.

3) Please ensure that the patient information poster reflects that University staff will be accessing patient records. **An updated poster was provided which detailed access to patient records.**

Further actions

Please ensure that you forward IG toolkit references and Caldicott Guardian confirmation in line with condition 2 prior to accessing data at each site.

This letter provides confirmation of final approval, subject to the above information being received prior to accessing data at each site. I will update the register of approved applications on the HRA website to reflect this approval and will include a list of those sites which have provided a satisfactory IG toolkit return and Caldicott Guardian confirmation.

Annual review

Please note that this approval is subject to submission of an annual review report to show how you have met the conditions or report plans, and action towards meeting them. It is also your responsibility to submit this report 6 weeks prior to the anniversary of your final approval and to report any changes such as to the purpose or design of the proposed activity, or to security and confidentiality arrangements.

Reviewed documents

The documents reviewed were:

Document	*Version*	*Date*
Research protocol		September 2012
Supporting documents for research protocol		September 2012
IRAS application form		29 January 2013
Patient Information Poster Pharmacy		
Patient Information Poster Practice		
REC provisional opinion letter with responses		29 May 2012
Email from applicant with additional info		20 February 2013
NIGB response letter		8 April 2013

Membership of the Group

The members of the Confidentiality Advisory Group who considered this item are listed below

There were no declarations of interest in relation to this item.

Please do not hesitate to contact me if you have any further queries in relation to this letter, I would be grateful if you could quote the above reference number in all future correspondence.

Yours sincerely

Claire Edgeworth
Deputy Confidentiality Advice Manager

Email: HRA.CAG@nhs.net

Enclosures: Standard conditions of approval

Copy to: NRES North West – Haydock, nrescommittee.northwest-haydock@nhs.net

Confidentiality Advisory Group
Sub-group members

Name	Capacity
Dr Mark Taylor (Chair)	Lay
Dr Patrick Coyle	
Mr Terence Wiseman	Lay

Standard conditions of approval

The approval provided by the Health Research Authority is subject to the following standard conditions.

The applicant will ensure that:

1. The specified patient identifiable information is only used for the purpose(s) set out in the application.

2. Confidentiality is preserved and there are no disclosures of information in aggregate or patient level form that may inferentially identify a person, nor will any attempt be made to identify individuals, households or organisations in the data.

3. Requirements of the Statistics and Registration Services Act 2007 are adhered to regarding publication when relevant.

4. All staff with access to patient identifiable information have contractual obligations of confidentiality, enforceable through disciplinary procedures.

5. All staff with access to patient identifiable information have received appropriate ongoing training to ensure they are aware of their responsibilities.

6. Activities are consistent with the Data Protection Act 1998.

7. Audit of data processing by a designated agent is facilitated and supported.

8. The wishes of patients who have withheld or withdrawn their consent are respected.

9. The Confidentiality Advice Team is notified of any significant changes (purpose, data flows, data items, security arrangements) prior to the change occurring.

10. An annual report is provided no later than 12 months from the date of your final confirmation letter.

11. Any breaches of confidentiality / security around this particular flow of data should be reported to CAG within 10 working days, along with remedial actions taken / to be taken.

Appendix 12: PCT/CCG Questionnaire

Department of Pharmacy
Pharmacy, Practice and Public Health,
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University of Hertfordshire
Hatfield
AL10 9AB
UK

Tel +44 (0)1707 285087

Fax +44 (0)1707 284506
m.ghaleb@herts.ac.uk

Date:

Dear Sirs,

Re: "Safety of Medication Use in Primary Care Research Project"

We are writing to invite you to participate in a survey questionnaire to understand your Clinical Commissioning Group's (CCG) current systems for medication error identification, recording and reporting. This research project is part of a doctorate (PhD) degree investigating the safety culture within primary care organisations, and the prevalence of prescribing errors in this setting.

Previous research has shown that patients are exposed to risks from preventable adverse drug events in primary care (Avery et al, 2012, PRACtICE Study). Critical incidents are increasingly being recorded, and now reported routinely following the Department of Health (DH) 2001 report, "*An organisation with a memory",* which emphasised the importance of error reporting and learning within the National Health Service (NHS). To date, CCGs' error management procedures (including identification, recording and reporting) have not been documented. We would therefore like to describe the CCGs' current processes of error management, with the hope to highlight strengths and weaknesses of these systems to facilitate learning from errors and to improve patient safety.

This research has obtained ethical approval from the Cambridge Central Research Ethics Committee, REC (Reference number 12/EE/0166), and is funded by a University of Hertfordshire studentship.

Please find enclosed information on the survey. All the information you provide will **remain strictly confidential** and no individual or CCG will be identified.

Thank you for your participation

Yours sincerely

Dr Maisoon Ghaleb
Senior Lecturer
Pharmacy, Practice and Public Health

"Safety of Medication Use in Primary Care Research Project"

Title: To investigate the Clinical Commissioning Group procedures for "*error* management"

Participant Information for SAFECaRE study

This survey is being conducted across Clinical Commissioning Groups (CCG) in England, and will only take about 10 minutes of your time. By participating in this survey, you are consenting to the research.

Please kindly answer all questions below as completely as possible. All the information you provide will **remain strictly confidential** and no individual or CCG will be identified
Should you require any clarifications, please contact:

Dr. Maisoon Ghaleb, Researcher and Senior Lecturer, Department of Pharmacy, Pharmacy, Practice and Public Health School of Life and Medical Sciences, University of Hertfordshire. Hatfield AL10 9AB. Telephone: 01707285087; fax: 01707284506. Email address: m.ghaleb@herts.ac.uk

If you would like to complete the survey online, please send an email to the address above to request an electronic version the survey.

Thank you so much for helping with this survey.

Safety of Medication Use in Primary Care (SAFECaRE) Study

Title: To investigate the Clinical Commissioning Groups procedures for "*error* management"

Current role: _____
Number of years in current role: _____
Number of years of related role (please tick) : <5□ 5-10□ 11-20□ >20□
Sex: Male/Female (please circle)
Age (please tick): 20-29 □ 30-39 □ 40-49 □ 50+ □

Please kindly answer these questions below:

1) What types of incident(s) would you class as prescribing error(s) based upon your experience or reports from general practices (surgeries)?

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2) What types of incidents(s) would you class as dispensing error(s) based upon your experience or reports from community pharmacies?

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3) How are critical incidents (prescribing and dispensing errors) reported to your CCG –
    a. Are general practices (surgeries) and community pharmacies instructed to submit their periodic critical incident reports OR
    b. Do you ask them for periodic critical incident reports?

    (Circle as appropriate, and add further comments below)

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4) How often are critical incident **data** collated from general practices (surgeries) and community pharmacies by your CCG?

(Please tick as appropriate)

Monthly □ Quarterly □ Yearly □ Other (Specify) □

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5) Could you describe any processes or protocols currently in use by general practices (surgeries) and community pharmacies in your CCG to identify, record, and report medication error incidents to the CCG clinical governance or medicines management department?

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6) Does your clinical governance or medicines management department have any systems in place to review critical incidents?

Yes □ No □

If 'Yes', please describe the system briefly, adding how often this is done

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.....

7) Do you collect information on medication "near miss" incidents from general practices and community pharmacies?

Yes □ No □

If 'Yes', how often? Please tick as appropriate:

Monthly □ Quarterly □ Yearly □ Other (Specify) □

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8) What interventions have been implemented by your clinical governance/medicines management department to prevent occurrence of medication incidents in primary care organisations within your ward, notably in GP surgeries and community pharmacies?

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Appendix 13: Form 1 - for collecting data on patient demographics and drugs prescribed

The SAFECaRE Study

"Safety of Medication Use in Primary Care"

Form 1: Prescribing Record Sheet Database Unique ID No.___

Instructions: Please use one sheet per patient (use extra sheets if more than 15 prescriptions) and record any possible prescribing errors.

Initials of student doing review: _____ Date _____
Practice ID code: _____ (assigned by research team)
Patient ID code: _____ (for internal use by practice)
Patient information:
Age: _____ Years/Months (indicate as appropriate) Sex: Male/Female (please circle)
Months registered with practice during the 12-month data collection period: _____

If no prescriptions for this patient, tick here ----- and move on to the next patient.

In the table below, please record summary data on the prescriptions for this patient over the last 12 months (record data in relation to the latest prescription if a drug (at a particular dose) has been prescribed more than once during the year).
If you pick up any potential errors, please fill in **Form 2** for each of these errors.
If you pick up any omission errors relating to failure to prescribe for an existing condition, please fill in **Form 3**.

Rx[1]No.	Drug name/dose/form[2]	Acute (A) or Repeat (R) [3]	Prescriber (GP, nurse or other) [4]	No. Of possible Rx error (s) [5]
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				

[1]: Rx = prescription; [2]: Name of drug/preparation as it appears in the patient record; [3]: Record "A" for acute prescription and "R" for repeat prescription; [4]: Record prescriber type (1 = GP; 2 = nurse prescriber; 3 = non-medical prescriber; 4 = other; 5 = unknown); [5]: if no error, please put zero (0);

If this patient has more than 15 prescriptions, please tick here--- and do an extra Form 1

Appendix 14: Form 2 - Form for collecting information on potential error

The SAFECaRE Study

"Safety of Medication Use in Primary Care"

Form 2: Details of possible prescribing errors Database Unique ID No.___

For the possible errors identified on Form1, please provide further details below and overleaf (use additional sheets as required).

