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**Antimicrobial Stewardship Through the Nurses' Lens: Knowledge, Perceptions
and Challenges in a Mixed-Methods Study**

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ANTIMICROBIAL STEWARDSHIP THROUGH THE NURSES' LENS: KNOWLEDGE, PERCEPTIONS AND CHALLENGES

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Acceptance Page

This thesis of **JERIBELLE BARCELONA** titled: “**Antimicrobial Stewardship Through the Nurses’ Lens: Knowledge, Perceptions and Challenges**” is hereby accepted by the Faculty of Management and Development Studies, U.P. Open University, in partial fulfilment of the requirements for the degree **Master of International Health**.

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Biographical Sketch

The author earned a Bachelor of Science in Nursing in 2014 and has since developed a diverse clinical background, beginning in emergency nursing and extending to primary and occupational health. In 2020, she migrated to the United Kingdom, at the early start of the COVID-19 pandemic and was assigned to a hip fracture unit which had to be subsequently converted into a COVID-19 ward. This pivotal experience fostered her professional interest in infection prevention and control (IPC) and its integral relationship with public health, leading to her transition into the speciality. She currently serves as an IPC Clinical Nurse Specialist in the UK. Her research interests encompass infection prevention and control, public health, antimicrobial resistance (AMR), and antimicrobial stewardship (AMS), with particular focus on the underexplored role of nurses in AMS. She aspires to contribute to the advancement of nursing and health systems by fostering a more holistic and collaborative approach to IPC and AMS – integrating clinical practice, research, education and policy to strengthen health systems and promote sustainable, patient centred and population-focused health outcomes.

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Above all, the author is deeply grateful to God for granting her the wisdom, strength, and grace to complete this journey.

Dedication

This work is lovingly and wholeheartedly dedicated to my immediate family – my husband and son – whose love, sacrifice and constant encouragement have sustained me throughout this journey. To my parents, whose unwavering faith in me has been my guiding light, and to my brother, for his quiet but steadfast support. Above all, this work is dedicated to God, who has been my source of strength, wisdom, and purpose.

Abstract

Antimicrobial resistance (AMR) remains a global health threat, and nurses play a pivotal yet often under-recognized role in antimicrobial stewardship (AMS). This study examined nurse's knowledge, perceptions, and challenges related to their role in AMS using a mixed methods explanatory sequential design. The quantitative phase involved 313 registered nurses from various clinical settings who completed a validated online questionnaire assessing their AMS knowledge, perceptions, and perceived challenges. Data were analysed using descriptive statistics, correlation, and logistic regression. The qualitative phase involved semi-structured interviews with 10 purposively selected nurses to explore and contextualize the quantitative findings.

Results indicated that most participants demonstrated high AMS knowledge (88.8%) and a generally positive perception of their role in AMS (WM = 3.97, "Agree"). However, gaps remained in application-level knowledge, particularly in areas such as intravenous-to-oral conversion and understanding environmental contributors to resistance. Linear regression analysis revealed that knowledge significantly predicted perception ($B = -1.55$, $p < .001$), suggesting that more knowledgeable nurses held more critical or realistic perspectives on AMS practice within hierarchical healthcare structures. Conversely, knowledge was not significantly associated with perceived challenges ($p = .399$), indicating that the barriers were primarily systemic rather than individual.

The qualitative analysis identified six themes: fragmented and experience-driven knowledge, limited role perception, competing priorities and workload pressures, confidence and hierarchy, patient education limitations, and training and empowerment. The integration of findings indicated that although nurses demonstrated a strong foundational awareness of AMS, their potential contributions were constrained by institutional culture, workload demands, and the absence of structured AMS training programs.

The study concludes that empowering nurses through targeted AMS education, interprofessional collaboration, and organisational support is essential for strengthening their stewardship role and addressing antimicrobial resistance.

Keywords: Antimicrobial Stewardship, Antimicrobial Resistance, Nurses, Knowledge, Attitudes, and Practices, Professional Role Perception, Practice Challenges, Mixed-Methods Research, Healthcare System Factors

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Chapter I

THE RESEARCH PROBLEM

Background of the Study

Antimicrobial resistance (AMR) is a major global health threat that poses serious risks to patient safety and public health (WHO, 2023). The growing prevalence of AMR requires the need for robust antimicrobial stewardship (AMS) programs to preserve the efficacy of existing treatments and improve patient outcomes (NICE, 2015).

Existing AMS initiatives have extensively examined the roles of physicians and pharmacists; however, there remains a gap in understanding the nursing perspective. Both the Centers for Disease Control and Prevention (CDC) and the American Nurses Association (ANA) have emphasized the importance of a multidisciplinary approach to antimicrobial stewardship, highlighting nurses as key members of the healthcare team.

Nurses constitute the largest group of frontline healthcare providers and play a critical role in the delivery of health services (World Health Organization [WHO], 2024). Despite their constant patient interactions and responsibilities in medication administration, infection prevention, and patient education, their role in AMS remains underexplored.

In the United Kingdom, the National Health Service (NHS) has prioritized Antimicrobial Stewardship (AMS) as a key strategic initiative. This commitment is evident in the integration of AMS within the UK's five-year Antimicrobial Resistance Strategy (2019-2024). However, despite this emphasis, the limited knowledge among

nurses continues to hinder their engagement in AMS programs. Barriers such as inadequate training and education in antimicrobial prescribing and stewardship, competing priorities, and organizational constraints remain significant challenges (Chater et al., 2022). Consequently, nurses are often excluded from the decision-making processes related to antimicrobial use. Furthermore, the variability of AMS implementation across NHS trusts—driven by differences in local resources, leadership commitment, and educational support—further complicates the nursing role in stewardship (Castro-Sánchez et al., 2019).

Globally, similar challenges persist. In high-income countries such as Australia and the United States, nurses have expressed a desire to participate in AMS initiatives but report lacking confidence and knowledge due to insufficient education and institutional support (Broom et al., 2016; Monsees et al., 2018). These issues are further exacerbated in low- and middle-income countries (LMICs), where the structural and educational foundations for AMS frameworks remain underdeveloped. In many LMICs, nurses serve as key frontline healthcare providers, particularly in rural and under-resourced settings, yet often lack access to stewardship training, clinical microbiology services, and regulatory oversight (Ayukekbong et al., 2017; Pokharel et al., 2019). Additional challenges arise from the widespread availability of over-the-counter antibiotics and prevalence of empirical prescribing practices.

