Results of Three-Phase Research Project Investigating Antibiotic Prescribing and Antimicrobial Stewardship in 2019 and 2020

Authors: Rasha Abdelsalam Elshenawy[1]

Publication Type: Results

Publication Date: 8th January 2024

Language: EN

DOI: 10.57874/t6eg-je32

Phase 1: Systematic Literature Review

Antimicrobial stewardship implementation before and during the COVID-19 pandemic in the acute care settings: a systematic review

This study has been published in the PMC Public Health Journal: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-023-15072-5

The systematic literature search was conducted from the 9th to the 13th of March 2021 using predefined search terms and updated on the 20th of March 2023 and the 24th of November 2023. This search yielded 8,763 articles, with the screening process outlined in the PRISMA flow diagram (Figure 3.1.) and the included articles summarised in Table 3.4. The initial search produced 8,763 abstracts potentially eligible for inclusion: MEDLINE (n=3,640), all OVID journals (n=44), CINHAL PLUS (n=4,708), PsycINFO (n=10), SCOPUS (n=101), Web of Science (n=12), Cochrane (n=75), and an additional 173 from Google Scholar. After duplicates were removed, 4,566 articles proceeded to title and abstract screening. Of the 101 articles eligible for full-text screening, 79 met the inclusion criteria (Figure 3.1.). Sixty-six articles were excluded for not

meeting the inclusion criteria due to lack of AMS intervention (n=36), inappropriate study settings (n=22), or irrelevant outcomes such as infection control precautions (n=8). Ultimately, 13 studies were included in the final analysis (Figure 1). For details from this link: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-023-15072-5

Figure 1. Systematic literature review results and screening process according to PRISMA guidelines.