ONE FORM PER POSSIBLE ERROR

Initials of student doing review: _____ Date: _____
Practice ID code: _____ (assigned by research team)
Patient ID code: _____ (for internal use by practice)
Patient information:
Age _____ Years/Months (indicate as appropriate) Sex: Male/Female (please circle)

Rx No from Form 1[1]	
Drug name and Formulation[2]	
Strength	
Dosage instructions	
Quantity	
Initials of prescriber	
Error code[3]	

[1]: Please use the appropriate prescription number from Form 1; [2]: Name of drug/preparation as it appears in the patient record; [3]: please use the following error code:
Prescribing error codes are

1. Unnecessary drug
2. Incorrect drug
3. Duplication
4. Allergy/error
5. Contraindication error
6. Interaction error
7. Dose/strength error
8. Formulation error
9. Frequency error
10. Timing error
11. Information incomplete
12. Generic/brand name error
13. Omission error relating to failure to prescribe concomitant medication
14. Not classified
15. Inadequate documentation in medical records
16. Quantity error
17. Inadequate review
18. Duration error

Monitoring errors

19. Monitoring not requested
20. Requested but not done
21. Results not available
22. Results not acted upon

Form 2: Details of possible prescribing errors

1) Please describe the potential error:

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.....
.....
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.....

2) Was the potential error a single event?
Yes/No (please circle as applicable) If 'Yes' (go to Question 4)
If 'No' (go to Question 3)

3) If the potential error has been repeated, how many weeks/ months/ years has the error been repeated over?

.....Weeks/ months/ years (please circle as appropriate)

4) Why do you think the error occurred? And what happened in the lead up to the error?
(Give details as much as you can)

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.....

5) Has there been any adverse event associated with the possible error?

Yes/No/Uncertain (Please circle as applicable) If 'Yes' (go to Question 6)
If 'No' (go to Question 7)

6) If you think there may have been an adverse event associated with the error, please describe this below:
.....
.....
.....
.....

7) Was the error reported through the PCT normal reporting procedure?

Yes/No /Unknown (Please circle as applicable)

8) Was the error reported to NPSA?

Yes/No /Unknown (Please circle as applicable)

9) If there is any evidence that the error has been rectified?

Yes/ No (Please circle as applicable, and give brief details below).
.....
.....
.....

Appendix 15: Form 3 - for collecting information on omission errors relating to failure to prescribe for an existing clinical condition

The SAFECaRE Study

"Safety of Medication Use in Primary Care"

Form 3: Omission errors relating to failure to prescribe for an existing clinical condition

Database Unique ID No._____

Please note that this form is for recording medication that, after careful examination of the patients' records, you think should have been prescribed because of an existing condition e.g. aspirin, ACE inhibitor, beta-blocker and/or statin post-MI.

Note: use Forms 1 and 2 to record possible omission errors relating to failure to prescribe necessary concomitant therapy in relation to patients' existing medications, e.g. failure to prescribe a PPI to a patient taking NSAID when they are at high risk of GI bleed.

Initials of student doing review: _____ Date _____
Practice ID code: _____ (assigned by research team)
Patient ID code: _____ (for internal use by practice)
Patient information:
Age_____ Years/Months (indicate as appropriate) Sex: Male/Female (please circle)

Please describe the possible omission error(s) in this patient.

1. Clinical condition(s) for which you believe medication should have been prescribed:
   .....
   .....
   .....
   .....
2. Medicine(s) that you believe should have been prescribed:
   .....
   .....
3. Please provide an explanation for why you think this was an omission error:
   .....
   .....
   .....
   .....
   .....
4. Having thoroughly reviewed the patient's records is there anything to suggest that the medicine you think should have been prescribed may not be indicated e.g. due to previous ADR, expressed patient preference, caution or contraindication?

   Yes/No/Uncertain (Please circle as applicable)
   If 'Yes' or 'uncertain', please give details below

Appendix 16: List of drugs requiring monitoring

1) Monitoring following the initiation of therapy

Drug/drug group	Monitoring on initiation
ACE inhibitor/Angiotensin-II receptor antagonists	On initiation: Pre U&E and 2 weeks after
Digoxin	Pre U&E
Diuretics	Pre U&E and 1 month after starting
Glitazones	Pre LFT
Statins	Pre LFT before starting treatment

2) Monitoring of maintenance therapy

Drug/drug group	Maintenance monitoring
ACE inhibitor/Angiotensin-II receptor antagonists	12 monthly U&E
Amiodarone	6 monthly TFT 6 monthly LFT
Azathioprine	3 monthly FBC
Carbimazole	3 monthly TFT (6 monthly if patient been stabilised for over 1 year)
Digoxin	Digoxin level if toxicity or lack of efficacy suspected.
Diuretics	12 monthly U&E
Glitazones	12 monthly LFT
Levothyroxine	12 monthly TFT
Lithium	3 monthly lithium levels 12 monthly TFT
Methotrexate	3 monthly FBC 3 monthly LFT 6 monthly U&E
Sulfasalazine	FBC 3 monthly in 1st year LFT 3 monthly in 1st year FBC 6 monthly in 2nd year LFT 6 monthly in 2nd year No further monitoring if stable
Theophylline	Theophylline level if toxicity suspected
Valproate	3 monthly LFT for first 6 months
Warfarin	12 Weekly INR
Statin	3 monthly and 12 monthly LFT in the first year following initiation

Appendix 17: Types of prescribing and monitoring errors

Prescribing errors

1. Unnecessary drug
2. Incorrect drug
3. Duplication
4. Allergy error
5. Contraindication error
6. Interaction error
7. Dose/strength error
8. Formulation error
9. Frequency error
10. Timing error
11. Information incomplete
12. Generic/brand name error
13. Omission error relating to failure to prescribe concomitant treatment
14. Not classified
15. Inadequate documentation in medical records
16. Quantity error
17. Inadequate review
18. Duration error

Monitoring errors

19. Monitoring not requested
20. Requested but not done
21. Results not available
22. Results not acted upon

Appendix 18: Examples of judgements made in the PRACtISE Study (Avery et al, 2012)

Scenario	Judgement	Rationale for judgement
Helicobacter eradication treatment to a patient who is Helicobacter negative.	Error: unnecessary drug.	Significant increased risk of harm with no likely benefits from the antibiotic components of the treatment.
Combined oral contraceptive pill left on repeat prescription after an alternative hormonal contraceptive had been given.	Sub optimal prescribing: risk of duplication low.	The panel felt that it was suboptimal prescribing to leave a combined oral contraceptive pill on repeat prescription and alternative hormonal contraception had been given. Nevertheless, the panel felt that it was highly unlikely that the patient would request this medication having been given an alternative hormonal contraceptive.
Prescription of a second dose of the same influenza vaccine within one flu season (whether or not the patient received the second dose).	Error: duplication.	Significant increased risk of harm if patient was to receive a second dose (even if this was just a local reaction to the injection) without any benefits.
Prescription of paracetamol when another paracetamol containing product is on the patient's repeat prescription (or vice-versa): both products prescribed at the same time with no warning that they should not be taken together.	Error: duplication.	Significant increased risk to the patient if they were to take the two products together.
Prescription of paracetamol when another paracetamol containing product is on the patient's repeat prescription (or vice-versa): products not prescribed at the same time, e.g. >3 months between prescriptions, but no warning that the preparation should not be taken together.	Assess on a case-by-case basis.	The panel felt that it was difficult to produce case law on this scenario and so cases should be judged individually.
Prescription of a drug in circumstances where the pharmacist notes that an allergy to that drug has been recorded, and the prescriber gives no acknowledgement/justification for prescribing in light of the previous allergy documentation.	Error: allergy error.	Significant increased risk of harm. Not all allergy recordings represent true allergy. Nevertheless, at a minimum one would expect a prescriber to acknowledge that previous (potential) allergy had been recorded and to justify their prescription in these circumstances.
Prescription of a drug that is contraindicated according to the BNF (unless a clear and defensible justification has been given by the prescriber or in correspondence from secondary care). An example would be the prescription of combined	Error: contraindication error.	Significant increased risk of harm.