A notable gap in the current literature concerns the limited exploration of nurses' specific knowledge, perceptions, and challenges related to AMS. Previous research has primarily focused on prescribing clinicians and pharmacists, with relatively few studies providing an in-depth examination of the nursing perspective (Castro-Sánchez et al., 2016). Existing studies often position nurses as peripheral stakeholders in AMS

rather than as active participants whose attitudes and engagement directly influence antimicrobial use. Moreover, although some studies acknowledge nurses' willingness to engage in stewardship activities, there remains insufficient evidence on how nurses perceive their role, what knowledge gaps persist, and what contextual challenges they encounter when implementing AMS responsibilities in daily practice (Charani et al., 2013). Therefore, understanding nurses' knowledge, perceptions, and challenges in AMS is essential to inform the development of targeted educational interventions and policy initiatives that empower nurses to contribute effectively to antimicrobial stewardship.

This study aims to examine the knowledge, perceptions, and challenges experienced by nurses in AMS. By identifying these knowledge gaps and barriers, the study seeks to provide evidence-based recommendations to strengthen the nursing role in AMS and improve patient outcomes. Understanding nurses' perspectives on AMS also highlights their unique contributions and promotes greater interprofessional collaboration in antimicrobial stewardship efforts.

Statement of the Problem

Antimicrobial resistance (AMR) remains a critical global health challenge, intensified by the inappropriate and excessive use of antimicrobials in healthcare settings (WHO, 2023). Antimicrobial stewardship (AMS) programs have been established as essential strategies to address AMR. However, the engagement of nurses who are at the forefront of patient care and infection prevention remain inadequately investigated (ANA & CDC, 2017). While nurses play an integral part in medication administration, infection control, and patient education, limited research

has examined their knowledge, perceptions, and challenges related to antimicrobial stewardship. Existing evidence points to significant gaps in understanding stewardship principles, as well as barriers such as inadequate training, competing priorities, and unclear role definitions that hinder their active participation.

This study seeks to explore the knowledge, perceptions, and challenges experienced by nurses regarding antimicrobial stewardship. Specifically, it intends to identify the factors influencing their engagement and to propose strategies that strengthen their role in AMS, thereby contributing to the prevention of antimicrobial resistance.

Research Questions

1. What is the knowledge, perceptions, and challenges of nurses regarding their role in antimicrobial stewardship (AMS)?
2. Does nurses' knowledge of AMS significantly predict their perceptions and challenges related to their role in antimicrobial stewardship (AMS)?
3. Are there significant differences in nurses' knowledge, perceptions, and challenges in antimicrobial stewardship (AMS) when grouped according to their clinical area, highest educational attainment, length of nursing practice, and previous antimicrobial stewardship (AMS) training?

Objectives of the Study

Main Objective

To determine the knowledge, perceptions, and challenges of nurses regarding their role in antimicrobial stewardship (AMS).

Specific Objectives

1. To determine the level of knowledge of nurses on antimicrobial stewardship
2. To determine the perception of nurses regarding their role in antimicrobial stewardship
3. To identify the challenges encountered by nurses in performing their role in antimicrobial stewardship
4. To determine the association between the following:
 - a. Nurses' knowledge of antimicrobial stewardship (AMS) and their perception on their roles in AMS
 - b. Nurses' knowledge of AMS and the challenges they encounter in performing their roles
5. To compare the knowledge, perception, and challenges of nurses regarding their role in AMS according to:
 - Clinical Area
 - Highest educational attainment
 - Length of nursing practice
 - Previous AMS training
6. To compare the qualitative findings with the quantitative results to explain and elaborate on the patterns identified in the initial quantitative phase.

Significance of the Study

The World Health Organization (WHO) identifies antimicrobial resistance as one of the leading global health threats. AMR contributes to prolonged hospital stays and increased healthcare costs, which, in turn, affect the productivity and livelihoods of patients and caregivers. Consequently, AMR imposes substantial financial burdens on health systems and national economies.

AMR affects all countries regardless of income level. The Global Action Plan on Antimicrobial Resistance formally encourages countries to implement comprehensive strategies to address AMR (WHO, 2015).

At the national level, the United Kingdom (UK) government has published a 20-year vision for addressing AMR supported by successive 5-year action plans. In 2024, the plan specifically focuses on reducing the need for antibiotics and optimizing antimicrobial use through infection prevention and control measures, public education, and the strengthening of AMS and AMR workforce capacities.

This study holds significance across three key domains:

a. Academic and Theoretical Contributions:

This study addresses a notable gap in the existing literature by exploring the knowledge, perceptions, and challenges nurses encounter in AMS participation. By examining these dimensions, the research contributes to a deeper theoretical understanding of the behavioral and organizational factors that influence nurses' engagement in AMS practices.

b. Clinical and Policy Implications:

The findings of this research can inform the development of targeted interventions, including nurse-specific antimicrobial stewardship programs, policy frameworks, and interprofessional collaboration models that enhance nurses' active participation in stewardship roles. These efforts underscore the need for inclusive, multidisciplinary approaches to AMS implementation, aligning with WHO's 2021 Policy Guidance on integrated AMS activities.

c. Global Health and Sustainable Development Goals (SDGs):

This research supports SDG 3.3 and 3.d which aims to combat communicable diseases and strengthen health system resilience by integrating nurses into AMS strategies. Furthermore, the study contributes to the broader One Health approach endorsed by the WHO and the United Nations, recognizing that combating AMR requires multisectoral collaboration and inclusive health governance.

Finally, this research aims to advance systemic change by strengthening the role of nurses in antimicrobial stewardship. By identifying the knowledge gaps, perception issues, and practical challenges, the study seeks to generate insights that enhance infection prevention strategies, improve patient care, and contribute to global efforts to mitigate antimicrobial resistance.

Scope and Limitation of the Study

Scope

This study aims to assess the knowledge, perceptions, and challenges of nurses regarding their role in antimicrobial stewardship within one of the National

Health Service (NHS) Trusts in the United Kingdom. Specifically, it seeks to identify and understand how nurses' knowledge and perceptions influence their participation AMS initiatives within a hospital-based setting, as well as to determine the factors that support or hinder their involvement.

The study will be conducted across all sites of the University College London Hospitals NHS Foundation Trust (UCLH). It will focus exclusively on Nursing and Midwifery (NMC) registered nurses working in various inpatient departments (e.g. Medicine, Surgery, Oncology) across the different hospital sites. A mixed-methods explanatory sequential design will be adopted, comprising of two phases:

- Phase 1 involved the administration of a validated questionnaire to collect quantitative data on nurses' knowledge and perceptions regarding their role in AMS.
- Phase 2 consisted of semi-structured interviews to further explore and contextualize the challenges identified in Phase 1, providing deeper qualitative insights.

