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

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Phase 1: Systematic Literature Review

Method:

Search Terms

Prior to the initial search, the review was registered at PROSPERO website (registration number CRD42021242388) https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42021242388. The scope of the review was defined by applying the acronym PICOS (Population, Intervention, Comparison, Outcome, Setting), as shown in Table 3.1. A systematic search of databases was conducted using the following keywords and their synonyms (Appendix 7). After this, follow the Preferred Reporting Items for Systematic Reviews (PRISMA) guidelines for reporting. The PRISMA 2020 was drawn up and approved by the research team before the commencement of the systematic review (Page *et al.*, 2021). The plan was employed as a guidance document to review relevant primary studies published between 2000 and 2021 systematically. It described the review's scope, intended purpose, and methodological and analytical approach. Ethical approval was not required before the commencement of the review as the use of patients' identifiable data was not intended.

An electronic search of International Pharmaceutical Abstracts, MEDLINE (via PubMed), CINAHL, PsychINFO, SCOPUS, Cochrane Library, Web of Science and Google Scholar (Wilczynski *et al.*, 2004). Choices of databases to be searched were based on insights from the

method's section-related reviews. The search was restricted to articles published from January 2000 to March 2021. The AMS strategies and metrics identified within the MEDLINE database through the MeSH term "antimicrobial stewardship" were employed as search terms for AMS intervention. Antibiotic use before and during the COVID-19 pandemic was employed as the search term. Settings were specified as acute care settings, AND/OR were used to combine search terms (Table 1).

Table 1. The systematic literature review of search strategies.

Table 3.1. Search Strategy
1. Antimicrobial resistance OR antibiotic management OR acute care settings OR hospitals.
2. Antimicrobial stewardship OR antimicrobial utilisation OR antimicrobial use OR antimicrobial stewardship strategies OR antibiotic metrics OR antimicrobial stewardship intervention OR antimicrobial stewardship outcomes OR antibiotic use.
3. COVID-19 OR coronavirus OR SARS CoV2 OR severe acute respiratory infection OR pandemic.
4. 1 AND 2 AND 3
5. Limit 18-65 to yr. = '2000-2021' = lang: 'English'

1. COVID-19 – Coronavirus
2. SARS CoV2 - Severe Acute Respiratory Syndrome Coronavirus 2

The databases searched for this study included PubMed, Scopus, PsycINFO, CINHAL Plus, Web of Science, all Ovid journals, and OpenGrey. These were selected based on a review of methodologies in other published systematic reviews relevant to this research. Additionally, the researcher's experience from conducting previous systematic reviews informed the choice of databases. A rationale for selecting each database is detailed in Table 2. All search results were exported to Mendeley, which served as a reference manager and facilitated de-duplication. The search was limited to English-language articles.

Table 2. The rationale behind selecting each database used to conduct the systematic literature review.

Database	**Rational**

PubMed	Free full-text database that covers MEDLINE and EMBASE journals from life and biomedical sciences, including papers not yet indexed in MEDLINE.
Scopus	Freely available; one of the most substantial citations and abstract database of peer-reviewed literature, including journals and conference abstracts.
PsycINFO	This weekly updated database is considered the most significant resource in mental and behavioural sciences, including different types of literature, such as dissertation abstracts.
CINHAL Plus	Covers a wide range of health topics, including nursing, health and allied medical sciences.
Web of Science	Consists of many databases and citations, including Conference Proceedings Citation Index – Social Science & Humanities and MEDLINE.
All Ovid journals	Include numerous journals, including health and medical journals.
OpenGrey	Consists of grey literature, including research reports, doctoral dissertations, and several conference papers.

Studies selection

The selection of studies for this review was based on specific inclusion criteria: (i) Peer-reviewed English articles; (ii) Population of patients prescribed antibiotics aged 18 years and over; (iii) Studies describing the AMS intervention in acute care settings; (iv) Outcomes of AMS strategies, measures, metrics before and during the COVID-19 pandemic; (v) Primary studies; and (vi) Published between 2000 and 2021. The included study designs were observational (retrospective or prospective case-control, case series non-interventional, cross-sectional, cohort) and interventional (quasi-experimental, randomised controlled trials) studies. However,

studies that did not meet these inclusion criteria, those unrelated to the review objectives, abstract-only papers, studies not involving human subjects, and literature and systematic review studies were excluded from this review (Table 3).