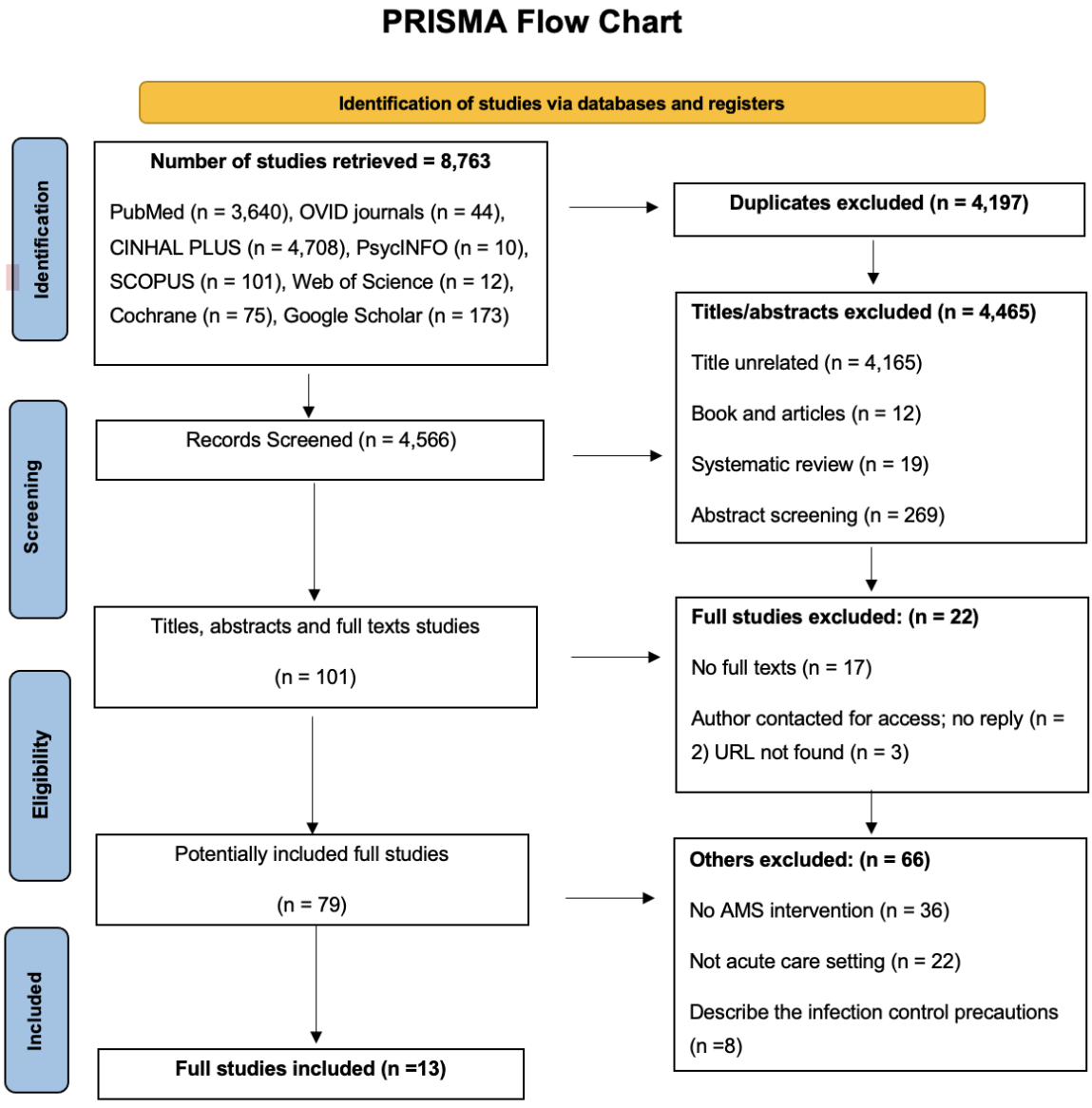


Table 2. Summary of findings about antimicrobial stewardship implementation prior to and during the COVID-19 pandemic.

Study			Antimicrobial Stewardship (AMS)																			
			AMS Strategies									AMS Measures										
			AMS Core Strategies				AMS Supplemental Strategies															
	Before-the-pandemic	During-the-pandemic	Multidisciplinary stewardship team	Formulary restrictions and preauthorisation	Antibiotic Review	Prospective Audit with Feedback	Streamlining / timely de-escalation of therapy	Dose Optimisation	Parenteral to oral conversion	Guidelines and Clinical Pathways	Antibiotic Order Form	Education	Computerised decision support, surveillance	Laboratory surveillance and feedback	DDD	DOT	LOS	Cost	CDI	PCT	Indicators or Quality Improvement
Trivedi (2013) [19]	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓
Kallen (2017) [20]	✓		✓	✓		✓			✓			✓			✓	✓	✓				✓
Tamma (2021) [21]	✓		✓		✓				✓	✓		✓				✓			✓		✓
Surat (2021) [22]	✓		✓	✓		✓	✓	✓		✓		✓		✓	✓	✓	✓				✓
Weston (2012) [23]	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓								✓
Mehta (2014) [24]	✓		✓	✓	✓	✓		✓						✓		✓	✓	✓			✓
Moriyama (2021) [25]	✓		✓	✓		✓												✓			
Thakkar (2021) [26]	✓		✓	✓	✓	✓	✓	✓	✓			✓		✓		✓					
Panditrao (2021) [27]	✓		✓		✓	✓	✓	✓		✓		✓			✓	✓					✓
Ababneh (2020) [28]	✓		✓		✓	✓		✓		✓					✓	✓					✓
Spernovasilis (2021) [29]		✓	✓		✓	✓		✓		✓		✓		✓							
Ashiru-Oredope (2021) [30]		✓	✓		✓	✓	✓		✓	✓		✓							✓	✓	✓
Williams (2021) [31]		✓								✓			✓	✓	✓				✓	✓	✓