Participation in both phases will be voluntary.

Limitations

Several limitations are acknowledged in this study:

1. Contextual Boundaries

The study is only confined to a single NHS trust. While the findings may reflect trends within this Trust, they may not be generalizable to other organizations that differ in staffing composition, culture or AMS strategies.

Furthermore, the study excludes nurses working in non-acute settings (e.g. community or mental health trusts), limiting the scope of inference.

2. Participation

As participation is voluntary, there is a possibility of self-selection bias, wherein individuals with a stronger interest or prior experience in AMS are more likely to participate. Non-response from less engaged staff may limit the diversity of perspectives captured. In addition, the qualitative phase (Phase 2) will include a smaller, purposively selected sample of participants based on Phase 1 responses which may not fully capture the range of experiences across all nursing roles or units.

3. Time and Workload Constraints

Operational demands and staffing pressures within the Trust, particularly in high-acuity areas, limit nurses' availability to participate. This could impact sample diversity and overall representativeness.

CHAPTER II

THEORETICAL BACKGROUND

Review of Related Literature

Antimicrobial Resistance (AMR) is a leading global health crisis, exacerbated by the overuse and misuse of antibiotics (World Health Organization [WHO], 2023). To address this challenge, antimicrobial stewardship programs (ASPs) have been developed to optimize antimicrobial use and mitigate resistance, with the overarching goal of improving patient outcomes. Traditionally, these initiatives have been led by physicians and pharmacists. However, there is increasing recognition of the critical role that nurses play in implementing and sustaining antimicrobial stewardship programs (Olans et al., 2015).

As frontline healthcare providers and the largest group within the health workforce, nurses occupy a pivotal and unique position in influencing antimicrobial use. Their continuous patient contact, involvement in surveillance activities, and roles in patient education and advocacy position them as key contributors to antimicrobial stewardship (Edwards et al., 2011; WHO, 2024). Despite this, their contributions remain underutilized due to gaps in knowledge, unclear role definitions, and systemic barriers within healthcare institutions (Chater et al., 2022).

This review synthesizes recent literature on nurses' knowledge and perceptions regarding their role in antimicrobial stewardship, as well as the multifaceted challenges that hinder their full engagement in ASP initiatives. The aim is to discuss

the current state of research in this domain and identify areas where future studies can contribute to strengthening nurses' participation in antimicrobial stewardship.

The Nurses' Knowledge of Antimicrobial Stewardship

General Awareness, Knowledge Levels, and Clinical Knowledge Gaps

Several studies have identified varying levels of understanding among nurses regarding antimicrobial resistance (AMR) and the fundamental principles of antimicrobial stewardship (AMS). Empirical evidence consistently indicates that, although nurses are generally aware of the importance of AMR, their understanding of AMS practices tends to be superficial and inconsistent (Rout & Brysiewicz, 2020; Zhao et al., 2023).

Research has shown that while nurses demonstrate basic awareness of antibiotic resistance, they often have limited knowledge of appropriate prescribing practices, stewardship strategies, and underlying mechanisms of resistance (Blackburn et al., 2025; Lalithabai et al., 2022; Rábano-Blanco et al., 2019). In a multicenter study by Merrill et al. (2019), only 52% of surveyed nurses reported not being familiar with the concept of AMS. Hence, knowledge deficits were repeatedly identified across studies, with less than half of the respondents demonstrating familiarity with current AMS guidelines.

Similarly, a cross-sectional survey conducted in a neonatal intensive care unit revealed significant knowledge gaps related to antibiotic de-escalation protocols, dose optimization, and the impact of resistance on patient outcomes (Hamidi & Blatz, 2022). These findings underscore that, although nurses recognize the problem of AMR, they often lack the depth of knowledge required for effective stewardship participation.

Further evidence suggests that nurses frequently have limited awareness of microbiological testing protocols, antimicrobial pharmacokinetics, and classifications of antibiotic spectrum classifications. Fleuren et al. (2019) found that many nurses were unable to distinguish between broad-spectrum and narrow-spectrum antibiotics, hindering their ability to identify inappropriate prescribing or advocate for timely discontinuation of antibiotics. Likewise, Monsees et al., (2018) reported that most nurses expressed low confidence in interpreting microbiology results, which are essential tools for guiding antibiotic selection. Similarly, Carter et al. (2018) observed that a considerable proportion of nurses lacked sufficient understanding of antibiotic selection, dosing, and microbiological testing which are critical to effective AMS engagement.

Impact of Formal and Informal Education in Knowledge Acquisition and Training

Research indicates that both formal education and on-the-job learning significantly contribute to the nurses' knowledge on antimicrobial use. However, despite the inclusion of antimicrobial resistance (AMR) and antimicrobial stewardship (AMS) content in some undergraduate nursing curricula, there remains inconsistency in the extent and depth of such coverage (Carter et al., 2018). Continuous professional development programs have been shown to enhance knowledge and the application of stewardship principles, yet these initiatives are often constrained by limited time and resources (Cadavid et al., 2017; Rout et al., 2021).

While certain healthcare institutions provide AMS related training, its scope and reach remain inconsistent. Rout et al. (2021) highlight that most stewardship training programs are designed primarily for physicians and pharmacists, with nursing staff frequently marginalized. Consequently, nurses often rely on informal learning

approaches such as peer discussions and self-directed online modules rather than structured educational opportunities. In addition, Olans et al. (2015) further emphasize that the exclusion of nurses from formal AMS training fosters uncertainty and role ambiguity in stewardship practices.

Encouragingly, studies have shown that targeted educational interventions for nurses can bridge these gaps. Hendy et al. (2022) reported that a nursing-focused AMS workshop led to improved perceptions, knowledge, and integration of stewardship principles into clinical practice. Similarly, a study conducted by Mittal et al. (2023) found significant improvements in knowledge scores following the implementation of an educational program on AMR and AMS among staff nurses, with participants affirming the program's practical relevance. These findings underscore the value of well-designed educational strategies such as simulation-based learning, interprofessional workshops, and targeted lectures that integrate theoretical understanding with practical application, thereby empowering nurses to play a more active and informed role in antimicrobial stewardship.