Scenario	Judgement	Rationale for judgement
hormonal contraceptives in patients with two or more risk factors for thromboembolism.		
Prescription of two oral NSAIDS at the same time.	Error: interaction error.	Significant increased risk of harm, e.g. from GI Bleed.
Aspirin 150 mg daily as secondary prevention for coronary heart disease.	Suboptimal prescribing: dose/strength error.	While the panel felt that doses >75mg daily increased the risk of harm while not being likely to increase benefits, it was felt that the increased risks were not sufficiently high to label this as an error. It was also noted that 150mg daily was a standard dose in the US.
Calcium tablets prescribed at lower than the recommended dose.	Suboptimal prescribing: dose/strength error.	Risk of harm (or reduction in probability of treatment being timely or effective) is probably low. Also, BNF is not very specific about calcium doses noting that dietary intake also needs to be taken into account.
Failure to act on a suggested dose change from secondary care correspondence, where that dose change was aimed at either increasing therapeutic benefits or reducing risk of harm.	Error: dose/strength error.	Significant increased risk of harm or reduced probability of treatment being timely and effective.
Overdose of an oral medication in a child, e.g. clearly above that recommended by BNF for height/age, unless the medication has extremely low risk of harm.	Error: dose/strength error.	Significant increased risk of harm.
Overdosage of an oral medication in an adult where there is clear increased risk of harm (unless a clear and defensible justification has been given by the prescriber or in correspondence from secondary care).	Error: dose/strength error.	Significant increased risk of harm.
Overdosage of a single dose of an oral medication (e.g. sulphonylurea) where BNF recommends dividing the dose above a certain dosage level (unless a clear and defensible justification has been given by the prescriber or in correspondence from secondary care).	Error: dose/strength error.	Significant increased risk of harm.
Prescription of a drug with significant potential for harm at a dose above that recommended by the BNF (for a specific indication) e.g. Rosuvastatin 40mg in a patient without sever hypercholesterolaemia or with high cardiovascular risk and under specialist supervision.	Error: dose/strength	Significant increased risk of harm.

Scenario	Judgement	Rationale for judgement
Underdosing of oral antimicrobial agents.	Error: dose/strength error.	Significant increased risk of harm if infection not treated adequately (or if infecting organism not fully eradicated, thus increasing the risk of resistant strains developing)
Underdosing for a condition that is not serious and where failure to prescribe the recommended dose is unlikely to have a significant deleterious effect on the patient in terms of lack of control of symptoms.	Suboptimal: dose/strength error.	The panel felt that for non-serious symptomatic conditions it was not appropriate to label underdosing as an error because prescribers may have consciously used a low dose to avoid side effects.
When a patient is under the care of a specialist, prescription of a drug with significant potential for harm at a dose above that recommended, e.g. failure to adjust doses in response to correspondence from secondary care.	Error: dose/strength error.	Significant increased risk of harm from prescribing a drug that a higher dose than that recommended.
Drug not prescribed in the correct formulation when this might lead to increased risk of patient harm, e.g. tacrolimus and other medications where the BNF states the importance of prescribing the correct formulation.	Error: formulation error.	Significant increased risk of harm, or reduction in the probability of treatment being timely or effective.
Oral antibiotics prescribed at a frequency below that recommended in the BNF.	Error: frequency error.	Significant increased risk of harm (development of antibiotic resistance) or reduced probability of treatment being timely and effective (due to failure to maintain adequate plasma levels of antibiotic).
Prescription of a hydrocortisone containing products in a child at a frequency higher than that advised by BNFC or SPC.	Error: frequency error.	The panel debated this at length, but with input from a paediatrician decided that prescribing hydrocortisone at a frequency greater than that recommended could increase the risk of harm to a child.
Prescription of a topical product which has low potential for harm, e.g. antifungal, mild corticosteroid (in an adult and not on the face), at a frequency different to that recommended by the BNF.	Suboptimal prescribing: frequency error	Risk of harm not significant.
Bendroflumethiazide prescribed OD.	Suboptimal prescribing: timing problem.	While thiazide diuretics should normally be taken in the morning, the panel did not feel there was a significant increased risk of harm from this once daily dosage instruction.

Scenario	Judgement	Rationale for judgement
Oral corticosteroids prescribed without instructions that they should be taken in the morning.	Suboptimal prescribing: timing problem.	The BNF states that the suppressive action of a corticosteroid on cortisol secretion is least when it is given as a single dose in the morning. The panel felt that the risks of harm to patients from not stating that the drug should be taken in the morning were small in the majority of patients. Therefore this was classified as suboptimal prescribing rather than error.
Simvastatin prescribed without instructions that it should be taken at night.	Error: timing error.	Significant reduction in the probability of simvastatin being effective if not taken in the evening/at night.
Benzodiazepines at low dose, e.g. 2 mg, and small numbers of tablets, e.g. 10, prescribed, "as directed" for conditions such as flight phobia and muscle spasm.	Suboptimal: information incomplete.	The panel felt that in the majority of patients there would not be at significant increased risk of harm from this pattern of prescribing.
Ear drops prescribed without indicating which ear they should be used in.	Suboptimal prescribing: information incomplete.	The panel felt that risks of harm to the patient would be low here as it is highly likely that the patient would know which ear to use the drops in.
Eye drops (for non-serious symptomatic conditions such as conjunctivitis or dry eye) prescribed without indicating which eye the drop should be used in.	Suboptimal prescribing: information incomplete.	The panel felt that risks of harm to the patient would be low here as it is highly likely that the patient would know which eye to use the drops in.
Eye drops for glaucoma prescribed as directed or without indicating which eye the drop should be used in.	Prescribing error: information incomplete.	Given that glaucoma is usually asymptomatic, and that there are serious risks to sight if treatment is not administered correctly, the panel felt that risk of harm would be significantly increased by not having clear dosage instructions.
Eye drops containing steroids prescribed as directed or without indicating which eye the drop should be used in.	Prescribing error: information incomplete.	Given the risks of steroids in the eye, it is important to give clear instructions.
GTN sublingual tablets/spray prescribed, "as directed".	Suboptimal	It was felt that patients would almost certainly have been informed about how to take GTN sublingual tablets/spray and that these products come with a Patient Information Leaflet that gives detailed unequivocal instructions on how to take the medicine.
Inhaled corticosteroid prescribed without clear dosage instructions, e.g. PRN, BD.	Error: information incomplete.	The panel felt that given that inhaled corticosteroids are normally prescribed regularly for asthma in order to prevent exacerbations, there was a significant increased risk of harm from not having clear dosage

Scenario	Judgement	Rationale for judgement
		instructions.
Inhaled salbutamol prescribed PRN.	Suboptimal prescribing: information incomplete.	The panel felt that there was unlikely to be a significant increased risk of harm here because salbutamol inhalers come with clear dosage instructions on the PIL.
Medication, with significant risk of harm if not taken according to precise dosage instructions, prescribed, "as directed" (e.g. Amiodarone, beta blockers, methotrexate, n.b. warfarin not included).	Error: information incomplete.	Significant increased risk of harm if the patient does not know what is meant by "as directed".
Medication prescribed without stating the number of tablets to be taken each time, e.g. metformin 500 mg tablets "twice daily" provided that the default dose of one tablet/capsule each time would be an appropriate dose (n.b. very high risk drugs not included in this scenario).	Suboptimal: information incomplete.	The panel felt that most community pharmacists and patients would interpret the instructions to mean one tablet to be taken at each dose, and that in most circumstances the inadequate dosage instructions would not present an increased risk to the patient.
Oral corticosteroids prescribed, "as directed" without further instructions.	Error.	Significant increased risk of harm if patients do not have clear instructions on how to take oral corticosteroids.
Oral corticosteroids prescribed, "as directed by X" (where X is usually a secondary care clinician).	Suboptimal.	The panel felt that while there was a potential increased risk of harm to patients, by specifying the patient was to follow directions given by another clinician it is likely that the patient had been given specific dosage instructions.
Phosphodiesterase type-5 inhibitors with "as directed" dosage instructions.	Suboptimal prescribing: information incomplete.	The panel felt the risks of harm in this situation were low.
Prescription of a preparation for an adult that is available OTC and is prescribed with "as directed" dosage instructions (n.b. NSAIDs to be considered on a case-by-case basis).	Sub optimal prescribing: information incomplete	OTC preparations come with clear dosage instructions and so use of "as directed" is not likely to expose a patient to significant increased risk of harm.
Prescription of a topical product which has very low potential for harm, e.g. emollient, antifungal, without clear dosage instructions.	Sub optimal prescribing: information incomplete.	Risk of harm not significant.
Prescription of a topical product with significant potential for harm if dosage instructions are incorrect or not clear, e.g. moderate-potent corticosteroid in a child, or potent corticosteroid in an adult, or products containing antibacterial agents (includes lack of information on duration of use).	Error: information incomplete.	Risk of harm significant.