Table 3. Criteria for inclusion and exclusion studies in the systematic literature review

	Inclusion criteria	**Exclusion criteria**
Participants	Studies targeting the public/patients' use of antibiotics. HCPs who are responsible for prescribing, dispensing, or administering antibiotics (doctors, pharmacists).	Non-HCPs (patient family or community or nursing or long-term care patients).
Intervention	Studies describe an intervention to improve antibiotic prescribing or AMS or any other intervention as the use of the parenteral-to-oral switch and the duration of IV and oral antibiotics.	Studies that do not describe an AMS intervention.
Comparison	Comparison with a control group/a group that carried out usual care without an AMS intervention; comparison between two or more AMS interventions.	
Context	Interventions carried out in adult inpatient settings in acute care hospitals.	Interventions carried out in nursing homes, care homes or long-term healthcare facilities; community settings; paediatric setting/hospital; and animals/ veterinary practice.

Outcomes	Primary outcomes: reviewing the AMS implementation before and during the COVID-19 pandemic.	
	Secondary outcomes: other AMS measures, metrics, and quality improvement before and during the pandemic.	
Study design	Randomised Controlled Trials (RCTs), non-randomized trials, Controlled Before-After (CBA) studies, interrupted time series designs, case-control and cohort studies, cross-sectional studies, and qualitative studies.	Literature reviews, systematic reviews, meta-analyses, single case studies, case reports, and conference abstracts.

1. HCPs - Healthcare Professionals; AMS - Antimicrobial Stewardship; COVID-19 - Coronavirus
2. RCTs - Randomised Controlled Trials; CBA - Controlled Before-After

Data extraction and synthesis

The articles retrieved from the databases were exported into CSV and Excel sheets for screening and identification of the eligible articles by RAE. Titles and abstracts were screened for relevance; duplicates were removed, followed by a screening of the complete articles for possible inclusion by one reviewer (RAE). Another reviewer (ZA) independently reviewed the titles, abstracts, and full studies, confirmed the relevance of studies in meeting the inclusion criteria and excluded studies deemed irrelevant. Three reviewers (ZOA and NU) screened the first 60 records to establish the quality of screening at this stage and ascertain that the level of agreement and discrepancies were addressed through mutual consensus among the reviewers. Additional suggestions and amendments to the search teams and relevant keywords were made. There was complete agreement on the relevance of selected studies by RAE, ZA and NU. Three studies were initially piloted to test the form. RAE extracted the data from these three studies into the data extraction tool, and any discrepancies in the extracted data were discussed with the other authors. Data obtained were grouped and summarised into two groups into two groups using narrative synthesis: PP and DP (Table 4.). RAE extracted the data for the included studies. In order to maintain the reliability and validity of the data extraction, another author (ABA) independently extracted the data from the included studies into data extraction form. Discrepancies in the extracted data were documented and resolved by discussion or

adjudication with a third author (ZA). Meta-analysis could not be performed because of the heterogeneity of the included studies. The following data were extracted: the author of the study, the year it was conducted (identifying if it was prior to or during the COVID-19 pandemic), the country of the study, the design of the study, the antimicrobial stewardship strategies used, and the measures for antimicrobial stewardship including any quality improvement projects.

Quality assessment

This systematic review necessitated a thorough quality assessment of the included studies due to their varied designs. The Mixed Method Appraisal Tool (MMAT) was selected for evaluating these studies based on evidence of its reliability and efficiency in appraising mixed-method systematic reviews (Souto et al., 2015). However, some limitations were identified in the qualitative study assessment section of MMAT, particularly regarding the clarity of questions. These issues were rectified in the updated 2018 version of MMAT, thus enhancing its utility (Hong et al., 2018). The 2018 version of MMAT, accompanied by a user guide, was employed for the quality evaluation in this study, selected for its established content validity and practicality (Hong et al., 2018). Two independent reviewers conducted the evaluation following a stringent methodology. After conducting database searches and eligibility screening to identify the final studies, three authors (RAE, NA, and ZA) independently conducted a quality appraisal of each study. This was followed by discussions to consolidate findings and ensure the comprehensive nature of the quality assessment.