Prior to the COVID-19 pandemic, DDD was noticed in five studies (Trivedi *et al.*, 2013; Kallen *et al.*, 2021; Surat *et al.*, 2021; Panditrao *et al.*, 2021; and Ababneh *et al.*, 2020). Additionally, the Days of Therapy (DOT) was found in eight studies (Trivedi *et al.*, 2013; Surat *et al.*, 2021; Mehta *et al.*, 2014; Thakkar *et al.*, 2021; and Ababneh *et al.*, 2020). The Length of Stay (LOS) was found in three studies (Kallen *et al.*, 2021; Surat *et al.*, 2021; and Mehta *et al.*, 2014), and Cost was found in three studies (Trivedi *et al.*, 2013; Mehta *et al.*, 2014; Moriyama *et al.*, 2021). Furthermore, the Clostridioides Difficile Infection (CDI) was found in two studies (Trivedi *et al.*, 2013; Tamma *et al.*, 2021). However, Indicators of Quality Improvement were found in eight studies (Trivedi *et al.*, 2013; Mehta *et al.*, 2014; Panditrao *et al.*, 2021; Ababneh *et al.*, 2020). Appendix 11 provides examples of measures used to evaluate the efficacy of Antimicrobial Stewardship implementation.

During the COVID-19 pandemic, DDD was found in only one study (Williams *et al.*, 2021), CDI was found in two studies (Ashiru-Oredope *et al.*, 2021; Williams *et al.*, 2021), and Procalcitonin (PCT) was found in one study (Williams *et al.*, 2021). Indicators or Quality Improvement were found in two studies (Ashiru-Oredope *et al.*, 2021 and Williams *et al.*, 2021) (Table 3.6) (Figure 2). For details from this link: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-023-15072-5

Figure 2. AMS before and during the COVID-19 pandemic in acute care settings (Total studies 13).

Phase 2: Retrospective Medical Records Review

Start Smart, Then Focus: Antimicrobial Stewardship Before and During the COVID-19 Pandemic at a Secondary Care

Clinical and Demographic Characteristics: A retrospective analysis was performed on 640 patient medical records from the Trust. The demographics of these patients are presented in Table 3. The comprehensive analysis of various variables did not reveal any statistically significant differences between the years 2019 and 2020. Patients admitted for RTIs during these years ranged in age from 25 to 99 years. A slight variation was observed in gender distribution: in 2019, females accounted for 49.4% (158) of the cases, increasing slightly to 49.7% (159) in 2020. Regarding patient outcomes, the data indicated that the mortality rate, the proportion of patients who passed away or died, remained steady at 15% during the two-year study period, as shown in Table 3.

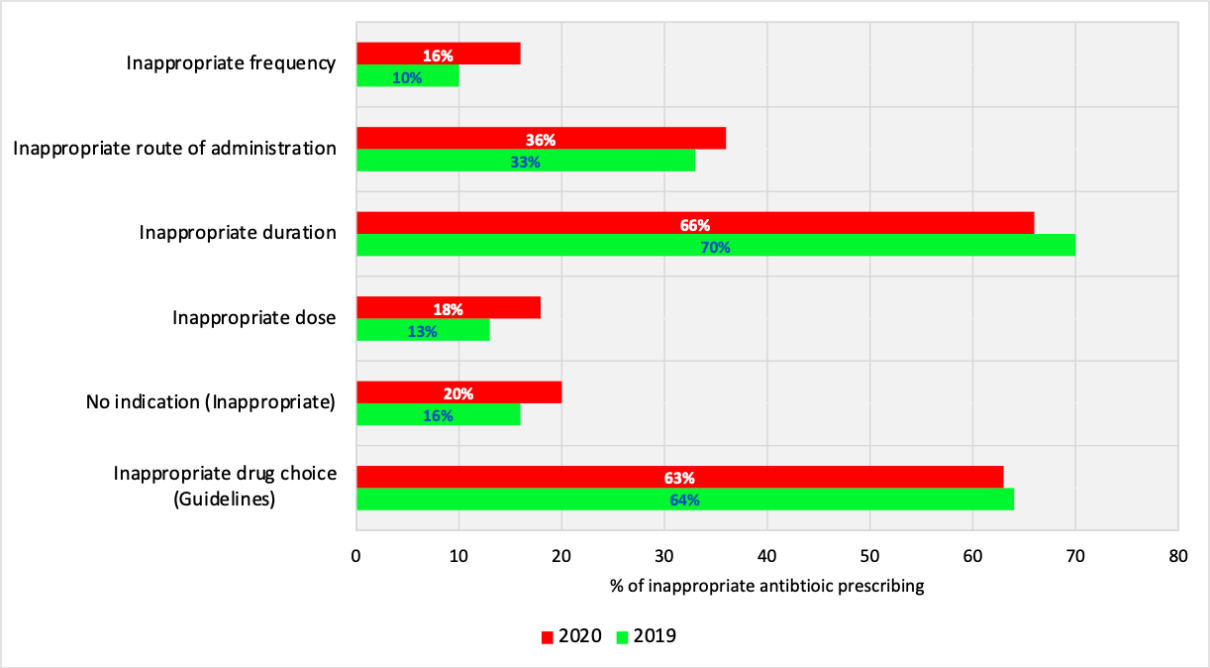
Table 3. Characteristics of the patient demographics admitted prior to the COVID-19 pandemic (n=320) and during the pandemic (n=320) (in 2019 and 2020).