Scenario	Judgement	Rationale for judgement
Prescription of oral antibiotics without clear dosage instructions, e.g. PRN.	Error: information incomplete.	The panel felt that there was a significant increased risk of harm from prescribing oral antibiotics without clear dosage instructions, e.g., due to risks of harm from underdosing, overdosing or prolonged treatment, and potential problems with development of antibiotic resistance.
Prescription of hormone replacement therapy without detailed dosage instructions, e.g. "as directed", for preparations where the PIL contains clear and unambiguous instructions.	Suboptimal prescribing: information incomplete.	For preparations where the PIL contains clear and unambiguous instructions the panel felt that there was not a significant increased risk of harm from "as directed" instructions.
Prescription of hormone replacement therapy without detailed dosage instructions, e.g. "as directed", for preparations where the PIL does not contain clear and unambiguous instructions.	Error: information incomplete.	The panel felt that there was significant increased risk of harm from overdose if "as directed" instructions were given for a HRT preparation where the PIL did not give unambiguous dosage instructions.
Prescription of the combined hormonal contraceptive pill/patch without detailed dosage instructions, e.g. "as directed".	Suboptimal prescribing: information incomplete.	It was felt to be common practice for some GPs to use "as directed" instructions knowing that patients will have been informed about how to take the contraceptive pill and that all pill packets come with a Patient Information Leaflet that gives detailed instructions on how to take the medicine.
Sofradex eye/ear drops prescribed without specifying whether they were to be used for eye or ear.	Prescribing error: information incomplete.	Given dangers of inadvertent use of steroids in the eye the panel judged this to be an error.
Steroid eye drops prescribed as directed or without indicating which eye the drop should be used in.	Prescribing error: information incomplete.	Given the dangers of topical eye drops, clear dosage instructions are essential.
Strong opioids with inadequate dosage instructions.	Prescribing Error: information incomplete.	Given legal requirements and risks from overdose, the panel felt that risk of harm to the patient was significantly increased if dosage instructions were not clear.
Topical preparation prescribed with dosage instructions implying an oral route for administration, e.g. take one twice daily.	Suboptimal: information incomplete.	The panel judged that while these dosage instructions could be misinterpreted, it is almost certain that a community pharmacist would put the correct instructions on the dispensing label.
Unclear dosage instructions on a corticosteroid inhaler for asthma in a patient with poorly controlled asthma.	Error: information incomplete.	Significant increased risk of harm if the patient is not receiving an adequate dose.
Varenicline starter pack with "as directed" instructions.	Sub optimal prescribing: information incomplete.	Instructions for use of the starter pack are complicated and these are clearly explained in the Patient Information Leaflet. The panel felt that it was not an error to write "as directed" as full and unequivocal

Scenario	Judgement	Rationale for judgement
		instructions are available in the PIL.
Antiepileptic treatments (modified release preparations) prescribed generically for epilepsy where more than one brand is available.	Error: generic/brand name error.	The panel felt there was a significant increased risk of patient harm from generic prescribing in these circumstances where there may be differences in bioavailability between brands.
Failure to prescribe calcium and vitamins D to a patient who is receiving a bisphosphonate for osteoporosis or fracture prevention.	Suboptimal: omission error.	The panel felt that while all trials of bisphosphonates had included calcium and vitamin D, some patients might be taking sufficient calcium and vitamin D through OTC supplementation or diet.
Prescription of an NSAID to an older person (>65 yrs.) without an ulcer healing (younger patients to be judged on a case-by-case basis).	Omission error related to failure to prescribe concomitant medication.	Significant increased risk of harm (although judgement required in cases at the lower risk end of the spectrum, e.g. occasional use of low dose ibuprofen in a 65-year-old with no other risk factors - such cases were discussed by the panel to reach a judgement).
Prescription of a drug in circumstances where the pharmacist notes that a previous adverse drug reaction (ADR) has been recorded, but the details of that ADR have not been documented and the patient has used the drug since without apparent problems.	Sub optimal prescribing: inadequate documentation in medical records.	Risk of harm probably not significant given that patient has been taking the drug without apparent ill effects.
Prescription of a drug with very high potential for harm (e.g. immunosuppressant, strong opioids) without documented evidence of an indication for the drug.	Error: inadequate documentation in medical records.	Significant increased risk of harm from prescribing high-risk medication without a recorded indication.
Prescription of any medication (except those with very high potential to cause harm) without documentation of the indication in the medical records.	Suboptimal prescribing: inadequate documentation in the medical records.	Lack of documentation made it difficult to judge whether the prescription was associated with a significant increased risk of harm. Therefore sub-optimal prescribing classification used rather than error.
Anthelminthic (for threadworms, head lice, scabies) prescribed on a single prescription with a quantity large enough to treat a whole family.	Suboptimal prescribing: quantity issue.	Even though the quantity is large, this does not necessarily imply an error and there is no legal issue unless the prescriber has explicitly suggested that someone other than the patient can use the medicine.
Oral antibiotics prescribed with a quantity that is clearly below that normally recommended for successfully treating infection.	Error: quantity issue.	Significant increased risk of harm if infection not treated adequately (or if infecting organism not fully eradicated, thus increasing the risk of resistant strains developing)
Prescription of a very large quantity (e.g. greater than six months) of a drug that is not high-	Suboptimal: quantity issue.	The panel felt that there was probably not a significant increased risk of harm to patients.

Scenario	Judgement	Rationale for judgement
risk and has low potential for misuse.		
Prescription of a large quantity (e.g. greater than three months) of a drug that is either high-risk or has significant potential for misuse.	Error: quantity error.	The panel felt that there was a significant increased risk of harm.
Oral Terbinafine prescribed (e.g. for fungal nail infection) for 3-6 months without review.	Suboptimal: duration problem.	The panel felt that in order to consider whether a prescription was still necessary, a patient should not go 3-6 months without a review. See further case below for prescribing beyond six months without review.
Oral Terbinafine prescribed (e.g. for fungal nail infection) for greater than six months without review.	Error: duration error.	Beyond 6 months without review, the panel felt that continuing prescribing might increase risks for patients when no assessment had been made as to whether further treatment was necessary.
Not responding to a request from secondary care to undertake laboratory test monitoring where this request is justified in terms of risks from the medication the patient is taking.	Error: monitoring not requested.	Significant increased risk of harm.
Increasing the dose of an ACE inhibitor/AR II antagonist without checking U&E within three weeks.	Error: monitoring not requested.	Increased risk of harm if adverse effects not picked up early.
Dosage instructions given using decimals rather than words, e.g. 0.5 tablets.	Not a problem.	The panel felt that while the use of decimals may be dangerous in some circumstances, it is unlikely that they would be transmitted on to the dispensing label having gone through a community pharmacy or dispensary.
Eye drops prescribed without indicating how many drops to use.	Not a problem.	Eye drops designed so that one drop gives a sufficient volume; patient inadvertently using more than one drop are unlikely to come to harm as excess liquid spills out of the eye.
Loop diuretics prescribed “twice daily” without stating “one to be taken in the morning and one at lunchtime”.	Not a problem.	The panel felt that while the usual twice daily dosage for loop diuretics was in the morning and at lunchtime some patients might wish to take the doses at different times.
Prescription of a broad spectrum oral antibiotic to a woman receiving the combined oral contraceptive pill (for contraception) without instruction (on the prescription, or documented in the patient's records) that extra contraceptive precautions should be taken.	Not a problem.	In light of WHO and RCOG advice that risks of pregnancy are not increased by use of non-enzyme inducing antibiotics, the panel judged this not to be a problem.

Scenario	Judgement	Rationale for judgement
Prescription of a cephalosporin to a patient with previously recorded history of penicillin allergy (but no evidence of anaphylaxis).	Not a problem.	Although cross sensitivity is a potential problem, the panel felt that it was not a significant risk unless the patient had previously had an anaphylactic reaction to penicillin.
Prescription of a drug, e.g. an oral NSAID, at a frequency greater than that recommended in the BNF, but with the total daily dose no higher than the recommended maximum.	Not a problem.	The panel felt there was no increased risk to patients from this pattern of prescribing.
Prescription of mild opioids to patients with mild-moderate COPD.	Not a problem.	The panel felt that the risk to patients was very low.
Prescription of two or more antihypertensive drugs to a patient with blood pressure in the normal range (this also includes prescriptions of ACE inhibitors and non-potassium-sparing diuretics (or spironolactone in heart failure).	Not a problem.	Risk of harm low and patients likely to receive benefit from having blood pressure in the normal range.
Stating oral doses in milligrams, e.g. “amoxicillin 125mg/5mL, 125mg three times a day” is acceptable practice, as is stating the volume per dose, e.g. 5mL three times a day.	Not a problem.	Either way of stating the dose is acceptable practice.

Appendix 19: Framework for analysis of data from the retrospective review of patients' medical records

The study's aim was to determine the prevalence and nature of prescribing errors in older patients and in children in general practice.

Description of general practices: the characteristics of the general practices, which will be described and compared, include their list size, number of GPs, age distribution of study age population, training status, Indices of Multiple Deprivation score (for 2010), Quality of Outcomes Framework (QoF) scores, and other relevant information.

Description of patients: the study population will be characterised by the total number of patients in the study, and per practice, age distribution of younger and older patients, gender, and the months the patients have been registered with the practice.

Description of prescribed drugs: the drugs prescribed to patients who are randomly selected will be grouped according to their British National Formulary (BNF) chapters. Analyses will include: the total number of drugs reviewed in each age group, median (and Interquartile Range, IQR) drugs per patient age group, total number (and percentage) of drugs on the monitoring list, numbers and percentages of acute and repeat prescription items, median and IQR of acute and repeat prescription items, topmost drugs and drug classes prescribed, medication formulation numbers and percentages, potential prescribing errors, the number and percentage of drugs with prescribing errors, potential monitoring errors, and the number and percentage of drugs with monitoring errors.