3.2.5 Reliability and validity

Ali and Usman (2018) described the concept of reliability in systematic literature reviews as the ability to conduct a search process repeatedly and yield consistent results (Ali & Usman, 2018). Repeatability in such reviews means that an external researcher can replicate the review process and identify the same set of papers (Ali & Usman, 2018). To enhance repeatability in this study, the PRISMA flow diagram and the PRISMA systematic review and meta-analysis protocol checklist were employed. Regarding the second aspect of reliability, consistency in a systematic review is when an external researcher searches the same topic and produces the same set of data (Ali & Usman, 2018).

Finding an existing systematic review with similar goals and using the same databases was challenging. Akpan et al.'s review examined Antimicrobial Stewardship Programs (ASPs) in hospitals, focusing on patient outcomes and included 63 studies. It assessed various ASPs strategies and their effects on antimicrobial use, costs, resistance patterns, infection rates, mortality, length of stay, and readmission rates. However, this review did not include AMS measures, lacked a systematic review approach like PRISMA, and did not consider the impact of the COVID-19 pandemic on ASP implementation and strategies (Akpan et al., 2016). Another Mas-Morey et al.'s systematic review evaluated ASPs involving clinical pharmacists in small-to-medium-sized hospitals, encompassing 28 studies primarily from American or Canadian institutions. The review discovered that these ASPs, although not significantly altering mortality or readmission rates, resulted in considerable cost savings, mainly due to reduced or more affordable antibiotic usage. The authors called for further research and standardised methods

to assess ASP outcomes. However, the focus was solely on pharmacists, without including broader AMS implementation strategies and measures in the search criteria (Mas-Morey et al., 2017).

In this systematic literature review, the inclusion and exclusion criteria significantly influence the number of studies included in a review. However, in order to ensure validity and reliability, two independent reviewers (RAE and ZA) performed the screening of titles, abstracts, and full texts. Data extraction was also independently conducted by RAE and APA, with their findings compared by adjudicator ZA. Discrepancies were resolved through dialogue until a consensus was reached. The authors (RAE, ZA, and NU) engaged in discussions to consolidate these findings. Additionally, quality assessment was carried out independently by RAE and ZA to ensure a comprehensive evaluation.

