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Research Paper

A cross-sectional descriptive study of pharmacists' knowledge, attitudes, and perceptions regarding antibiotic resistance and antimicrobial stewardship conducted post-COVID-19 pandemic at a UK NHS Foundation Trust

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Abstract

Objectives: Addressing antimicrobial resistance (AMR) has become increasingly vital due to the concerning rise in inappropriate antibiotic use exacerbated by the challenges faced during the Coronavirus disease (COVID-19) pandemic. This study aimed to investigate the knowledge, attitudes, and perceptions of pharmacists regarding antibiotic prescribing, AMR, and antimicrobial stewardship (AMS) practices, highlighting the role of the workforce in addressing these challenges, based on their experiences during the pandemic within a UK acute care setting at an National Health Service (NHS) Foundation Trust.

Methods: In 2023, an online survey conducted via Qualtrics facilitated a prospective cross-sectional study. Pharmacists working within an NHS Foundation Trust during the pandemic participated. Data were analysed using descriptive statistics with IBM SPSS Statistics.

Key Findings: The majority of respondents were aged 25–31 years, representing 44.0% (55/125), and 70.4% (88/125) held postgraduate degrees. Regarding knowledge, 85.2% (107/125) recognized AMR as a public health concern, 91.2% (114/125) believed actions against AMR would benefit society, and 85.6% (107/125) supported AMS for prudent antibiotic use. For attitudes, 80% (100/125) reported that COVID-19 patient conditions influenced antibiotic prescribing, and 79.2% (99/125) valued communication between microbiologists and AMS teams during the pandemic.

Conclusion: This descriptive study, conducted at a single NHS Foundation Trust, highlights pharmacists' exemplary knowledge, showcasing their capability to deliver effective and impactful AMS practices during the pandemic. As vital members of the healthcare workforce, they revealed the potential to co-lead AMS initiatives. Enhanced training is crucial for sustainable AMS practices, confronting AMR, and safeguarding patient lives.

Keywords: pharmacists; antibiotic prescribing; antimicrobial resistance; antimicrobial stewardship; knowledge; attitudes; perceptions; COVID-19 pandemic

Introduction

Antimicrobial resistance (AMR) represents a growing global challenge, posing a significant threat to public health and necessitating a well-prepared and highly skilled healthcare workforce to address its impact effectively [1]. A recent study published in The Lancet journal highlights that AMR-related mortality among individuals aged 70 and older has more than doubled since 1990, underscoring the urgent need for sustainable and resilient antimicrobial stewardship (AMS). Immediate global action, informed by recent research, is crucial to address this pressing health challenge and protect patient lives [1].

The COVID-19 pandemic has potentially exacerbated the AMR crisis. Evidence suggests that the increase in antimicrobial treatments during the pandemic may have contributed to a higher incidence of resistant infections. Misuse of antimicrobials in both healthcare and community settings further worsened the situation [2]. The 2024 English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) report highlights a 3.5% rise in AMR burden since 2019, driven by resistant *Escherichia coli*, the primary cause of bacteraemia [3]. Notable regional and ethnic disparities persist, with higher AMR rates in London and among Asian ethnic groups. Increasing resistance to key antibiotics like co-amoxiclav and cephalosporins in *E. coli* poses challenges for empirical treatment. The report underscores the urgency of robust AMS practices, enhanced surveillance, and targeted interventions to address AMR under the UK's 2024–2029 AMR National Action Plan [3].

Despite the UK publishing its *Living with COVID* guidelines in May 2022 and lifting most restrictions by July 2021, the World Health Organisation declared the end of the Public Health Emergency of International Concern for COVID-19 in May 2023 [4, 5]. This study specifically focused on pharmacists' knowledge, attitudes, and perceptions based on their experiences during the COVID-19 pandemic,

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particularly in 2020 and 2021. Although conducted in 2023, the survey aimed to capture insights into practices and challenges during those years, allowing respondents to reflect on their experiences. The UK Government has since developed a second 5-year national action plan, *Confronting Antimicrobial Resistance 2024 to 2029*, to optimize antimicrobial use and address the AMR threat [6].