Description of types of prescribers: the nature of prescribers will be loosely compared as the relationship between the type of prescriber and error is beyond the scope of this study.

Description of the types of errors: number and percentages of potential errors for each error category, errors on acute and repeat prescription, topmost drugs and drug classes associated with potential prescribing and monitoring errors, medication forms associated with prescribing and monitoring errors, numbers and proportion of each type of prescribing and monitoring errors, most common categories of errors associated with topmost drugs and drug classes, and formulation type. These are summarised in the table below:

Research Question		
What are the current rates and prevalence of medication error in primary healthcare?	Identify the incidence of medication errors in elderly and children	% Per patient % Per prescription Items % Acute medicines % Repeats
	Explore characterises of patients with and without medicines-related problems	
	Report number of medicines per patient	

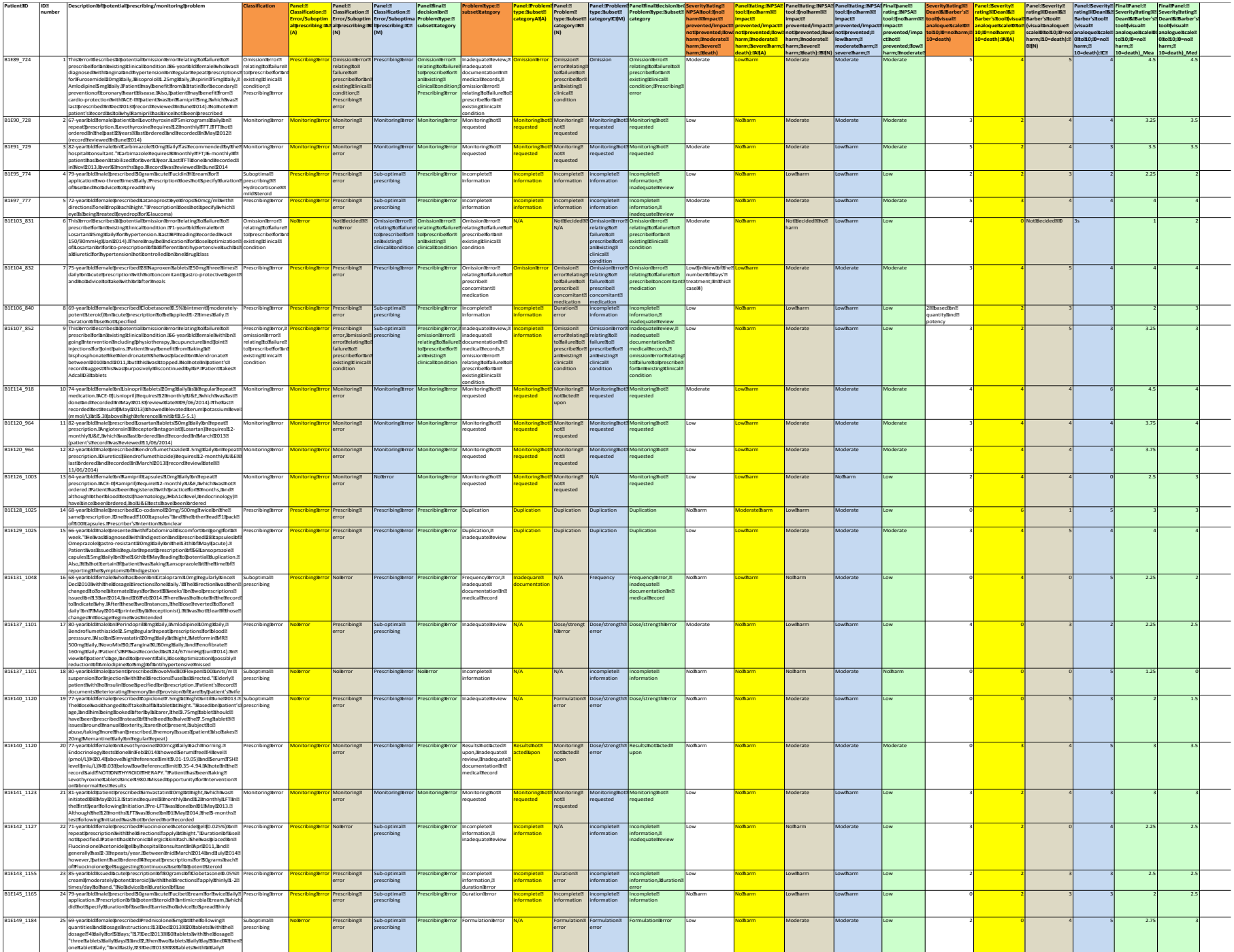
	Identify the BNF categories of Medicines prescribed in the elderly and in children	
	Identify the types of formulations prescribed in the elderly and in children	
	Identify age and gender of elderly patients and children with MRP	
	Explore association between factors impact on MRP • Gender • Age • No of medications • No of co morbidities (based on medication type) • No of acute and repeat prescriptions	
Category of Errors	Identify the incidence of different typology of errors in both patient groups • Monitoring o Not requested o Requested but not done o Requested but no results o Results no acted on	% Per patient % Per prescription Items % Acute medicines % Repeats BNF categories High risk drugs
	• Prescribing o Unnecessary drug o Incorrect drug o Duplication o Allergy error o Contraindication o Interaction etc.	% Per patient % Per prescription Items % Acute medicines % Repeats BNF categories High risk drugs
	Factors, which may influence the typology of error • Age • Gender • Acute v repeats • No of drugs	
Severity	Identify the range of severity of errors	

	• BNF drug categories • High risk medicines • Paediatrics versus elderly • Acute versus repeats • Number of medicines • Age • Gender • Formulation	
	Factors: • Practice list size • Safety culture • Prescriber type or category • Training status of practice	
Several Rating: Panel versus researcher	Inter-rater reliability	
MRP case vignettes to show data capture and analyses		

Appendix 20: Summary of studies included in systematic review (Chapter 3)