Phase 2. Retrospective Medical Records Review

Methods

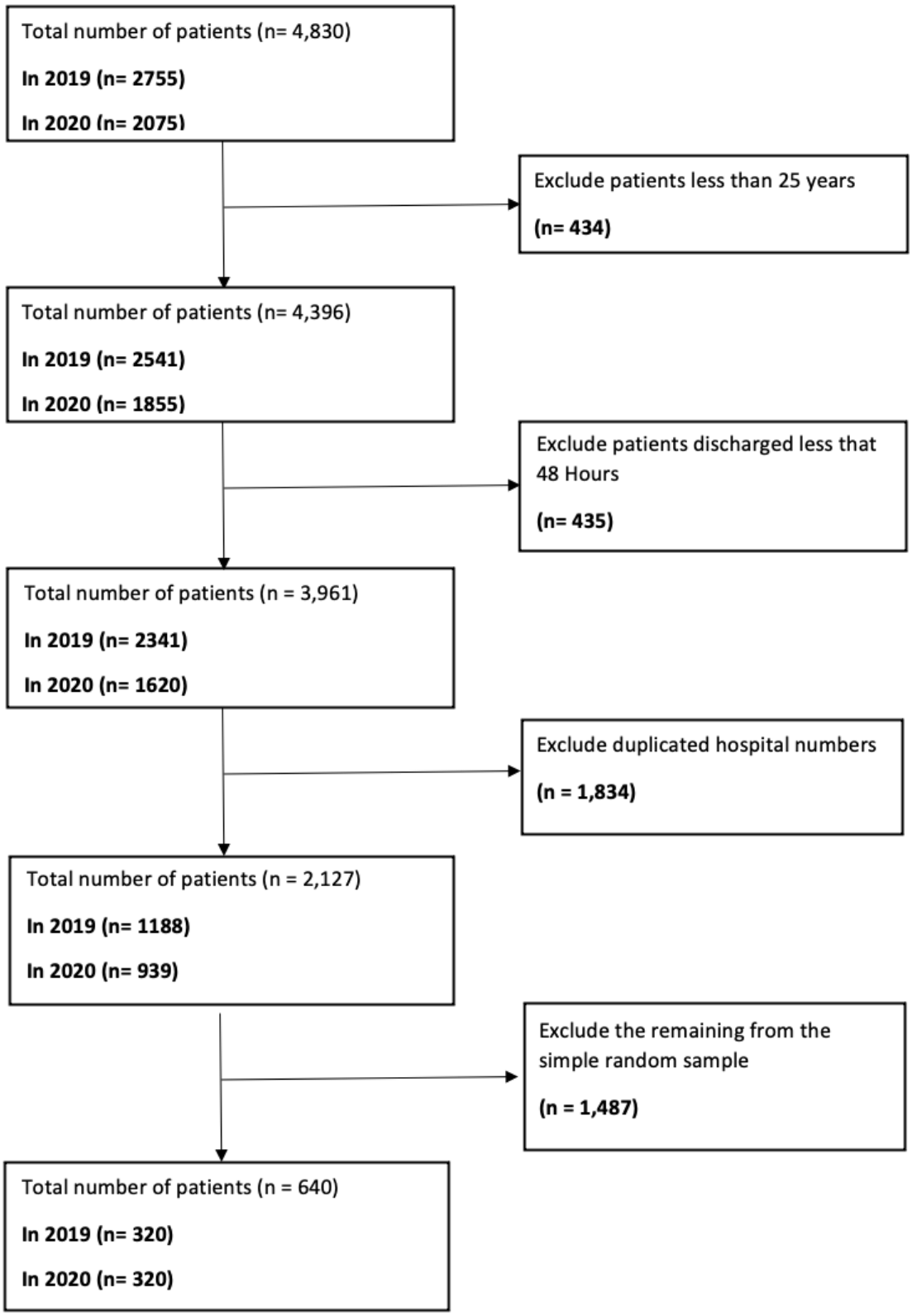
Study Design: A cross-sectional retrospective study was conducted to estimate the proportion of inappropriate antibiotic prescribing among adult patients aged 25 years and older admitted to Bedfordshire Hospitals NHS Foundation Trust, a secondary care provider serving approximately 400,000 individuals within Luton, South Bedfordshire, and parts of Hertfordshire and Buckinghamshire. Established as a foundation trust in 2006, the hospital comprises approximately 742 beds. A comprehensive literature review was undertaken to determine the most suitable tool for the investigation. The study comprehensively describes antibiotic prescribing patterns utilising a methodological approach based on retrospective cross-sectional analysis.

Sample size: The study's sample size was carefully determined based on Public Health England's estimate that 20% of all antibiotics prescribed in the UK might be inappropriate. (Public Health England, 2018) This figure, along with insights from relevant literature, guided the calculation of the required sample size. Using Minitab statistical software, the sample size was computed, factoring in the overall population size, a 10% margin of error, and a 95% confidence interval. To capture seasonal variations in antibiotic prescribing, data were collected from medical records at eight distinct time points, comprising four baselines (PP) and four during-pandemic (DP) points. The study included a systematic sampling of 320 patient records from 2019 (PP) and an equal number from 2020 (DP), resulting in a total of 640 records. Each year, data were systematically sampled at four different points, ensuring a representative sample of 80 patients per time point. This approach aimed to provide a robust and representative dataset for analysing antibiotic prescribing trends.

In this retrospective research, patient-identifiable data was accessed without explicit consent. Post HRA approval, the corresponding author communicated with the AMS pharmacist within Trust to initiate the study. The AMS pharmacist liaised with the coding team to prepare a list of RTI diagnoses using the ICD-10 system, corresponding to the study's timeline. Ensuring adherence to the National Opt-out Act, they also interacted with the Information Governance Team. Post-data extraction, the collaborator anonymised the dataset before handing it to the author. Anonymised data collection and processing was fair and lawful in line with General Data Protection Regulation (GDPR) principles, Caldicott Guardian, and Trust protocols. The study protocol was sent to representatives of the Citizens Senate, a patient care organisation with a good representation of many older people. They reviewed it and provided feedback. This study has been registered in the ISRCTN registry, which is a primary registry recognised by WHO and ICMJE that accepts all clinical research studies (ISRCTN, 2022).