Research on antibiotic use during the pandemic revealed an increase in the 'Watch' category of antibiotics for respiratory infections, underscoring the critical need for robust AMS strategies and adherence to the WHO's AWaRe classification to prevent misuse and ensure patient safety [7, 8]. AMS promotes judicious antibiotic use through a systematic approach [9]. This study explored antibiotic prescribing practices and AMS interventions at an acute care National Health Service (NHS) Foundation Trust, comparing data from before the COVID-19 pandemic (2019) to during the pandemic (2020), revealing notable differences in AMS activities. The results highlight the importance of informed prescribing practices to enhance AMS and safeguard public health in the UK [9, 10].

The exploration of antibiotic prescribing behaviours, including knowledge, attitudes, and perceptions (KAP) regarding AMR and AMS among healthcare professionals, is essential. Understanding bacterial resistance is crucial to prevent AMR, as inadequate knowledge can lead to misuse. However, research on healthcare professionals' KAP during COVID-19, particularly among pharmacists, remains limited. Previous studies have shown mixed results regarding HCPs' awareness of AMR, with some reporting limited knowledge and others indicating satisfactory understanding. The pandemic's unique challenges may have further diminished their understanding of AMR [11, 12].

For pharmacists, a recent survey conducted in Ghana revealed generally low knowledge about AMS, despite a positive attitude towards it. While many pharmacists expressed a willingness to engage in AMS activities, the practical application of AMS principles was often inadequate. To enhance their role in combating AMR, improving training and continuous professional development for pharmacists is crucial. Focused efforts on structured AMS training are essential for effective engagement [13].

The antimicrobial stewardship policy by the Royal Pharmaceutical Society (RPS) highlights the critical role of pharmacists in combating inappropriate antibiotic use. Pharmacists are central to optimizing antimicrobial therapy through AMS programmes, essential for addressing AMR. The RPS emphasizes key actions, including appropriate prescribing, patient education on antimicrobial use, and team training. Pharmacist leadership within multidisciplinary teams, participation in AMS networks, and raising awareness through campaigns like World Antimicrobial Awareness Week are pivotal. These efforts aim to promote safer antimicrobial use and strengthen AMS practices, contributing to global efforts to mitigate AMR challenges [14].

This study aimed to explore pharmacists' knowledge, attitudes, and perceptions regarding antibiotic prescribing, antimicrobial resistance and stewardship during the COVID-19 pandemic within an acute care setting at a UK NHS Foundation Trust in the East of England, covering two hospitals. By examining pharmacists' experiences, the study sought to derive valuable lessons from the pandemic, which disrupted healthcare systems. Understanding how the pandemic influenced pharmacists' behaviour provides key insights for preparing for future health crises.

Methods

Study design and setting

This research employed a cross-sectional design using a questionnaire survey, targeting pharmacists working within a UK acute care setting at an NHS Foundation Trust in the East of England, which encompasses two hospitals. Data were collected through the secure platform Qualtrics XM, with the survey conducted from 12 June 2023 to 13 September 2023. The study adhered to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines for reporting observational studies.

Participants (inclusion/exclusion criteria)

To be eligible for this study, participants must satisfy the following criteria: (i) they must be pharmacists; (ii) they must be at least 25 years old to ensure sufficient professional experience, particularly in antimicrobial stewardship; and (iii) they must be registered with the General Pharmaceutical Council (GPhC). In addition, pharmacists without work experience at the Foundation Trust during the COVID-19 pandemic were not eligible to participate.

Patient and public involvement

The study protocol was submitted to the Citizens Senate, an organization dedicated to patient care with important representation of elderly individuals. They offered valuable suggestions and feedback.

Registration

This study has been officially registered with the ISRCTN registry under number 14825813, a recognized primary registry endorsed by the International Committee of Medical Journal Editors and the WHO for all clinical research studies [15]. In addition, it was recorded in Octopus, a global primary research database [16], and received ethical approval from the University of Hertfordshire Ethics and Health Research Authority (HRA) (Research Ethics Committee [REC] Reference number 22/EM/0161).