	A	B	C	D	E	F	G	H	I
1	Reference	Years of study	Country	Study setting	Method of identification	Study design	Type of error	Definitions used for data collection	Incidence/rate reported
2	Abramson et al (2011)	2005/2006	USA	78 Community-based primary care providers across two states who used paper prescriptions	Prescription and medical record review	Non-randomised retrospective study	Prescribing	Errors in prescriptions and prescribing	36.7/100 prescriptions (95% CI 30.7-44.0), excluding illegibility errors
3	Al Khaja et al (2007)	2004	Bahrain	20 primary health care centres	Audit of paediatric prescriptions	Retrospective clinical prescription review	Prescribing	Omission (minor and major), commission (incorrect information) and integration errors (e.g. Drug interactions)	90.5% prescriptions (of 2,282 total prescriptions, exc minor errors of omission)
4	Al Khaja et al (2005)	2003	Bahrain	18 primary health care centres	Pharmacy staff screened prescriptions for errors: audit of prescriptions	Prospective clinical prescription review	Prescribing	Omission (minor and major), commission (incorrect information) and integration errors (e.g. Drug interactions)	7.7% prescriptions (5,959/77,511 prescriptions, exclu minor errors of omission)
5	Ashcroft et al (2005)	1995	UK	35 community pharmacies	Pharmacist-led identification	Prospective study	Dispensing	Near miss' 'an incident that was detected up to, including the point at which medication was handed over to patient or their representative' Incidents detected after patients had taken possession of medication were recorded as 'dispensing errors'	3.99 errors/10,000 dispensed items (95% CI 2.96 to 5.2 'near miss' 22.33 (95% CI 19.79-25.10)
6	Avery et al (2012)	2010	UK	15 general practices from four Primary Care Trusts	Review of patient clinical or medical records, healthcare professional interviews	Randomised retrospective study	Prescribing, monitoring	Prescribing error occurs when, as a result of a prescribing decision or prescription-writing process, there is an unintentional, significant reduction in the probability of treatment being timely and effective, or increase in the risk of harm when compared to generally accepted practice; Monitoring error occurs when a prescribed medicine is not monitored in the way which would be considered acceptable in routine general practice.	Percentage of prescriptions with prescribing or monit errors 9.4% (95% confidence intervals (CI) 8.4%-5.4 n=1,200); percentage of patients with errors 12%.
7	Barber et al (2009)	2009	UK	256 residents from 55 nursing/residential homes	Patient interview, note review, practice observation, dispensed items examination	Prospective study of random sample of residents within a purposive sample of homes	Prescribing, Dispensing, Administration Monitoring	Prescribing error deviations from prescribing standards in decision and writing (Dean et al, 2000); Monitoring deviations from monitoring standards (Alldred et al, 2008); Dispensing deviations from prescriptions and orders (Beso et al, 2005); Administration variations between prescriptions and administrations (Dean and Barber, 2001)	Prescribing 8.3% (95% CI 7.1-9.5); Dispensing 9.8% CI 8.5-11.2); Medication administration error 8.4% (7.0-10.0); Monitoring 14.7% (95% CI 10.3-20.1); all rates are percentages of opportunity for error; mean potential harm from prescribing, monitoring, dispens and administration errors=2.6, 3.7, 2.1, 2.0 (0=no harm 10=death). 69.5% residents had one or more errors; number of errors per resident 1.9 errors
8	Carruthers et al (2008)	2006	UK	2,480 residents from 42 primary care-based Regional aged-care facilities (RACFs)	Audit of the accuracy of dose administration aids (DAA)	Prospective observation (prior to patient administration)	Dispensing	Comparison of drug charts prepared by patients' GPs with contents of DAA by registered nurses. Discrepancies were recorded as incidents	4.3% packs (or 12% residents corresponding to 297 in 6,972 packs. Incidents: wrong drug, strength, labe instructions.
9	Chen et al (2005)	1999/2000	UK	40 General practices with an estimated of 37,940 patients	Review of computerised patient medical record	Retrospective review of identified potential drug-drug or drug-disease interactions	Prescribing	Potential for serious drug-drug interactions or drug-disease interactions (contraindications)	1.9 incidents/1,000 patient years (95% CI 1.5-2.3) (or 4.3/1,000 patients on 2 or more medications per yea CI 3.2-5.4); 2 adverse drug events
10	Chua et al (2003)	2002	UK	4 conveniently-sampled community pharmacies within the Hull and East Riding Pharmacy Research Network, North of England	Review and analysis of self-recorded dispensing errors and 'near misses'	Prospective audit	Dispensing	Near miss' dispensing error identified by pharmacy prior to patient receipt of medication; Dispensing error recorded if error discovered following patient receipt	Dispensing error rate=0.08% items; Near miss' rate= items; 56/10,000 items or 0.56% items total dispens errors or 'near miss' (95% CI 39-62)
11	Dhabali et al. (2011)	2010	Malaysia	Primary care setting of a University, Universiti Sains Malaysia (USM)	Review of data from 1 academic year using computerized databases	Retrospective study	Prescribing	Drug contra-indications	5.3% of all patients over a 1-year period or 5,339 DC 100,000 patients (923 patients had drug contra-indic of 17,288 registered patients); 3.8% patients were ex to 5 or more contra-indications
12	Field et al (2007)	2007	USA	Large multi-specialty group practice with 30,000 enrolees	Electronic tracking of administrative data; clinician reports; hospital discharge summary; emergency visit	Retrospective review of identified potential adverse events	Administration	Potential adverse drug events due to patient errors during medication use	Incidence difficult to interpret; patient errors leading adverse events was 1,290 (of 1,299 patients with an ad event in original study)
13	Flynn et al (2009)	2009	USA	100 Community chain pharmacies in large metropolitan areas of four states	Unidentified shoppers presented non-real life prescriptions	Retrospective observation of dispensed items	Dispensing	Variation between prescription and dispensed item (accuracy of dispensing)	22% (% errors of total prescriptions presented; n=10
14	Gagne et al (2008)	2008	Italy	Outpatient prescriptions of residents in Regione Emilia-Romagna, Italy	Review of all outpatient prescription claims in 2004 in the region	Retrospective review of claims data	Prescribing	Drug interactions = presence of minimum of 5-day overlap in days supply for drugs in an interacting pair	211/100,000 items prescribed (0.2%); 8894 potential interactions detected
15	Gandhi et al (2003)	2003	USA	1,202 patients at four adult primary care practices in Boston, USA	Patient survey, chart review	Prospective cohort study	Prescribing, Administration, Monitoring (adverse drug reactions from errors)	Preventable adverse drug events due to error which could have been avoided; ameliorable those whose severity or duration could have been reduced	Adverse drug event rate 2.5% patients or 27% event 661 patients responding to survey); 11% and 28% eve were preventable and ameliorable respectively, ther medication error rate 39.2% (i.e. (51+20)/100x181)
16	Gandhi et al (2005)	2003	USA	1,879 prescriptions of 1,202 patients at four adult primary care practices in Boston, USA	Prescription review, patient survey, chart review	Prospective cohort study	Prescribing	A medication error is any error that occurred in the medication use process. The subset of these errors related to prescribing errors. Errors causing injury were preventable; those with potential to cause injury were potential ADEs	7.6% prescriptions (95% confidence interval (CI) 6.4% 8.8%) contained a prescribing error; 3% prescriptions potential for patient injury, 1% was life-threatening; were serious; frequency and dosing errors most com
17	Gurwitz et al 2003	1999/2000	USA	Medicare enrolees (30,397 person-years of observation) in a multispecialty group practice >65 years	Review of provider reports, discharge summaries, emergency department notes, computer-generated signals, electronic clinic notes, incident reports	Retrospective cohort study	Prescribing, monitoring, administration	Adverse drug event = injury resulting from system of drug use; adverse drug event resulting from medication error was defined as preventable adverse drug event	13.8 preventable adverse drug events per 1000 pers years or 27.6% of 1,523 total adverse drug events; of prescribing errors 16.2%, monitoring 16.8%, administration 5.8% (all of total events)
18	Hammerlein et al (2007)	2005	Germany	Nation-wide study in 21,146 community pharmacies in Germany	Community pharmacies recorded identified Drug-related problems (DRPs) during any 1 week period per pharmacy within designated study period	Prospective study	Prescribing, administration ('patient level'), dispensing ('delivery level')	A drug-related problem (DRP) is an event or circumstance that actually or potentially interferes with desired health outcomes with potential for ineffective pharmacotherapy and/or drug-related morbidity and mortality.	Rate was difficult to interpret; 10,427 DRPs identifie representing 9.1 DRPs per pharmacy per week; drug-d interactions most common
19	Kaushal et al (2010)	2002/2003	USA	1,782 patients from six paediatric (<21 years) outpatient practice	Prescription review, telephone survey, chart review	Prospective cohort study	Prescribing, transcribing, administration, monitoring	Medication errors = errors in medication ordering, transcribing, dispensing administration and monitoring, with minimal potential for harm and near misses; Preventable ADEs were medication errors that caused harm	Medication errors rate 74% prescriptions or 93.7% patients; 68% patients (53% prescriptions) had minim potential for error; 26% patients (21% prescriptions) potential for harm ('near misses'). Most errors were prescribing stage
20	Kaushal et al (2007)	2002/2003	USA	1,788 patients from six paediatric (<21 years) outpatient practice	Prescription review, telephone survey, chart review	Prospective cohort study	Prescribing, transcribing, administration, monitoring	Medication errors = errors in medication ordering, transcribing, dispensing administration and monitoring, with minimal potential for harm and near misses; Preventable ADEs were medication errors that caused harm	Preventable ADEs 3% patients; administration error 2.24% patients; prescribing/ordering 26% errors; dispensing errors 3% errors
21	Khoja et al (2011)	2002	Saudi Arabia	10 public and private (5 each) primary health care clinics in Riyadh City	Review of a simple random selection of patient clinical management records (case notes); all prescriptions issued on study day	Retrospective audit	Prescribing	Prescription error = any preventable event that may cause or lead to inappropriate medication or patient harm when medication is in control of the healthcare professional, patient or consumer	Prescribing error=18.7% prescription items (990/529 items); Type A or potentially serious error rate=0.15% (8/5299 items)
22								Prescribing error = administrative/clinical prescription interventions by	