For sampling, the systematic method was employed to consistently select patient medical record data from a larger dataset of the Trust. Initially, data from 4,830 records (2,755 from 2019 and 2,075 from 2020) were extracted. After applying inclusion and exclusion criteria and eliminating duplicate records, the numbers were narrowed down to 1,188 for 2019 and 939 for 2020. Subsequently, a random selection of 80 records for each of the four-time points in 2019, as well as 80 records from 2020, was conducted using Excel's Random function. This resulted in a total of 640 patient records (as shown in Figure 2). The systematic sampling method ensured equal representation across the patient population and was consistently applied across all eight seasonal time points, spanning from Spring 2019 to Winter 2020. This approach streamlined the sampling process while ensuring a comprehensive representation of the patient population.

Figure 2. Data Filtering Algorithm for Extracting a Representative Sample of 640 Patient Medical Records from 2019 and 2020,



Ethics Approval: 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.

Study population: A stratified sampling strategy was employed to ensure maximum diversity among the included Medical Records (MRs). The inclusion criteria comprise the following: (i) adult patients aged 25 years and older; (ii) pregnant women and immunocompromised patients; (iii) patients admitted to the Trust; (iv) patients admitted in 2019 and 2020; and (v) patients prescribed antibiotics for respiratory tract infections (RTIs). However, patients who spent less than 48-72 hours in the Accident and Emergency (A&E) department, patients who were not prescribed antibiotics, and children were excluded from this study. Patient selection was based on Electronic Health Record (EHR) entries identified by their respective ICD-10 codes for RTIs. This encompassed a range of conditions, including both specific and indeterminate diagnoses. Specific conditions included community-acquired pneumonia (CAP), chronic obstructive pulmonary disease (COPD), hospital-acquired pneumonia (HAP), and ventilator-associated pneumonia (VAP). Notably, in 2020, the selection also extended to cases of COVID-19 pneumonia. Alongside these, indeterminate diagnoses such as upper respiratory tract infections (URTIs), lower respiratory tract infections (LRTIs), and unspecified pneumonia were also considered. The main diagnosis of RTIs in these records was pivotal in determining the initial or empirical antibiotic prescribed to the patients.

Data collection: Data was collected from the patient's electronic medical records within the Trust in accordance with the study's inclusion and exclusion criteria. The data collection process for each patient's medical record took about 45 minutes. Data was gathered from eight-time points, with four time points PP: (i) March (Spring 2019); (ii) June (Summer 2019); (iii) September (Autumn 2019); and (iv) December (Winter 2019). Additionally, four time points occurred DP: (i) March (Spring 2020) - the first wave of COVID-19; (ii) June (Summer 2020) - the first lockdown; (iii) September (Autumn 2020) - the second wave of COVID-19; and (iv) December (Winter 2020) - the vaccination rollout. A research student extracted the data from the patient's electronic medical records within the Trust, adhering to the study's inclusion and exclusion criteria. The student utilised a data extraction tool to obtain the necessary information from the patient's medical records. The extraction process took approximately 45 minutes per patient medical record for the research student to gather the required data.

Data extraction: A data extraction tool was employed to obtain the necessary data from patients' medical records (Table 4.1.). A Mind Map was created to aid in organising the data extraction tool in relation to the antibiotic use process and the PHE toolkit for AMS (Appendix 3). In order to extract data from patients fitting the inclusion criteria, access to three electronic systems in each hospital was required. For instance, at Luton and Dunstable University Hospital, data was extracted from three electronic systems; the Evolve system provided information on antibiotic prescribing upon admission (Prescribing Stage); the JAC hospital system supplied data on medications expected to be dispensed to the patient (Transcribing Stage); and the ICE electronic system collated all data related to the patient's discharge. Conversely, at Bedford Hospital, data was gathered from three alternative systems; the Viper hospital system, an

integrated hospital information management system and medical records database; the MedChart medicines management system, a pharmacy medication administration system; and the ICE System, which offered an integrated network of communication within the hospital, including details on culture results, lab results, and x-ray investigations. Prior to commencing 'Data Extraction', the research student completed training modules for all these systems and subsequently gained access to them. The framework for the antibiotic-use process was utilised, encompassing five stages: 1) prescribing, 2) transcribing, documenting, 3) dispensing, 4) administering, and 5) monitoring (www.usp.org, 2013).