Role of Multidisciplinary Collaboration

Stewardship literature consistently underscores interprofessional collaboration as a cornerstone of effective antimicrobial management. Nurses frequently report that their confidence in clinical decision-making is significantly strengthened through collaboration with pharmacists, infectious disease physicians, and microbiologists (Cadavid et al., 2017; Mittal et al., 2023). Integrated training sessions and shared governance frameworks have also been shown to reinforce nurses' involvement in antimicrobial stewardship (AMS) while promoting collective learning and accountability (Cadavid et al., 2017; Ladenheim et al., 2013; Olans et al., 2015). These collaborative

structures foster a culture of shared responsibility, enabling nurses to make more informed contributions to the multidisciplinary AMS team.

Nurses' Perceptions of Their Role in Antimicrobial Stewardship

Recognition of Professional Responsibility

Traditionally, antimicrobial decision-making has been viewed as the exclusive responsibility of physicians. However, emerging research reveals a paradigm shift in how nurses' perceive their roles in stewardship activities. Increasingly, nurses recognize themselves as integral members of AMS teams, acknowledging their ethical and professional responsibility to advocate for the appropriate use of antimicrobials (ACSQHC, 2018; Broom et al., 2016; Carter et al., 2018).

Baldwin et al., (2013) and Farhan (2018) highlighted a growing awareness among nurses that their professional duties extend well beyond medication administration. These responsibilities encompass infection surveillance, prevention, patient education, and escalation of care in cases of suspected antibiotic misuse. Similarly, Abahamye (2016) and Monsees et al. (2018) identified that nurses recognise their critical influence in antimicrobial stewardship (AMS) through timely specimen collection, vigilant monitoring of adverse reactions, and strict adherence to antimicrobial timing protocols. Moreover, many nurses view themselves as patient advocates that are willing to question or clarify prescriptions to ensure patient safety and stewardship integrity.

Despite these positive developments, ambiguity persists regarding the specific boundaries of nurses' responsibilities within multidisciplinary teams. Surveys suggest that while nurses recognize their potential influence, several studies indicate that they

contribute to perceive themselves as underutilized in decision-making processes related to antimicrobial prescribing (Monsees et al., 2018; Olans et al., 2017; Olans et al., 2015). This highlights the need for clear role delineation and institutional support to optimize their contributions to AMS initiatives.

Confidence and Autonomy in Practice

The sense of autonomy in clinical practice is a crucial determinant that affects nurses' engagement in AMS. Evidence suggests that nurses who perceive greater professional autonomy are more proactive in advocating for timely discontinuation of antimicrobials and in providing patient education on appropriate antibiotic use (Ierano et al., 2019). However, despite these positive tendencies, many nurses report diminished confidence in asserting their authority or independently influencing antimicrobial prescribing decisions due to lack of clear institutional policies and organizational support.

Several studies have highlighted nurses' hesitancy to challenge physician's antimicrobial decisions, even when they suspect inappropriate prescribing. (Charani et al., 2013; Davey & Aveyard, 2022; Rout & Brysiewicz., 2020). This reluctance is often rooted in professional hierarchies, unclear role boundaries, and perceived power differentials within healthcare systems. On the other hand, Kirby et al. (2020) found that nurses exhibit greater confidence and engagement when assigned structured AMS responsibilities such as monitoring antibiotic start and stop dates, documenting the rationale for antibiotic use, or participating in stewardship rounds. These findings emphasize the need to establish clear, measurable, and institutionally supported roles for nurses to strengthen their autonomy and participation in AMS programs.

Barriers to Effective Engagement

Organizational culture and hierarchical dynamics within healthcare institutions significantly influence nurses' perceptions of their role in antimicrobial stewardship. Research consistently indicates that when nurses perceive that their contributions are undervalued relative to those of physicians and pharmacists, their motivation and perceived efficacy in stewardship initiatives decline (Carter et al., 2018). In contrast, institutions that foster interprofessional respect, promote shared accountability, and define clear role expectations are linked to increased proactive nursing engagement in stewardship efforts.

Challenges Faced by Nurses in Antimicrobial Stewardship

Educational and Training Deficits

A recurring challenge identified in the literature is the insufficiency of formal education and structured training related to antimicrobial stewardship within nursing curricula. Although there is increasing awareness of antimicrobial resistance (AMR), the integration of AMS content in both undergraduate and post graduate programs remains inconsistent and often superficial (Castro-Sánchez et al., 2016; McEwen & Burnett, 2017). Courtenay et al. (2024) in a cross-sectional survey across 23 UK universities, found that nursing students reported feeling less prepared in areas requiring applied knowledge of microbiology and antimicrobial management. Even when AMS topics are incorporated into curricula, they often remain theoretical, lacking emphasis on practical decision-making, case-based studies, or interprofessional collaboration which are necessary for real-world application (Courtenay et al., 2019; McEwen & Burnett, 2017).

Additionally, continuing professional development (CPD) programs often fall short of comprehensively addressing stewardship, focusing instead on general infection control practices. This gap in applied education leaves nurses often feeling inadequately prepared to participate in antimicrobial decision-making processes, especially in complex scenarios such as multidrug-resistant infections (Kirby et al., 2020; Tembo et al., 2022). The absence of structured, practice-oriented education thus contributes to reduced confidence and hesitancy in handling antimicrobial therapies effectively.

Institutional and Organizational Barriers

Nurses' involvement in antimicrobial stewardship initiatives is significantly constrained by organisational and systemic factors. Commonly reported barriers include time limitations, staffing shortages, and insufficient institutional support. Research indicates that in many hospital settings, high workloads and administrative demands leave nurses with limited capacity to participate in additional stewardship-related responsibilities (Vicentini et al., 2024). Mula et al. (2019) similarly reported high patient-to-nurse ratios hinder their ability to monitor antibiotic administration schedules or engage in stewardship rounds consistently. Moreover, AMS responsibilities are frequently expected to be incorporated in their existing duties without adjustments in workload, time allocation, or compensation, resulting to fatigue and reduced motivation. The absence of formal recognition mechanisms or performance incentives for stewardship contributions further discourages sustained engagement among nursing staff (Monsees et al., 2020).

Communication Challenges and Interprofessional Dynamics

Effective communication is central to the success of AMS programs, however, persistent barriers in communication and interprofessional tensions often hinder their implementation. Studies have shown that nurses frequently encounter challenges in voicing their observations or concerns about antimicrobial use, particularly when physicians maintain dominant authority in prescribing decisions (Manning & Giannuzzi, 2015). The lack of standardized communication pathways or structured feedback protocols exacerbates these difficulties, resulting in inconsistent application of stewardship protocols and potential delays in timely intervention.