Data collection

A structured questionnaire consisting of nine questions was created. The design of the questionnaire was based on a literature review focusing on behaviour change and antibiotic prescribing in UK healthcare settings, as well as a behavioural analysis conducted by Public Health England (PHE) [17]. The survey was created to meet the study's objectives, with an overview provided in Supplementary Figure S1. It is divided into four sections: respondent demographics, awareness, and knowledge about antibiotic prescribing and AMR, perceptions and attitudes towards antibiotic prescribing and AMS activities.

Sample size

To accurately determine the survey sample size, data on the total number of pharmacists in the pharmacy department of the secondary care setting at the NHS Foundation Trust were collected. The verified population was approximately 206 registered pharmacists, explicitly excluding other pharmacy

roles, such as technicians, to ensure the power calculation focused solely on eligible participants. The NHS Foundation Trust, located in the East of England region, operates two hospitals and serves a population of approximately 700,000 people in East England and the surrounding areas. The substantial number of pharmacists employed reflects the diverse range of roles within the secondary care setting, which includes specialists, generalists, and support for acute services. Using a 5% margin of error, a 95% confidence interval, and an expected response rate of 20%, the calculated sample size was 125 pharmacists. This approach aligns with the study's focus on secondary care and acute care settings, ensuring the validity and robustness of the power calculation.

Recruitment and survey administration

The survey was anonymous, with participants providing implied consent by responding, as approved by the ethics committee. To engage busy pharmacists and meet participant targets, both traditional and modern strategies were used. Eye-catching posters with QR codes were placed in key areas of the pharmacy department, including the AMS board, main pharmacy, digital noticeboard, and kitchen. Group email campaigns distributed these posters, with communications timed for peak engagement periods like early mornings, lunch hours, and evenings. The invitation package, including the participant information sheet, survey link, and poster, was also emailed to pharmacists to boost participation.

Statistical methods

The primary author led data collection, extraction, and analysis. A pilot test with 25 participants (20% of the intended sample size) was conducted to evaluate the questionnaire's clarity, validity, and reliability, with an estimated completion time of 10 min. These participants were excluded from the main analysis to preserve statistical integrity and minimize bias. Based on feedback from the pilot, the questionnaire was refined to improve clarity and usability, ensuring a final sample size of 125 pharmacists. Validity was assessed through face validity by AMS pharmacists and content validity by the RPS research team, ensuring alignment with the study objectives. Internal consistency was confirmed using Cronbach's Alpha, with a strong score of 0.80, demonstrating the reliability of the instrument and mitigating potential biases.

Data analysis

The survey results were analysed using descriptive statistics with IBM SPSS Statistics version 27.0 for Windows. In addition, Excel 2019 for Windows was employed for further descriptive statistical analysis.

Results

Pharmacists' demographic characteristics

Table 1 presents the demographic characteristics of the survey respondents. The majority of respondents were aged 25–31, representing 55 out of 125 participants (44.0%). Female respondents comprised 89 out of 125 (71.2%). In terms of education level, 117 out of 125 respondents (93.6%) held a postgraduate degree (diploma, master, or doctoral). Regarding job banding, 63 out of 125 (50.4%) were in band 8 or higher. For years of experience, 52 out of 125 respondents (41.6%) had 6–20 years of experience, while 42 out of 125 (33.6%) had 5 years or less.