Appendix 21: An example of severity judgments made by error-judging panel



PatientID	ID number	Description	Classification	Panel: Classification: Error/Suboptimal prescribing (A)	Panel: Classification: Error/Suboptimal prescribing (N)	Panel: Classification: Error/Suboptimal prescribing (M)	Panel: decision Problem type: subset category	Problem type: subset category	Panel: Problem type: subset category (A)	Panel: Problem type: subset category (N)	Panel: Problem type: subset category (M)	Panel: Final decision Problem type: subset category	Severity rating: NPSA tool: harm: prevented/impact: not prevented; harm; moderate; harm; severe; death)	Panel rating: NPSA tool: harm: prevented/impact: not prevented; harm; moderate; harm; severe; death) (A)	Panel rating: NPSA tool: harm: prevented/impact: not prevented; harm; moderate; harm; severe; death) (N)	Panel rating: NPSA tool: harm: prevented/impact: not prevented; harm; moderate; harm; severe; death) (M)	Final panel rating: NPSA tool: harm: prevented/impact: not prevented; harm; moderate; harm; severe; death)	Severity rating: Dean & Barber's tool (visual analogue scale: 0 to 10, 0 = no harm; 10 = death)	Panel: Severity rating: Dean & Barber's tool (visual analogue scale: 0 to 10, 0 = no harm; 10 = death) (A)	Panel: Severity rating: Dean & Barber's tool (visual analogue scale: 0 to 10, 0 = no harm; 10 = death) (N)	Panel: Severity rating: Dean & Barber's tool (visual analogue scale: 0 to 10, 0 = no harm; 10 = death) (M)	Final Panel: Severity Rating: Dean & Barber's tool (visual analogue scale: 0 to 10, 0 = no harm; 10 = death)	Final Panel: Severity rating: Dean & Barber's tool (visual analogue scale: 0 to 10, 0 = no harm; 10 = death)_Mean	Final Panel: Severity rating: Dean & Barber's tool (visual analogue scale: 0 to 10, 0 = no harm; 10 = death)_Median
B1E89_724	1	This error describes a potential admission error relating to failure to prescribe for an existing clinical condition. 86-year-old female who was diagnosed with angina and hypertension and regularly repeat prescriptions for furosemide 20mg daily, bisoprolol 1.25mg daily, aspirin 75mg daily, simvastatin 40mg daily, amlodipine 5mg daily. Patient may benefit from statins for secondary prevention of coronary heart disease. Also, patient may benefit from cardio-protection with ACE-I. Patient was on ramipril 5mg, which was last prescribed in Dec 2013 (reviewed in June 2014). No documented patient's record as to why ramipril has since been prescribed	Omission error relating to failure to prescribe for an existing clinical condition	Prescribing Error	Omission error relating to failure to prescribe for an existing clinical condition; Prescribing error	Prescribing Error	Omission error relating to failure to prescribe for an existing clinical condition	Inadequate review, Inadequate documentation in medical records, Omission error relating to failure to prescribe for an existing clinical condition	Omission Error	Omission error relating to failure to prescribe for an existing clinical condition	Omission	Omission error relating to failure to prescribe for an existing clinical condition; Prescribing error	Moderate	Low Harm	Moderate	Moderate	Moderate	5	4	5	4	4.5	4.5
B1E90_728	2	67-year-old female patient on Levothyroxine 75micrograms daily on repeat prescription. Levothyroxine requires 12 monthly FT4, FT3 not ordered in the past 2 years. Last ordered and recorded in May 2012 (record reviewed in June 2014)	Monitoring Error	Monitoring Error	Monitoring error	Monitoring Error	Monitoring Error	Monitoring not requested	Monitoring not requested	Monitoring not requested	Monitoring not requested	Monitoring not requested	Low	No harm	Moderate	Moderate	Moderate	3	2	4	4	3.25	3.5
B1E91_729	3	82-year-old female on Carbimazole 10mg daily. Last recommended by the hospital consultant. "Carbimazole requires 3 monthly FT4, 6-monthly U&E, patient has been stabilized for over 1.5 year. Last FT4 done and recorded in Nov 2013, over 5 months ago. Record was reviewed in June 2014	Monitoring Error	Monitoring Error	Monitoring error	Monitoring Error	Monitoring Error	Monitoring not requested	Monitoring not requested	Monitoring not requested	Monitoring not requested	Monitoring not requested	Moderate	No harm	Moderate	Low Harm	Moderate	5	2	4	3	3.5	3.5
B1E95_774	4	79-year-old female prescribed 30g cream Fucidin for eczema for 5 application of two-three times daily. Prescription does not specify duration of use and no advice to spread thinly	Suboptimal prescribing Hydrocortisone mild steroid	Prescribing Error	Prescribing error	Sub-optimal prescribing	Prescribing Error	Incomplete information	Incomplete information	Incomplete information	Incomplete information	Incomplete information, inadequate review	Low	No harm	Low Harm	Low Harm	Low	2	2	3	2	2.25	2
B1E97_777	5	72-year-old female prescribed Latanoprost eye drops 50mcg/ml with directions for one drop in each light." Prescription does not specify which eye is being treated (eye drops for Glaucoma)	Prescribing Error	Prescribing Error	Prescribing error	Sub-optimal prescribing	Prescribing Error	Incomplete information	Incomplete information	Incomplete information	Incomplete information	Incomplete information, inadequate review	Moderate	No harm	Moderate	Low Harm	Moderate	5	3	4	4	4	4
B1E103_831	6	This error describes a potential admission error relating to failure to prescribe for an existing clinical condition. 71-year-old female on Losartan 25mg daily for hypertension. Last BP reading recorded was 150/80mmHg (June 2014). The pharmacy indication for dose optimization of Losartan or for co-prescription with different anti-hypertensive such as a thiazide diuretic for hypertension not controlled on one drug class	Omission error relating to failure to prescribe for an existing clinical condition	Not error	Not Decided not error	Omission error relating to failure to prescribe for an existing clinical condition	Omission error relating to failure to prescribe for an existing clinical condition	N/A	Not Decided N/A	Omission error relating to failure to prescribe for an existing clinical condition	Omission error relating to failure to prescribe for an existing clinical condition	Omission error	Moderate	No harm	Not Decided Not harm	Low Harm	Low	4	0	Not Decided 0	3s	1	2
B1E104_832	7	75-year-old female prescribed 28 Naproxen tablets 250mg three times daily on 'acute' prescription with no concomitant gastro-protective agent and no advice to take with or after meals	Prescribing Error	Prescribing Error	Prescribing error	Prescribing Error	Prescribing Error	Omission error relating to failure to prescribe concomitant medication	Omission Error	Omission error relating to failure to prescribe concomitant medication	Omission error relating to failure to prescribe concomitant medication	Omission error relating to failure to prescribe concomitant medication	Low (in view of the number of days treatment, in this case)	Low Harm	Moderate	Moderate	Moderate	3	4	5	4	4	4
B1E106_840	8	69-year-old female prescribed Clobetasone 0.5% ointment (moderately-potent steroid) on 'acute' prescription to be applied 1-2 times daily. Duration of use not specified	Prescribing Error	Prescribing Error	Prescribing error	Sub-optimal prescribing	Prescribing Error	Incomplete information	Incomplete information	Duration error	Incomplete information	Incomplete information, inadequate review	Low	No harm	Low Harm	Low Harm	Low	2 (1 based on quantity and potency	2	3	3	2	3
B1E107_852	9	This error describes a potential admission error relating to failure to prescribe for an existing clinical condition. 66-year-old female with DM going Intervention (including physiotherapy, acupuncture and joint injections for joint pains. Patient may benefit from taking a bisphosphonate (like Alendronate). She was placed on Alendronate between 2010 and 2011, but this was stopped. No hotel in patient's record suggest this was purposively discontinued by GP. Patient takes Adcal D3 tablets	Prescribing Error, omission error relating to failure to prescribe for an existing clinical condition	Prescribing Error	Prescribing error, omission error relating to failure to prescribe for an existing clinical condition	Sub-optimal prescribing	Prescribing Error, Inadequate review, Inadequate documentation in medical records, omission error relating to failure to prescribe for an existing clinical condition	Incomplete information	Omission error	Omission error relating to failure to prescribe for an existing clinical condition	Omission error relating to failure to prescribe for an existing clinical condition	Inadequate review, Inadequate documentation in medical records, omission error relating to failure to prescribe for an existing clinical condition	Moderate	Low Harm	Moderate	Low Harm	Low	3	2	5	3	3.25	3
B1E114_918	10	74-year-old female on Lisinopril tablets 20mg daily (as 1 regular repeat) medication. ACE-I (Lisinopril) requires 12 monthly U&E, which was last done and recorded in May 2013 (review date 09/06/2014). The last recorded test result (May 2013) showed elevated serum potassium level (mmol/L) at 5.3 (above high reference limit of 5.5-5.1)	Monitoring Error	Monitoring Error	Monitoring error	Monitoring Error	Monitoring Error	Monitoring not requested	Monitoring not requested	Monitoring not actioned upon	Monitoring not requested	Monitoring not requested	Moderate	Low Harm	Moderate	Moderate	Moderate	4	4	4	6	4.5	4
B1E120_964	11	82-year-old female prescribed Losartan tablets 50mg daily on 'repeat' prescription. 'Angiotensin II receptor antagonist (Losartan) requires 12-monthly U&E, which was last ordered and recorded in March 2013 (patient's record was reviewed 11/06/2014)	Monitoring Error	Monitoring Error	Monitoring error	Monitoring Error	Monitoring Error	Monitoring not requested	Monitoring not requested	Monitoring not requested	Monitoring not requested	Monitoring not requested	Low	Low Harm	Moderate	Moderate	Moderate	3	4	4	4	3.75	4