Furthermore, the hierarchical structures within health care teams discourage open communication and restrict the integration of nursing insights in clinical decisions. Research has identified that successful and effective AMS models prioritize nurse empowerment and interdisciplinary collaboration (Monsees et al., 2020).

Technological and Resource Limitations

Technological infrastructure and access to accurate, timely data are essential components of effective antimicrobial stewardship (AMS) practices. However, many nurses report limited access to real-time patient data and evidence-based decision support systems, which restricts their ability to monitor antibiotic use and effectively contribute to therapeutic decision-making (Wentzel et al., 2014). Resource constraints, namely, limited availability of continuing education materials and simulation-based training tools, further impede their capacity to apply stewardship principles in daily practice.

Additionally, inadequate dissemination of AMS practices has resulted in many nurses being unaware of national or institutional frameworks. In the absence of standardized protocols, checklists or accessible digital platforms, nursing practices related to antimicrobial use often vary widely across clinical settings, reducing consistency and accountability.

The reviewed literature clearly indicates that nurses increasingly recognise their vital role in antimicrobial stewardship, multiple barriers continue to hinder their full participation. Knowledge gaps that stem from inconsistent nursing curricula and limited professional development opportunities, remain a major concern. At the same time, perceptions of insufficient recognition, authority, and professional autonomy within clinical practice diminish nurses' from actively engaging in stewardship activities. Institutional and organizational barriers, including high workloads, inadequate staffing, and hierarchical dynamics further limit the efficacy of nursing contributions to AMS.

Addressing these multi-faceted challenges requires a holistic approach incorporating educational reform, improved interprofessional collaboration, and supportive institutional policies. Future research should continue to focus on examining and developing innovative strategies that integrate nursing perspectives into AMS frameworks. Doing so will not only empower nurses to contribute more effectively but also advance global efforts to mitigate antimicrobial resistance and improve patient outcomes.

Synthesis

Antimicrobial stewardship is a pivotal strategy in addressing antimicrobial resistance, one of the most pressing global public health threats (World Health Organization [WHO], 2023). While AMS initiatives have traditionally been led by physicians and pharmacists, nurses occupy a strategic position that allows them to play a vital role in administering antibiotics, monitoring therapeutic responses and educating patients. However, their contributions to AMS remain insufficiently explored and underutilized (Olans et al., 2015).

Research consistently highlights the nurses' insufficient knowledge of AMS principles. Castro-Sánchez et al. (2019) and Blackburn et al. (2025) have identified significant knowledge gaps, particularly in key areas like de-escalation, therapy duration, and microbiology. Although some nurses receive in-service training, AMS education remains inconsistent and often informal (Rábano-Blanco et al., 2019). These knowledge gaps are partly due to the insufficient integration of AMS into nursing curricula.

Furthermore, nurses often perceive AMS as a physician-led initiative. Research indicates that nurses consider themselves as supporters rather than active contributors to stewardship activities, due to professional hierarchies and unclear role definitions (Davey & Aveyard, 2022). However, active engagement in AMS rounds leads to increased confidence and ownership among nurses (Hansen et al., 2023). There remains limited research exploring the knowledge, perceptions, and challenges of nurses in antimicrobial stewardship within hospital settings.

Despite the increasing recognition of the need for multidisciplinary AMS approaches, existing research reveals persistent gaps in nurses' AMS knowledge,

ambiguous perceptions of their roles, and organizational barriers that limit their participation. Therefore, a comprehensive understanding is essential to identify the knowledge gaps, perceptions, and perceived barriers of nurses in their involvement in AMS with the aim of informing more comprehensive and effective stewardship strategies.

Theoretical Framework

This research is based on Social Cognitive Theory (SCT) by Albert Bandura (2001) and the Health Belief Model (HBM) by Rosenstock et al. (1988). Together, these frameworks provide a comprehensive foundation for understanding the cognitive, behavioral, and contextual factors influencing nurses' engagement in antimicrobial stewardship (AMS).

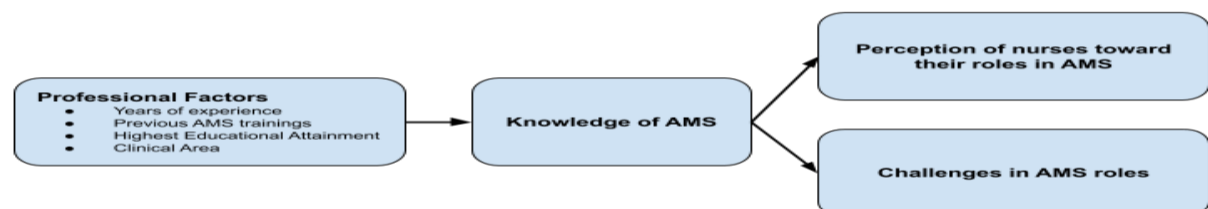
Social Cognitive Theory (SCT) asserts that human behaviour is shaped by the dynamic interplay of personal, behavioral, and environmental influences. A pivotal concept within SCT is self-efficacy, which denotes the belief in one's ability to perform actions necessary to handle future situations (Bandura, 1991). In the context of AMS:

- a. **Personal factors** refer to nurses' knowledge and perceptions regarding antimicrobial resistance and stewardship, which significantly influence their engagement in AMS practices;
- b. **Behavioral factors** pertain to ways in which nurses execute their roles in AMS;
and
- c. **Environmental factors** encompass organizational support and culture, as well as institutional training programs which collectively either facilitate or hinder nurses' involvement in AMS.

The Health Belief Model (HBM) augments Social Cognitive Theory by providing a comprehensive understanding of the determinants of health-related behavior, including perceived susceptibility, severity, benefits and barriers, as well as cues to action and self-efficacy (Rosenstock et al, 1988). Nurses' perceptions of antimicrobial resistance (AMR) along with the perceived benefits and obstacles associated with AMS, shape their willingness and ability to engage in stewardship efforts.

Collectively, Social Cognitive Theory and Health Belief Model provide a robust theoretical lens through which to analyze the impact of individual beliefs, confidence, and external support mechanisms on nurses' perceptions and the challenges they face in executing their AMS responsibilities.

Figure 1. Conceptual Framework



Definition of Terms

1. Antimicrobial Stewardship (AMS)

An integrated framework within healthcare settings that promotes the appropriate application of antimicrobials, with the goals of optimizing patient outcomes, reducing microbial resistance, and limiting the transmission of

infections caused by multidrug-resistant organisms. For this study, AMS encompasses activities such as adherence to prescribing guidelines, participation in infection control protocols, and engagement in educational programs related to antimicrobial use.