Knowledge of pharmacists on antibiotic prescribing and AMR/AMS

Figure 1 displays pharmacists' responses regarding their knowledge and perceptions of antibiotic prescribing, antimicrobial resistance, and stewardship during the pandemic. In terms of knowledge, the majority of respondents (84.8%) agreed that 'antimicrobial resistance poses a public health issue influencing clinical practice'. Furthermore,

Table 1. Demographic characteristics of survey respondents (n = 125).

		n	%
Age	25–31 years old	55	44.0%
	32–41 years old	31	24.8
	42–51 years old	3	2.4
	52–61 years old	29	23.2
	62–75 years old	7	5.6
Gender	Female	89	71.2
	Male	36	28.8
Level of educational achievement	Undergraduate degree	8	6.4
	Postgraduate degree (diploma/master/doctoral)	117	93.6
Job banding[a]	≤Band 6	23	18.4
	Band 7	39	31.2
	≥Band 8	63	50.4
Years of professional experience	≤5 years	42	33.6
	≥20 years	31	24.8
	6–20 years	52	41.6

[a]In the UK, job roles within the National Health Service (NHS) are categorzsed into bands. Healthcare professionals typically advance through these bands annually until they reach the highest level. Band 2 comprises roles such as Healthcare Assistants, while newly qualified staff begin at Band 5. Bands 6 and above encompass management positions, with Band 8 designated for upper management and Band 9 exclusively for senior managers. The bands span from Band 2 for Healthcare Assistants to Band 9 for Consultant Level, each presenting unique responsibilities and avenues for career development.

76.8% concurred that 'Actions taken to combat AMR within the trust will affect society and future generations'. In addition, 61.6% of participants agreed with the statement that 'Implementing AMS promotes the judicious use of antibiotics'.

Attitudes and perceptions of pharmacists on antibiotic prescribing and AMR/AMS

Figure 2 presents the attitudes and perceptions of pharmacists towards antibiotic prescribing and AMR/AMS during the