Table 4. Data Extraction Tool from the Individual Patient Medical Record

Patient Demography	
Patient Study ID number:	Patient hospital number:
Patient age:	Gender:
Start Smart	
Allergies:	Date of admission:
Main diagnosis/Clinical Indication:	Medical history / Co-morbidities:
Name of Initial antibiotic: (dose, frequency, route, and duration)	Is the duration/stop date documented (Y/N)?
Is complies with local guidelines (Y/N)?	Did culture send to Mic prior to Abx (Y/N)
Clinical investigations: • X-Ray finding: • Blood culture results: • WBCs count: • CRP result: • D Dimer result: • PCT result: • Urea result:	Other relevant clinical information: • Symptoms on admission • Confusion (Y/N): • Others:
Then Focus	
Is abx clinically reviewed? (Y/N)	If yes, what is the review day, e.g., D1, D2, D3...?
If yes, who reviewed the Antibiotics? • Prescribing Doctor • Pharmacist	What type of AMS intervention: • Continue Antibiotics • Change Antibiotics • Escalation • De-Escalation • IV-to-Oral Switch • Stop Antibiotics • No Intervention
Antibiotic change (Escalation/De-escalation)	
What are the cultural results?	What is culture sensitivity results (S/R/I/NA)?
What is the name of the antibiotic changed after the culture results?	Is the changed antibiotic appropriately selected (Y/N)?
IV-to-Oral Switch	
Name of changed Oral Antibiotics?	Is the changed antibiotic appropriately selected (Y/N)?
Abx Stop	
When the antibiotic has been stopped?	Is antibiotic stop complying with the local guidelines (Y/N)?
Infection Control / Healthcare-associated infection (If the patient developed Secondary infection)?	
MRSA bacteremia (Y/N)	CDI (Y/N)
MDRO (Y/N)	COVID-19 (Y/N)
Antibiotic Safety Alert	
Is there any antibiotic allergic reaction? (Y/N)?	Is the antibiotic prescribed comply with the 5Rs, i.e. Right drug, dose, duration, route, and frequency)?
Patient Outcome	
What is the patient outcome(Discharged=1, Deceased=2)?	If discharged, what is the discharge date?
What is the Length of Stay (LOS)?	

Pilot study: The research student undertook the pilot study. Data were extracted from 10 medical records for each time point for 80 patient medical records in 2019 and 2020 (Appendices 19 -20). This pilot study aimed to provide more description of the data and examine the feasibility of the data extraction tool in answering the research questions. It was expected to include both descriptive and statistical data. The result of the pilot study indicated that the data extraction form was sufficient to address all the study objectives. Due to the small sample size of the pilot study, not all statistical analyses were applied. It was impossible to

undertake statistical tests for relationships (associations and correlations). More data were required to calculate the prevalence of antimicrobial resistance, Clostridium Difficile Infections (CDI), and antibiotic safety issues, as every patient had one or more of them according to their prognosis. Data generated and extracted from the pilot test will not be included in the actual study analysis.

Validity and Reliability: The research student developed the data extraction tool based on the literature. Items within the data extraction tool were identified and agreed upon through discussions with the supervision team members. The research student assessed AMS implementation according to the PHE Toolkit. To ensure the validity of the data extraction tool, an AMS pharmacist at the Trust and the research student independently assessed approximately 1% of the sample (Five Records). A standardised data extraction tool was utilised, including demographic information, antibiotics used on admission, clinical diagnosis, co-morbidities, antibiotics used after culture, discharge date, and selected laboratory results (Table 4.2.). The research student and the AMS Pharmacist at the study site independently extracted data from approximately 1% of the sample (Five Records). Inter-rater reliability was determined by examining the percentage of agreement in the data extracted independently. Agreements of ≥80% were indicators of the data extraction tool's reliability. Any disagreements were resolved through dialogue.