Patient characteristics		Prior to Pandemic 2019 n (%)	During the Pandemic 2020 n (%)	P value
Age (Range= 25-99)	Mean (SD)	74.3 (16.0)	76.2 (15.5)	0.127
Gender	Female (%)	158 (49.4)	159 (49.7)	
	Male (%)	162 (50.6)	161 (50.3)	
Patient Outcome	Deceased (%)	48 (15.0)	50 (15.6)	0.886
	Discharged (%)	272 (85.0)	270 (84.4)	

The Five Rights of Antibiotic Safety

The Five Rights of Antibiotic Safety are essential for ensuring proper antibiotic use in acute care settings before and during the COVID-19 pandemic (Institute for Safe Medication Practices, 2007). These rights encompass the correct patient, drug, dose, time, and duration (Appendix 22). This study evaluated adherence to the 'Five Rights of Antibiotics' for the years 2019 and 2020. As illustrated in Figure 3. below, there were significant shifts in the proportions of inappropriate antibiotic prescribing during this period. The inappropriate route of antibiotic administration saw a slight increase from 33% in 2019 to 36% in 2020. Similarly, instances of inappropriate dosing rose from 13% in 2019 to 18% in 2020. However, the proportion of inappropriate duration prescriptions showed improvement, decreasing from 70% in 2019 to 66% in 2020. However, prescriptions made without clear indications increased from 16% in 2019 to 20% in 2020. Interestingly, the selection of the antibiotic, in accordance with antimicrobial guidelines, remained relatively stable, levitating at 63-64% across both years. These findings highlight a concerning rise in inappropriate antibiotic prescribing patterns, especially during the 2020 COVID-19 pandemic. It has been published in the Journal of Global Antimicrobial Resistance: https://www.sciencedirect.com/science/article/pii/S2213716523002369?via%3Dihub

Figure 3. Five Rights of Antibiotic Safety: A Comparison of 2019 and 2020 During the COVID-19 Pandemic.