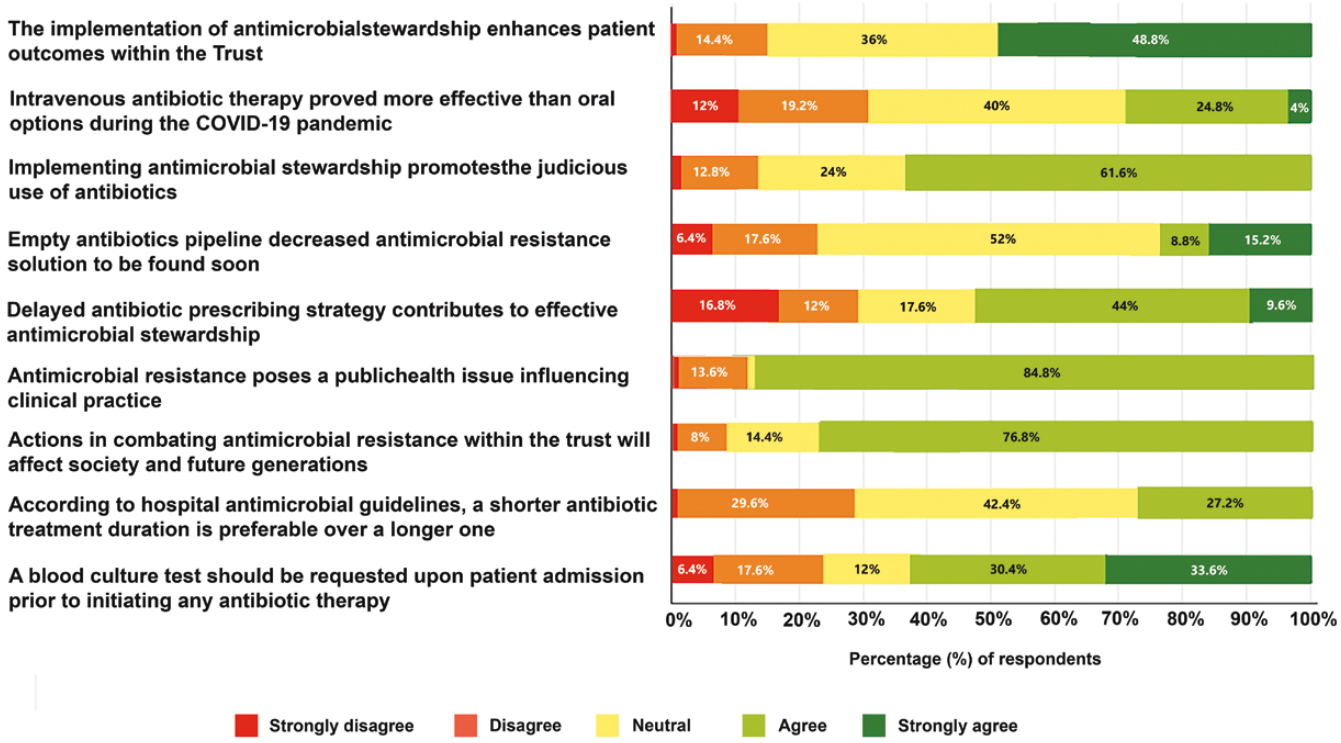

Figure 1: Knowledge of pharmacists towards antibiotic prescribing and AMR/AMS during the pandemic (n = 125).

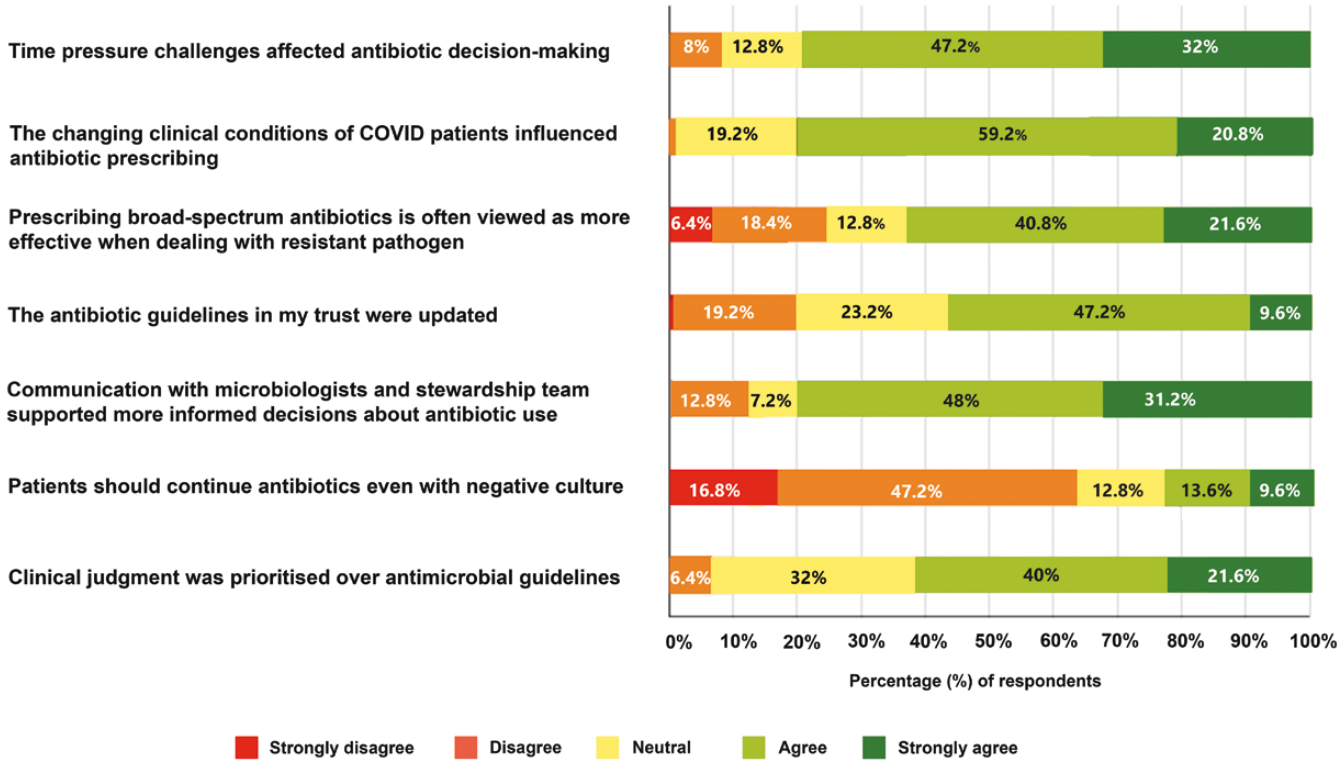

Figure 2. Attitudes and perceptions of pharmacists towards antibiotic prescribing and AMS during the pandemic (n = 125).