2. Knowledge of AMS

Refers to the level of understanding nurses possess regarding the principles, guidelines, and rationale of antimicrobial stewardship. This includes awareness of antimicrobial resistance, appropriate prescribing practices, and infection prevention strategies.

3. Perception of AMS

Denotes the beliefs, attitudes, and perceived significance that nurses attribute to their role in antimicrobial stewardship. This includes their views on AMS's impact on patient care, its relevance to nursing practice, and the extent to which they feel accountable and empowered to participate.

4. Challenges in AMS participation

Refers to the barriers or difficulties perceived or experienced by nurses in effectively fulfilling their role in antimicrobial stewardship. These may include inadequate training, time limitations, restricted authority, unclear role definitions, and challenges in interprofessional collaborations.

5. Nurses

For the purpose of this research, nurses refer to Nursing and Midwifery (NMC) registered nurses who deliver direct, hands-on patient care in inpatient environments, such as medical, surgical, or critical care wards. These nurses

are directly involved in patient monitoring, medication administration, and collaboration with the multidisciplinary healthcare team.

6. Nursing and Midwifery Council (NMC)

The Nursing and Midwifery Council (NMC) refers to the statutory regulatory body for nurses and midwives in the United Kingdom. It is responsible for maintaining the register of qualified practitioners and for setting standards for education, training, conduct, and professional performance. This study will include only respondents who are NMC registered.

7. National Health Service (NHS)

The publicly funded healthcare system of the United Kingdom that provides an extensive health services free at the point of use for UK residents. This study focuses on nurses employed within NHS hospitals in England, specifically those working under a specific NHS trust.

8. NHS Trust

A managerial unit within the NHS responsible for the administration of hospitals and healthcare services within a defined geographical area. NHS Trusts operate under the Department of Health and Social Care and are tasked with ensuring the effective delivery of care, workforce management, and adherence to national health policies and initiatives, including AMS programs.

9. Eolas

A knowledge management platform and application tailored for healthcare professionals to optimize access to clinical information, guidelines, and resources. The platform integrates multiple national guidelines, clinical

calculators, patient leaflets, and other critical resources into one comprehensive system.

Statement of Hypotheses

This study posits that nurses with a comprehensive understanding of antimicrobial stewardship (AMS) principles are more likely to hold a positive perceptions of their roles in AMS initiatives and are less likely to encounter significant challenges in carrying out AMS-related responsibilities within hospital settings. Moreover, it is hypothesized that nurses who have participated in structured AMS training, whether through continuing professional development (CPD), in-service education, or formal AMS academic programs will exhibit greater confidence, greater engagement, and a clearer understanding of their roles in AMS activities, relative to those without such educational and training exposure.

It is also hypothesized that professional variables, such as clinical area, highest educational attainment, length of nursing practice, and prior AMS training may significantly influence nurses' levels of AMS-related knowledge, perceptions, and the challenges they face in AMS participation. It is further assumed that nurses with extensive professional experience and higher educational attainment may be more adept to integrate AMS practices more effectively into their daily workflow, due to familiarity with protocols, confidence in interdisciplinary communication, and awareness of antimicrobial resistance trends.

Overall, this study proposes that enhanced AMS knowledge, supported by continuous education, training, and professional experience enhances nurses' perception of their roles and reduces barriers to active participation in antimicrobial stewardship, ultimately contributing to better institutional initiatives.

CHAPTER III

RESEARCH METHODOLOGY

Research Design

The study adopted a mixed-method explanatory sequential design, integrating both quantitative and qualitative approaches to examine nurses' knowledge, perceptions, and challenges related to their roles in antimicrobial stewardship (AMS) within an NHS Trust. Given that knowledge and perception are quantifiable constructs, while challenges are often context-dependent and experiential, a mixed-method approach offers both breadth and depth. The quantitative phase identifies patterns and associations (e.g., between knowledge and perception levels), whereas the qualitative phase explores the underlying reasons behind why such patterns exist (Fetters et al., 2013). Therefore, employing this design strengthens the study's capacity to produce comprehensive insights relevant to nursing practice, institutional policy and educational development.

The first phase involved the collection and analysis of quantitative data through a structured questionnaire distributed to a sample of NMC registered nurses. This phase aimed to measure levels of knowledge, perceptions, and reported challenges, as well as to identify potential relationships between these variables and selected demographic factors (e.g. clinical area, highest educational attainment, length of nursing practice, and previous AMS training).

The second phase comprised qualitative semi-structured interviews with a purposive subset of participants from the first phase. This follow-up phase sought to

explain and contextualize the quantitative findings by providing deeper insights into the factors influencing nurses' engagement in AMS and by uncovering challenges that may not be fully captured through the survey.

Sampling Technique

The study population comprised approximately 1,670 registered inpatient nurses working across all clinical sites within University College London Hospitals NHS Foundation Trust (UCLH) who met the inclusion criteria.

For the quantitative phase, a convenience sampling technique was employed to recruit a sample size of 313 nurses. The sample size was determined using Cochran's equation, calculated through an online calculator with a precision level of $\pm 5\%$, a confidence level of 95%, and estimated proportion of 0.5 for small proportions. Participants were approached within their respective wards or departments and invited to participate upon confirmation that they meet the inclusion criteria and provided consent to participate in the research. This sampling method was selected for its practicality and feasibility within a the context of a busy hospital environment.

For the qualitative phase, a purposeful sampling approach was used to select a subset of survey respondents based on their questionnaire results. Participants were chosen to reflect a range of knowledge levels, perceptions, and reported challenges, enabling the exploration and explanation of key quantitative findings. This approach supports methodological triangulation, enhancing both the depth and validity of the research outcomes. A total of 10 nurses were targeted, with data collection continuing

until data saturation was reached—when no new themes or insights emerged from the interviews.

Inclusion and Exclusion Criteria

Inclusion Criteria:

- Registered Nurses with an active Nursing and Midwifery Council (NMC) registration.
- Nurses directly involved in patient care and medication administration.
- Willingness to participate and provide informed consent.

Exclusion Criteria:

- Nurses in administrative or non-clinical roles.
- Student nurses, pre-registered nurses. or nursing assistants.
- Nurses on leave during the data collection period.

Setting

The study was conducted at the University College London Hospitals NHS Foundation Trust (UCLH), a major academic health science centre located in Central London, United Kingdom. UCLH consists of ten hospital sites that provide a wide range of general and specialist services, including oncology, neurology, infectious diseases, surgery, maternity, emergency medicine, and critical care. The Trust serves a large and diverse patient population.