Phase 3: Prospective Survey Study

Method

Ethics: 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. Informed consent is implicitly provided by participants responding to the survey, with agreement to the collection of their information for survey-specific objectives. Data extracted from respondents were completely anonymised.

Study design and setting: This study utilised a cross-sectional design, employing a questionnaire survey to explore HCPs' knowledge, attitudes, and perceptions about antibiotic prescribing PP and DP. The research was executed through an online survey targeting doctors, nurses, and pharmacists at NHS Foundation Trust. Data collection was facilitated using the secure and UH-trusted platform Qualtrics XM (Qualtrics, 2015). The survey began on June 12, 2023, a Monday, and was completed by September 13, 2023, a Wednesday.

Participants: Eligibility for participation in this study is determined by inclusion and exclusion. The Inclusion Criteria are as follows: (i) Participants must be HCPs, which includes professionals such as doctors, nurses, and pharmacists; (ii) Participants must be adults, with a minimum age

of 25; and (iii) participants must be registered with their respective professional regulatory organisations: doctors with the General Medical Council (GMC), pharmacists with the General Pharmaceutical Council (GPhC), and nurses with the Nursing and Midwifery Council (NMC). All HCPs, regardless of their professional role as a doctor, nurses, or pharmacists, are ineligible to participate if they lack work experience at NHS Foundation Trust during the pandemic.

Registration: This study has been officially registered with the ISRCTN registry. The ISRCTN registry is a primary registry acknowledged by the WHO and the International Committee of Medical Journal Editors (ICMJE), accepting all clinical research studies.19 Moreover, it was registered in Octopus, the global primary research record.20

Data collection tools and approach : A structured questionnaire comprising 12 closed and open-ended questions was developed. The questionnaire's design was developed by a literature review on behaviour change and antibiotic prescribing in UK healthcare settings, and a behavioural analysis from PHE.21 The survey, designed to align with the objectives of the study, can be found in the Supplementary Documents S1 to S3. The survey comprises four sections: Respondent Demographics, Awareness and Knowledge about Antibiotic Prescribing and AMR, Perceptions and Attitudes towards Antibiotic Prescribing and AMS, and AMS Practices.

Sample size: To ascertain an appropriate and accurate sample size, data on the total number of healthcare professionals was gathered: 206 pharmacists, 2,140 nurses, and 5,636 doctors, with a total headcount of 7,982. The survey sample size was calculated at 240, considering a 5% margin of error, 95% confidence interval, and an expected 20% response rate. The survey commenced from Monday, June 12, 2023, to Wednesday, September 13, 2023, using an online-based data collection method. The survey invitations, featuring a link and a unique barcode, were distributed online.

Statistical methods: The main author collected, extracted and analysed the results. The responses from the participants were provided to the researcher as a completely anonymised set for analysis. A pilot test, involving 20% of the sample (50 out of 240 respondents, later excluded from the main survey), evaluated the survey's effectiveness in addressing research questions and established its validity and reliability. This pilot also helped estimate the questionnaire's completion time, roughly 10 minutes. Post-pilot, the questionnaire was refined for clarity and relevance. Validity assessments included face validity by AMS pharmacists at the Trust and content validity by the Royal Pharmaceutical Society (RPS) research team.22 Reliability was confirmed using Cronbach's Alpha on pilot responses, with excellent, good, and moderate reliability scores across various sections. The average score of 0.80 demonstrates high internal consistency.

Patient and public involvement: The study protocol was submitted to the Citizens Senate, an organization focussed on patient care with a considerable representation of elderly individuals. They provided useful suggestions and comments.

Data analysis: The survey results were analysed using descriptive statistics and IBM SPSS Statistics version 27.0 for Windows. 23 For data analysis, the study also utilised descriptive statistical techniques through Excel 2019 for Windows (www.microsoft.com, 2019).24

Affiliations

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https://www.isrctn.com/ISRCTN14825813

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

Parent publications

Evaluating Changes in Antibiotic Prescribing and AMS Practices at a UK NHS Trust: A Comparative Study of 2019 and the 2020 COVID-19 Period

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Conflict of interest

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