pandemic. A substantial proportion of respondents, 79.2%, agreed that 'Time pressure challenges affected antibiotic decision-making', with 47.2% agreeing and 32% strongly agreeing. Furthermore, 80% concurred that 'The changing clinical conditions of COVID patients influenced antibiotic prescribing', with 59.2% agreeing and 20.8% strongly agreeing. In terms of guideline updates, 56.8% of respondents agreed that 'The antibiotic guidelines in my trust were updated', with 47.2% agreeing and 9.6% strongly agreeing. In addition, 79.2% affirmed that 'Communication with microbiologists and the stewardship team supported more informed decisions about antibiotic use', with 48% agreeing and 31.2% strongly agreeing.

Pharmacists' views on AMS practice during the pandemic

Figure 3 presents the views of pharmacists on AMS practices during the COVID-19 pandemic. The majority of respondents (86.4%) agreed that 'overuse/misuse of antimicrobials during COVID-19 could impact antimicrobial resistance', with 49.6% strongly agreeing and 36.8% agreeing. Similarly, 80% of respondents concurred with the statement 'Review the use of IV antibiotics post-receipt of culture results', with 64% agreeing and 16% strongly agreeing. Regarding the use of technology, 63.2% acknowledged the effective use of platforms such as Zoom, Teams, or Skype for multidisciplinary meetings, with 45.6% agreeing and 17.6% strongly agreeing. However, 52.8% mentioned that they were not informed about the resistance pattern within the Trust.

Discussion

This study explored the knowledge, attitudes, and perceptions of pharmacists towards antibiotic prescribing, antimicrobial resistance, and antimicrobial stewardship practices based on their experiences during the pandemic within a UK acute care setting at an NHS Foundation Trust.

Regarding pharmacists' demographic characteristics, the majority of survey respondents were female, representing 71.2%, compared to 61.6% of female pharmacists in England, according to the GPhC [18]. This discrepancy suggests a potential participation bias towards female pharmacists. In addition, 44% of participants were aged 25–31 years, while the GPhC identifies the most common age group as 25–34 years, comprising 37% [18]. Though both the survey and GPhC data reflect a strong presence of younger pharmacists, the survey sample is slightly younger and more female-dominated, highlighting the need for future research to better represent the pharmacist population.

Highlighting the challenges posed by AMR, its exacerbation during COVID-19 emphasizes the critical need for AMS to promote rational antimicrobial use effectively [19]. A 2023 study in a non-UK setting reported that 60% of pharmacists dispensed antibiotics without prescriptions [20], a practice mitigated in the UK through strict adherence to the Medicines Act [21]. Furthermore, pharmacists in countries such as India and South Africa face educational barriers, limiting their AMS contributions [22]. This study found that 84.8% of pharmacists recognized AMR as a significant public health concern, with 76.8% supporting AMR mitigation efforts. Strengthening AMS training and curricula is essential to empower pharmacists, whose expertise plays a pivotal role in AMS, patient education, and reducing unnecessary antibiotic use [23–25].

This study examined pharmacists' attitudes towards antibiotic prescribing and AMS during the pandemic. It found that 56.8% recognized updates in antibiotic guidelines, and 79.2% valued enhanced communication with microbiologists to support informed decision-making. Importantly, 64% adhered to stewardship principles by discontinuing antibiotics after negative cultures, highlighting the role of time constraints, clinical developments, and collaboration on AMS practices. Pharmacists' attitudes were shaped by concerns regarding secondary infections during COVID-19 [10]. Regarding AMS activities, 86.4% agreed that antimicrobial misuse during the pandemic could impact resistance, and 63.2% supported using