The study respondents comprised staff nurses working across different hospital sites within UCLH. The trust employs approximately 3,000 NMC registered nurses

representing a highly diverse workforce in terms of nationality, cultural background, clinical specialty, and NHS band levels.

While UCLH has a well-established infrastructure to support antimicrobial stewardship (AMS), including an AMS Committee, dedicated AMS pharmacists, an Infection Prevention and Control (IPC) team, and access to Microbiology and Virology services; it currently does not offer formal AMS training programs specifically for nurses. The Trust also uses Eolas, an internal digital knowledge base platform, to guide the appropriate use of antibiotics for certain infections.

Research Instrument

This study utilised two primary data collection instruments aligned with its explanatory sequential mixed-methods design: a structured questionnaire for the quantitative phase and a semi-structured interview guide for the qualitative phase.

Quantitative Instrument

The study design employed a cross-sectional survey. using a validated questionnaire, informed by the research of Ashiru-Oredope et al. (2022). Permission was obtained from the original authors to use and modify the instrument to align with the present study's objectives. The questionnaire, originally comprising of 43 questions, was refined to suit the research context. It is organized into four sections: professional factors, knowledge, perceptions, and challenges. The questionnaire included multiple-choice questions, true or false statements assessing knowledge, and 5-point Likert Scale statements measuring perceptions and challenges.

Prior to full deployment, a pretest of the research instrument was conducted to ensure the clarity, reliability, and content validity. The pretest involved a small sample of registered nurses (n=10) with similar characteristics to the target population but who were excluded from the final sample. Participants completed the questionnaire and provided feedback on the wording, clarity, and overall structure, which informed subsequent revisions of the tool.

Section One collected demographic information and professional data of the respondents (e.g. age, years of service, and highest educational attainment). Section Two assessed the nurses' knowledge using true or false items, which were further categorized according to Bloom's taxonomy of Cognitive Domains (Adams, 2015). This included three hierarchical levels: knowledge (recall of facts), comprehension (understanding of concepts), and application (practical use of knowledge in clinical contexts). Employing this framework enabled a more distinct analysis of the nurses' cognitive performance, identifying strengths, and areas for improvement in nurses' understanding of AMS.

Section Three and Four explored nurses' perceptions and challenges using 5-point Likert scales (1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly Agree). Additional Likert scales were used to measure familiarity with AMS resources (1=Very familiar; 2=Familiar; 3=Neutral; 4=Unfamiliar; 5=Very unfamiliar) and the likelihood of collaboration with other healthcare professionals for antimicrobial stewardship (1=Very likely; 2=Likely; 3=Somewhat Likely; 4=Unlikely; 5=Very unlikely).

The questionnaires were distributed electronically through a secure digital form.

Qualitative Instrument

Following the quantitative phase, a semi-structured interview guide was developed to explore in depth the themes that emerged from the survey data. The guide included open-ended questions designed to elicit comprehensive insights into nurses' experiences, perceptions, and challenges related to AMS. The questions were organized around three thematic sections consistent with the study's objectives:

1. Personal experiences with antimicrobial stewardship practices;
2. Perceived facilitators and barriers to effective nurse participation in AMS; and
3. Suggestions for training and support to enhance AMS engagement.

The semi-structured format allowed for flexibility for the interviewer to ask follow-up or probing to clarify and expand participant responses. The interview guide underwent expert review to ensure content validity and was refined based feedback and pilot interviews to improve clarity, flow, and relevance to the research aims.

Data Collection Procedure

Step 1: Submit a proposal to the Ethics committee

A form was submitted to University College London (UCL) Research Ethics Committee to inform about the research. Following approval, the Matrons and Managers were informed about the research.

Step 2. Courtesy call to the Matrons and the Ward Managers

The researcher scheduled meetings with the Matrons and Ward Managers. Objectives of the study and research details such as the forms, questionnaire to be

used, the respondents that will be involved and the duration of the research was relayed during the meeting.

Step 3. Assessment of Participant Eligibility

Eligible participants were identified based on the inclusion and exclusion criteria. Those who met the eligibility requirements were invited to participate and provided with a questionnaire. The questionnaire was accompanied by an information sheet containing a brief introduction, the study's objectives, and a consent form indicating their willingness to participate in the study. Additionally, detailed and clear instructions for completing the questionnaire were also provided to the respondents.

Step 4: Quantitative Data Processing

The data gathered were process and analyzed using appropriate statistical methods. Data cleaning and coding were performed prior to analysis to ensure accuracy and reliability.

Step 5: Selection of Interview Participants

Following the quantitative data analysis, a purposive sampling approach was used to identify a diverse subset of survey respondents representing varying levels of AMS knowledge, perceptions, and reported challenges. These participants were invited to take part in the qualitative phase.

Step 6: Scheduling of Interviews

Interviews were scheduled at mutually convenient times to minimize disruptions to clinical duties and responsibilities. Participants were reminded of their right to withdraw at any stage and assured of confidentiality and anonymity.

Step 7: Conduct of Interviews

Semi-structured interviews were conducted in private, quiet, pre-booked meeting rooms within UCLH sites or remotely via secure video calls, with each interview lasting approximately 30-60 minutes. Interviews were audio-recorded with the participant's informed consent.

Step 8: Transcription and Verification

Audio recordings were transcribed verbatim. To enhance accuracy and trustworthiness, participants were given the option to review their transcripts.

Data Analysis

Before the data analysis, the responses were reviewed for accuracy, completeness, and consistency. Incomplete or inconsistent responses were flagged and handled accordingly. Missing data were addressed using imputation methods or excluded from specific analyses, depending on the extent and nature of the missing information.

Quantitative Data Analysis

Descriptive statistics were used to summarize the demographic and professional characteristics of the respondents, as well as their knowledge scores, perception ratings, and reported challenges related to AMS.

Inferential statistics were implied to identify differences and associations among key variables (i.e. knowledge levels, perceptions, and challenges according to clinical area):

- ANOVA test was used to examine differences in knowledge and perception across four different groups, namely, clinical area, highest educational attainment, length of nursing practice, and previous AMS training.
- Kruskal Wallis and Chi-square were applied to identify differences on knowledge and perception across the same variables.
- Simple Linear regression analysis was used to identify associations between knowledge and perception.
- Chi-square test for association were also performed to identify presence of relationship between knowledge and identified challenges encountered in AMS participation.