The WHO Access, Watch, Reserve (AWaRe) classification: A heatmap was generated to visually display the antibiotics prescribed for RTIs before and during the COVID-19 pandemic. The WHO Access, Watch, Reserve (AWaRe) classification was employed as the gold standard for antibiotic classification. Table 4.7. shows the heatmap for antibiotic consumption in 2019 and 2020 based on AWaRe criteria, indicating a significant increase in antibiotic consumption in 2020 compared to 2019. Among Access Classification antibiotics, Amoxicillin/Clavulanic Acid was the most frequently prescribed in both 2019 and 2020. However, for Watch Classification antibiotics, Azithromycin showed a significant increase in 2020 (13 in March 2020, 19 in June 2020, 3 in September 2020, and 11 in December 2020) compared to 2019. Clarithromycin also significantly increased to 33 in December 2019 and 32 in March 2020. In contrast, Quinolones, such as Ciprofloxacin and Levofloxacin, were more frequently prescribed in 2020 (26 and 64, respectively) than in 2019 (15 and 40, respectively). Broad-spectrum antibiotics were also increasingly used before and during the pandemic. Furthermore, Linezolid, a Reserve Classification antibiotic, was more commonly used before the pandemic (7 in 2019) compared to during the pandemic (2 in 2020). It has been published in Frontiers Microbiology Journal: https://www.frontiersin.org/articles/10.3389/fmicb.2023.1298858/full

Table 7. The heatmap for antibiotic use in 2019 and 2020 is based on AWaRe criteria.

WHO Access, Watch, Reserve (AWaRe) classification for antibiotics evaluation and monitoring before and during the COVID-19 pandemic

	Mar-19	Jun-19	Sep-19	Dec-19	Mar-20	Jun-20	Sep-20	Dec-20
Access								
Amoxicillin	2	1	2	3	6	6	0	1
Amoxicillin/clavulanic acid	67	61	56	76	25	70	86	66
Benzylpenicillin	1	0	2	0	3	0	0	0
Doxycycline	1	1	3	2	1	2	0	1
Flucloxacillin	2	2	3	2	0	5	2	1
Gentamicin	0	0	0	0	0	2	0	0
Metronidazole	3	7	2	0	4	4	2	4
Sulfamethoxazole/Trimethoprim	0	1	1	0	4	2	0	0
Clindamycin	1	0	0	0	0	0	0	0
Cephalexin	0	0	2	1	1	0	0	0
Watch								
Azithromycin	0	1	2	0	13	19	3	11
Ceftazidime	2	2	0	0	0	1	0	0
Ceftriaxone	0	0	0	1	1	0	1	0
Cefuroxime	0	0	1	0	0	0	0	0
Ciprofloxacin	3	3	1	8	7	5	9	5
Clarithromycin	14	21	26	33	32	21	25	32
Levofloxacin	12	9	8	11	14	13	14	23
Meropenem	2	0	1	1	5	4	4	5
Piperacillin/Tazobactam	29	30	15	16	29	21	22	25
Teicoplanin	0	0	1	0	3	0	0	0
Vancomycin	1	4	0	1	0	1	0	0
Reserve								
Aztreonam	0	0	0	0	0	1	0	0
Cefazidime/Azobactam	0	0	2	0	0	0	0	0
Linezolid	3	2	1	1	0	0	1	1

	0: Absence of antibiotic usage
	1 - 9: Minimal antibiotic consumption
	10 - 29: Moderate level of antibiotic usage
	30 and above: High level of antibiotic consumption

The Top Seven Prescribed Antibiotics Prior to and During the COVID-19 Pandemic

The seven most commonly prescribed antibiotics in both PP and DP, further detailed in Supplement 1. In 2019, amoxicillin/clavulanic acid was the most frequently prescribed antibiotic, accounting for 247 instances. This trend persisted in 2020 with 260 instances, maintaining its top position. In 2020, compared to 2019, there was an increase in prescriptions for most of the other antibiotics. For instance, clarithromycin saw an increase from 94 prescriptions in 2019 to

100 in 2020. Piperacillin/tazobactam also witnessed a slight rise, from 90 instances in 2019 to 97 in 2020. Additionally, 2020 saw increased prescriptions of levofloxacin, azithromycin, and ciprofloxacin compared to 2019. Levofloxacin prescriptions grew from 40 in 2019 to 64 in 2020. Azithromycin had a surge, jumping from 12 in 2019 to 46 in 2020. Ciprofloxacin also displayed a rising trend, going from 15 in 2019 to 26 in 2020, while meropenem's usage modestly increased in 2020, from 10 to 18 instances.