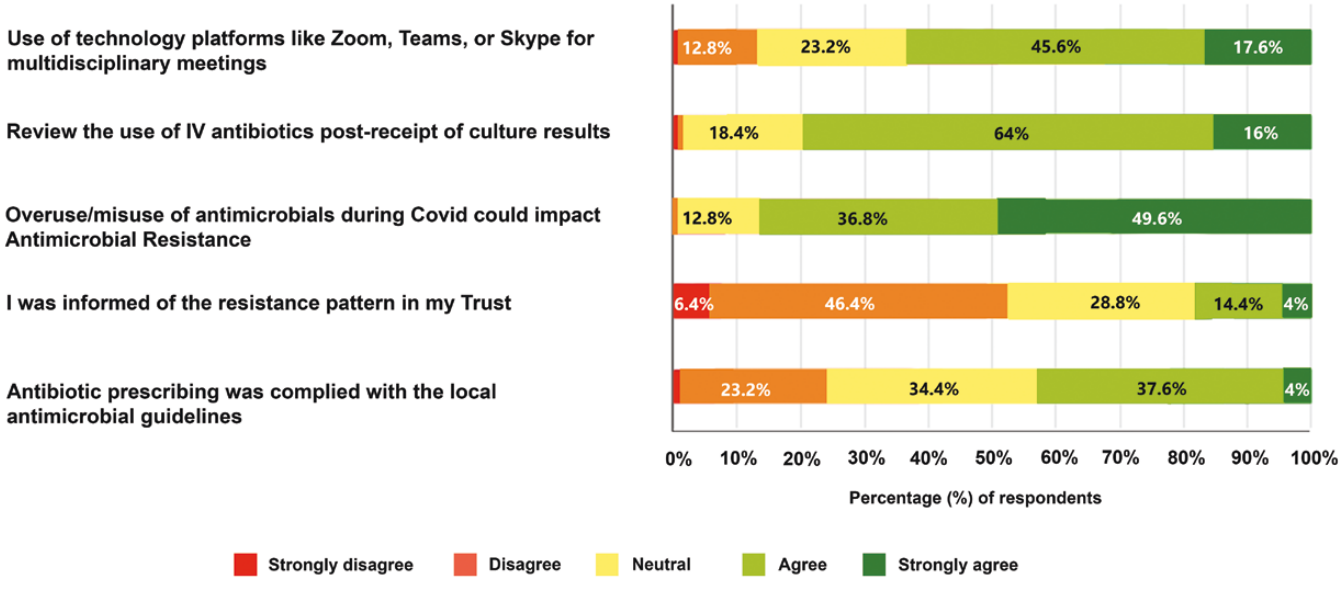

Figure 3. Pharmacists' view towards AMS practice during the pandemic (n = 125).

technology to facilitate multidisciplinary meetings. These findings highlight the significance of conducting post-culture reviews and improving communication regarding resistance patterns to enhance AMS. The RPS emphasizes that effective AMS depends on pharmacist leadership in action plans, multidisciplinary collaboration, informed decisions through patient records, and greater public awareness and education to combat AMR [14].

The study's findings highlight the critical role pharmacists play in combating AMR, emphasizing the importance of strengthening the workforce's capacity through education, training, and leadership in AMS initiatives, aligning with the International Pharmaceutical Federation (FIP)'s emphasis on pharmacist-led AMS efforts [26]. The FIP, a global federation representing pharmacy, pharmaceutical sciences, and pharmaceutical education, advocates for the integration of pharmacists in AMS programmes. The high agreement on the impact of antimicrobial misuse and support for technology in multidisciplinary meetings underscores the need for improved communication regarding resistance patterns. This highlights the importance of pharmacist leadership, collaboration, and education to strengthen AMS efforts and address AMR challenges effectively [26].

In Australia, qualitative research has highlighted the effectiveness of pharmacist-led antimicrobial stewardship initiatives and multidisciplinary collaboration. Similar to the findings of this study, it highlights the pivotal role of pharmacists in AMS and the necessity for improved communication regarding resistance patterns. Both emphasize that empowering pharmacists through leadership roles, education, and better communication is essential to combat AMR globally [27].