B1E120_964	12	82-year-old female prescribed Bendroflumethiazide 2.5mg daily on 'repeat' prescription. 'Diuretics (Bendroflumethiazide) requires 12-monthly U&E last ordered and recorded in March 2013 (record review date 11/06/2014)	Monitoring Error	Monitoring Error	Monitoring error	Monitoring Error	Monitoring Error	Monitoring not requested	Monitoring not requested	Monitoring not requested	Monitoring not requested	Monitoring not requested	Low	Low Harm	Moderate	Moderate	Moderate	3	4	4	4	3.75	4
B1E126_1003	13	64-year-old female on Ramipril capsules 10mg daily on 'repeat' prescription. 'ACE-I (Ramipril) requires 12-monthly U&E, which was last ordered. Patient has been registered with practice for 8 months, and although other blood tests (haematology, HbA1c level, Endocrinology) have since been ordered, no U&E tests have been ordered	Monitoring Error	Monitoring Error	Monitoring error	No Error	Monitoring Error	Monitoring not requested	Monitoring not requested	Monitoring not requested	N/A	Monitoring not requested	Low	Low Harm	Moderate	No Harm	Low	2	4	4	0	2.5	3
B1E128_1025	14	68-year-old female prescribed Co-codamol 30mg/500mg twice when the same prescription. One to read of 100 capsules "and then when the other ran out of 100 capsules. Prescriber's intention is unclear	Prescribing Error	Prescribing Error	Prescribing error	Prescribing Error	Prescribing Error	Duplication	Duplication	Duplication	Duplication	Duplication	No Harm	Moderate Harm	Low Harm	Moderate	Low	0	6	1	5	3	3
B1E129_1025	15	66-year-old female presented with abdominal discomfort on going for a week. "He was diagnosed with indigestion and prescribed 28 capsules of Omeprazole (gastro-resistant 20mg daily on the 13th of May (acute). Patient was issued this 'regular' repeat prescription of 56 Lansoprazole capsules 15mg daily on the 16th of May leading to potential duplication. Also, it is not certain if patient was taking Lansoprazole when they reported the symptoms of indigestion	Prescribing Error	Prescribing Error	Prescribing error	Prescribing Error	Prescribing Error	Duplication, inadequate review	Duplication	Duplication	Duplication	Duplication	Low	Low Harm	Moderate	Moderate	Moderate	3	4	5	4	4	4
B1E131_1048	16	68-year-old female who has been on Citalopram 10mg (regularly) since Dec 2010 with the dosage directions "one daily." The direction was then changed to one alternate days for the 28 weeks' then two prescriptions issued on the 13 Jan 2014, and 26 Feb 2014. There was no note in the record to indicate why. After these two instances, the dose reverted to one daily' on 7th May 2014 (printed by the receptionist). It was not clear if those changes in dosage regime was intended	Suboptimal prescribing	Prescribing Error	No Error	Prescribing Error	Prescribing Error	Frequency Error, Inadequate documentation in medical record	N/A	Frequency	Frequency Error, Inadequate documentation in medical record	No Harm	Low Harm	No Harm	Moderate	Low	0	4	0	5	2.25	2
B1E137_1101	17	80-year-old female on Perindopril 8mg daily, Amlodipine 10mg daily, Bendroflumethiazide 2.5mg regular repeat prescriptions for blood pressure. Also on Simvastatin 20mg daily at night, Metformin MR 500mg daily, Novo Mix 30, Tanginal XL 60mg daily, and Fenofibrate 160mg daily. Patient's BP was recorded as 124/67 mmHg (June 2014). In the view of patient's age, and to prevent falls, dose optimization (possibly reduction) of Amlodipine to 5mg) or anti-hypertensive missed	Prescribing Error	No Error	Prescribing error	Sub-optimal prescribing	Prescribing Error	Inadequate review	N/A	Dose/strength error	Dose/strength error	Dose/strength error	Moderate	No Harm	Low Harm	Low Harm	Low	4	0	3	2	2.25	2.5
B1E137_1101	18	80-year-old female patient prescribed Novo Mix 30 Flexpen 100 units/ml suspension for injection with the directions "as directed." Elderly patient with no insulin dose specified on prescription. Patient's record documents deteriorating memory and provision of care by patient's wife	Suboptimal prescribing	No Error	No Error	Prescribing Error	No Error	Incomplete information	N/A	N/A	incomplete information	Incomplete information	No Harm	No Harm	No Harm	Moderate	No Harm	0	0	0	5	1.25	0
B1E140_1120	19	77-year-old female prescribed Zopiclone 7.5mg (at night) in June 2013. The dose was changed to half a tablet at night. "Based on patient's age, and him being looked after by a carer, the 3.75mg tablet should have been prescribed instead of the need to halve the 7.5mg tablets" issues around manual dexterity, carer present, Subjected to abuse/taking more than prescribed, memory issues, patient also takes 20mg Mematine daily (irregular repeat)	Suboptimal prescribing	Not Error	Prescribing error	Prescribing Error	Prescribing Error	Inadequate review	N/A	Formulation error	Dose/strength error	Dose/strength error	No Harm	No Harm	Moderate	Low Harm	Low	0	0	5	3	2	1.5
B1E140_1120	20	77-year-old female on Levothyroxine 100mcg daily (at each morning. Endocrinology tests done in Feb 2014 showed serum free T4 level (pmol/L) at 20.4 (above high reference limit of 9.01-19.05) and Serum TSH level (mu/L) at 0.03 (below low reference limit of 0.35-4.94). Latest in the record said if NOT ON THYROID THERAPY. "If patient has been taking Levothyroxine tablets since 1980. Missed opportunity for intervention on abnormal test results	Prescribing Error	Monitoring Error	Monitoring error	Monitoring Error	Prescribing Error	Results not actioned upon, Inadequate review, Inadequate documentation in medical record	Results not actioned upon	Monitoring not actioned upon	Dose/strength error	Results not actioned upon	No Harm	No Harm	Moderate	Moderate	Moderate	0	3	4	5	3	3.5
B1E141_1123	21	81-year-old patient prescribed Simvastatin 20mg at night, which was initiated 08 May 2013. Statins require 3 monthly and 12 monthly LFTs in the first year following initiation. Pre-LFT was done on 01 May 2013. Although the 12 months LFT was done on 01 May 2014, the 3-month test following initiated was not ordered or recorded	Monitoring Error	Monitoring Error	Monitoring error	Monitoring Error	Monitoring Error	Monitoring not requested	Monitoring not requested	Monitoring not requested	Monitoring not requested	Monitoring not requested	Low	No Harm	Moderate	Low Harm	Low	3	2	4	3	3	3
B1E142_1127	22	71-year-old female prescribed Fluocinolone Acetonide gel (0.025%) on 'repeat' prescription with the directions "apply at night." Duration of use not specified. Patient has chronic allergic skin rash. She was placed on Fluocinolone Acetonide gel by hospital consultant in Apr 2011, and generally has 2-3 repeats/year. Between mid-March 2014 and July 2014, however, patient has ordered the repeat prescription for 30 grams each of Fluocinolone gel suggesting continuous use of a potent steroid	Prescribing Error	Prescribing Error	Not Error	Sub-optimal prescribing	Prescribing Error	Incomplete information, inadequate review	Incomplete information	N/A	incomplete information	Incomplete information, inadequate review	No Harm	No Harm	Moderate	Low Harm	Low	3	2	0	4	2.25	2.5
B1E143_1155	23	85-year-old issued 'acute' prescription of 30 grams of Clobetasone 0.05% cream (moderately potent steroid) with the directions "apply thinly 1-2 times/day" to hand. "No advice on duration of use	Prescribing Error	Prescribing Error	Prescribing error	Sub-optimal prescribing	Prescribing Error	Incomplete information, duration error	Incomplete information	Duration error	incomplete information	Incomplete information, Duration error	Low	No Harm	Low Harm	Low Harm	Low	2	2	3	3	2.5	2.5
B1E145_1165	24	79-year-old female prescribed 30 gram 'acute' Fucibet cream for 'twice' daily application. "Prescription of a potent steroid with antimicrobial cream, which did not specify duration of use and if arrested no advice to spread thinly	Prescribing Error	Prescribing Error	Prescribing error	Sub-optimal prescribing	Prescribing Error	Duration error	Incomplete information	Incomplete information	incomplete information	Incomplete information	No Harm	No Harm	Low Harm	Low Harm	Low	0	2	3	3	2	2.5
B1E149_1184	25	69-year-old female prescribed Prednisolone 5mg tablets the following quantities and dosage instructions. 31 Dec 2013 "20 tablets with the dosage of "4 daily for 5 days," "17 Dec 2013 "60 tablets with the dosage "three tablets daily for 3 days, then two tablets daily for 3 days and then one tablet daily," and lastly, "23 Dec 2013 "28 tablets with the daily"	Suboptimal prescribing	No Error	Prescribing error	Sub-optimal prescribing	Prescribing Error	Formulation error	N/A	Formulation error	Formulation error	Formulation Error	Low	No Harm	Moderate	Moderate	Low	2	0	4	5	2.75	3

Appendix 22: Form for collecting data in community pharmacies

Form for collecting demographic and prescription data on patients, and pharmacist's intervention on prescription errors

The SAFECaRE Study (Safety of Medication Use in Primary Care)

Form 4: Community Pharmacy medicine-related problem (prescription errors)

Date: _____ Time: _____ Origin: _____

Patient's Age (Years/Months): _____/_____ Gender: Male/Female (please circle)

Prescription type (First dispense/repeat/Dental etc.): _____

Total No. of medicines: _____ Prescription date: _____

Name of medicine implicated: _____

Error category	Intervention	Comment

Date: _____ Time: _____ Origin: _____

Patient's Age (Years/Months): _____/_____ Gender: Male/Female (please circle)

Prescription type (First dispense/repeat/Dental etc.): _____

Total No. of medicines: _____ Prescription date: _____

Name of medicine implicated: _____

Error category	Intervention	Comment

Date: _____ Time: _____ Origin: _____

Patient's Age (Years/Months): _____/_____ Gender: Male/Female (please circle)

Prescription type (First dispense/repeat/Dental etc.): _____

Total No. of medicines: _____ Prescription date: _____

Name of medicine implicated: _____

Error category	Intervention	Comment