Phase 3: Prospective Survey Study

Healthcare professionals' knowledge, attitudes and perceptions regarding antibiotic prescribing, antibiotic resistance and stewardship during the COVID-19 pandemic: A descriptive study at a secondary care setting in the UK

A total of 240 HCPs responded to the survey, with results recorded online and subsequently analysed. Data was exported to an Excel sheet from the secure online platform, 'Qualtrics' (Qualtrics.com, 2023). The researcher organised and cleaned the data, providing codes for the 5-point Likert scale responses as follows: 0 for Strongly Disagree; 1 for Disagree; 2 for Neutral; 3 for Agree; and 4 for Strongly Agree.

Healthcare professionals' demographic characteristics

Most survey respondents were pharmacists (n=125, 52%), doctors (n=72, 30%), and nurses (n=43, 18%). Table 5.2 illustrates the breakdown of participants' age characteristics: most respondents (n=96, 40.0%) were between 32 and 41 years old. In regard to education, most participants held a postgraduate master's degree (n=163, 68.0%) or a postgraduate doctorate degree (n=43, 18.0%), while only a small percentage had an undergraduate degree (n=24, 10%). Regarding years of experience, those with 6-20 years were most represented among respondents (n=132, 55%). Table 5.2 provides a detailed breakdown of theHCPs' demographic characteristics. Most respondents were female (56%), and the predominant qualification was a pharmacist (52%). Concerning educational achievements, the majority of respondents held a postgraduate master's degree (68%). Regarding job banding, the majority were in band 7 (27%). Descriptive statistics and logistic regression analysed healthcare professionals' views on antibiotic use and antimicrobial stewardship during COVID-19.

Affiliations

1. University of Hertfordshire: Watford, Herefordshire, GB

References

Antimicrobial stewardship implementation before and during the COVID-19 pandemic in the acute care settings: a systematic review:
https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-023-15072-5

Antibiotic prescribing in an English secondary care setting before and during the COVID-19 pandemic:
https://www.isrctn.com/ISRCTN14825813

An Evaluation of the Five Rights Antibiotic Safety Before and During COVID-19 at an NHS Foundation Trust in the United Kingdom:
https://www.sciencedirect.com/science/article/pii/S2213716523002369?via%3Dihub

WHO AWaRe classification for antibiotic stewardship: tackling antimicrobial resistance – a descriptive study from an English NHS Foundation Trust prior to and during the COVID-19 pandemic:
https://www.frontiersin.org/articles/10.3389/fmicb.2023.1298858/full

Five Rights of Antibiotic Safety: Antimicrobial Stewardship at One NHS Foundation Trust in England Before and During the COVID-19 Pandemic:
https://academic.oup.com/ijpp/article/31/Supplement_2/ii2/7453117?login=false

Start Smart, Then Focus: Antimicrobial Stewardship Practice at One NHS Foundation Trust in England Before and During the COVID-19 Pandemic:
https://www.medrxiv.org/content/10.1101/2023.06.09.23291146v1

Parent publications

Three-Phase Methodology: Antimicrobial Stewardship Before and During COVID-19 in Secondary Care

Ethical statement

The results in this publication involved human or animal subjects.

The studies involving humans were approved by Ethical approval for this study was granted by the Health Research Authority (HRA), with the Research Ethics Committee (REC) assigning reference number 22/EM/0161. In compliance with this approval, the study protocol underwent review and received approval from the University of Hertfordshire (UH) ethics committee under the reference LMS/PGR/NHS/02975. The authors have no conflicts of interest to disclose. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin in accordance with the national legislation and institutional requirements.

Data permissions statement

The results in this publication does **not** involve access to materials owned or copyrighted materials (except those in the private ownership of the authors).

Data access statement

This publication contains partial data because full data contains transcripts of interviews, which were impossible to anonymise or where the participants did not consent to sharing.

Funders

No sources of funding have been specified for this publication.

Conflict of interest

This publication does not have any specified conflicts of interest.