In the UK, a study assessed the impact of the pandemic on AMS support for general practices. It found that AMS was deprioritized and adapted to technology. Pharmacists emphasized the importance of prioritizing antimicrobial stewardship by integrating innovative and established strategies to improve effectiveness [28]. During the pandemic, the increased use of technology and procalcitonin tests presented new opportunities for future enhancements and sustainability in antimicrobial stewardship [29]. Another study in the UK, conducted in 2022, revealed the mixed impact of COVID-19 on AMS activities. However, the adoption of hybrid working, including virtual ward rounds and meetings, helped resume AMS implementation during the pandemic [30].

Pharmacists, as medication experts, play an essential role in antibiotic review and medicine optimization [12]. They could contribute innovatively to combating AMR by leveraging novel survey distribution methods to increase participation rates in surveys on antibiotic prescribing. This would enable pharmacists to gather comprehensive data on prescribing behaviours, attitudes towards AMR, and AMS practices, informing evidence-based interventions to combat AMR [1]. Pharmacists could co-lead AMS implementation during emergencies, ensuring preparedness for future crises that disrupt healthcare systems. Effective AMS requires well-trained pharmacists who are confident in multidisciplinary roles, participate in AMS ward rounds, communicate with microbiologists, and stay updated on resistance patterns. Structured AMS training, education, and a clear roadmap are crucial for their leadership in AMS initiatives.

Strength and limitations

This study provides valuable insights into pharmacists' robust awareness of AMR, recognizing it as a critical public health concern impacting clinical practice. It investigates pharmacists' knowledge, attitudes, and perceptions towards AMR/AMS, highlighting their pivotal role in AMS practices, particularly during crises or emergencies that could disrupt the healthcare system. The majority of respondents advocated for actions to combat antimicrobial resistance in order to sustain antimicrobial stewardship efforts. Furthermore, endorsing AMS to promote prudent antibiotic use reflects a readiness to adopt evidence-based practices.

This study has several limitations. The cross-sectional design restricts the ability to establish causal relationships between variables, and future research should employ longitudinal designs with inferential statistical methods to explore deeper data relationships and validate findings. Reliance on self-reported data introduces potential biases, such as social desirability or overestimation of adherence to AMS practices. In addition, some questions intended to assess knowledge may have inadvertently measured attitudes or perceptions, affecting accuracy. The results are limited to pharmacists in one healthcare setting, reducing generalisability. Excluding pharmacy technicians also limits the findings, as both professions are crucial to AMS and AMR efforts. Future research should include both pharmacists and pharmacy technicians to provide a more comprehensive understanding of their roles and improve the robustness of the findings.

Conclusion

This descriptive study, conducted at a single NHS Foundation Trust, highlights that pharmacists showcased exemplary knowledge and awareness of antimicrobial resistance and stewardship during the pandemic, emphasizing their critical role as frontline members of the healthcare workforce. Their responses suggest the capacity to co-lead impactful AMS initiatives, which are vital for addressing AMR, safeguarding patient lives, and advancing sustainable and resilient AMS practices. However, further education, workforce development, and training are urgently needed to empower pharmacists to enhance AMS practices and ensure preparedness for future emergencies, effectively confronting AMR as a pressing global health threat.

Supplementary material

Supplementary data are available at *Journal of Pharmaceutical Health Services Research* online.

Author contribution statement

R.A.E. was tasked with formulating the research questions, designing the study, conducting the research, analysing the data, and drafting the original version of the article. N.U. contributed to visualization, validation, and reviewing and editing of the manuscript. Z.A. provided supervision, contributed to visualization, and assisted in reviewing and editing the article.

Conflict of interest

None declared.

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Ethical approval

This study received ethical approval from the Health Research Authority (HRA) with the Research Ethics Committee (REC) reference number 22/EM/0161. In addition, the study protocol was reviewed and approved by the University of Hertfordshire (UH) Ethics Committee under reference LMS/PGR/NHS/02975.

Data availability

The data sets generated during the current study are available from the corresponding author upon reasonable request.

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