Qualitative Data Analysis

Interview transcripts from the semi-structured interviews were analyzed using thematic analysis. The process involved familiarization with the data through repeated reading of transcripts; initial coding to identify recurring patterns related to challenges; theme development, grouping similar codes into overarching categories; reviewing and refining themes to ensure coherence and distinctiveness; interpreting findings with illustrative quotes to enhance meaning and context.

Integration of Quantitative and Qualitative Findings

Findings from both data sets were integrated during interpretation phase. The qualitative results were used to explain, elaborate, and contextualize the quantitative results, particularly the findings emerging from the regression models. This triangulation enhanced the validity and richness of the findings, offering a more

comprehensive understanding of the factors influencing nurses' engagement in AMS and informing the development of actionable recommendations for practice and policy.

Interpreting Factors

Interpretation focused on the following:

- **Knowledge:** This was assessed based on participant's correct answers to the true or false statements.
- **Perception:** This was measured using Likert scale items, with higher scores indicating more positive perceptions.
- **Challenges:** This was evaluated using a semi-structured interview which provided qualitative insights into barriers encountered by nurses implementing AMS.

Ethical Considerations

Ethical approval for this study was obtained from the Research Ethics Committee of the local NHS trust. The following ethical principles were upheld:

- **Informed consent:** Participants received an information sheet and consent form detailing the purpose, procedures, potential risks, and their right to withdraw at any time.
- **Confidentiality and Anonymity:** All data were anonymized, stored on password-protected devices accessible only to the researcher. Survey responses and interview transcripts were coded using unique participant identifiers. Direct quotations used in reports were anonymized using

pseudonyms, and any potentially identifying details were removed from transcripts and reports to prevent participant's identities.

- **Voluntary Participation:** Participation in the study was entirely voluntary, and no incentives were provided.
- **Minimizing Harm:** The study posed minimal risk to participants; however, participants were informed that they could skip questions or discontinue participation at any point if they experience discomfort.
- **Respect for Participants:** The participants were treated with dignity and respect throughout the study, with careful attention to cultural, social, and personal contexts.
- **Reflexivity:** The researcher actively reflected on their own positionality, potential biases, and influence on the research process. A reflective journal was maintained throughout the research process to ensure transparency and minimize subjective bias during data collection and analysis.
- **Data Protection:** The study complied with UK General Data Protection Regulation (UK GDPR) and the Data Protection Act 2018.

CHAPTER IV

RESULTS AND DISCUSSIONS

This section presents the data, analysis, interpretation, and discussion of findings collected in the study regarding the knowledge, perceptions, and challenges of nurses in relation to their role in antimicrobial stewardship (AMS).

4.1 Demographic and Professional Characteristics of Participants

Table 4.1 summarizes the demographic and professional characteristics of the nurse respondents. The majority were female (78%), reflecting the gender composition typical of the nursing workforce. The largest proportion of respondents belonged to the 25-34 years age group (44.4%), indicating a relatively young cohort. Most nurses were employed in wards under the specialist hospital board (40.6%), and the bachelor's degree (72.8%) was the common highest educational attainment.

In terms of professional experience, the majority had 11-19 years of clinical practice (46.6%), suggesting that many respondents had achieved a substantial level of professional experience. The most common designation was Band 6 (41.9%), followed by Band 5 (35.1%), representing a group of nurses in more senior or supervisory positions. This differs from the larger UK nursing workforce, where Band 5 remains predominant. Regarding training, the majority of the respondents (89.5%) reported having no formal training in antimicrobial stewardship (AMS), although most (59.4%) indicated having some form of teaching on antibiotics during their education or continuing professional development.

Table 4.1.*Demographic characteristics of respondents (n=313)*

Sex	Frequency (f)	Percentage
Male	69	22.0%
Female	244	78.0%
Age Group	Frequency (f)	Percentage
Under 25	14	4.5%
25-34	139	44.4%
35-44	112	35.8%
45-54	33	10.5%
55-64	12	3.8%
65+	3	1.0%
Clinical Area	Frequency (f)	Percentage
Medicine Hospital Board	89	28.4%
Specialist Hospital Board	127	40.6%
Surgical and Oncology Hospital Board	97	31.0%
Highest Educational Attained	Frequency (f)	Percentage
Diploma	15	4.8%
Bachelor's	228	72.8%
Post-Graduate Diploma	31	9.9%
Master's Degree or Higher	39	12.5%
Years of Nursing Practice	Frequency (f)	Percentage
<1 year	15	4.8%
1-3 years	33	10.5%
4-5 years	17	5.4%
5-10 years	102	32.6%
11-19 years	146	46.6%
Current Band	Frequency (f)	Percentage
Band 5	110	35.1%
Band 6	131	41.9%
Band 7	59	18.8%
Band 8	13	4.2%
Training on AMS	Frequency (f)	Percentage
Yes	33	10.5%
No	280	89.5%
Teaching on antibiotics	Frequency (f)	Percentage
Yes	186	59.4%
No	127	40.6%

The demographic and professional profile of respondents reflects broader global nursing workforce trends, wherein female nurses constitute the majority (WHO, 2025). The predominance of respondents in the 25-34 years of age indicates a relatively young yet experienced workforce. This finding is particularly significant in an international context, as many health systems are grappling with workforce sustainability amid ageing nursing populations and global shortages (Buchan et al., 2022). A younger and professionally established cohort can represent a vital resource for sustaining long-term antimicrobial stewardship (AMS) initiatives.

The predominance of Band 6 nurses suggests that the many participants occupied senior positions with supervisory responsibilities, encompassing both direct patient care and oversight functions such as mentoring and quality assurance. Internationally, such mid-level leadership roles are crucial. The WHO (2019) emphasizes the importance of “nurse champions” who can operationalize AMS principles in daily clinical practice. Studies conducted in both high-income and low- and middle-income countries (LMICs) demonstrate that mid-level nurse leaders are often well-positioned to drive stewardship but are frequently underutilized due to limited training (Charani et al., 2019; Cox et al., 2017).

The finding that most respondents held a bachelor’s degree aligns with the global trend to advance professionalization of nursing through higher education (ICN, 2021). However, the concurrent lack of formal AMS training reflects findings from multi-country surveys that highlight stewardship education as underrepresented in nursing curricula worldwide (Chater et al., 2022). Even in high-income contexts, AMS training for nurses often remains optional or fragmented, while in LMICs, stewardship training for nurses is further constrained by resource limitations (Kpokiri et al., 2020).

Although some respondents reported prior instructions on antibiotics, existing literature indicates partial exposure to pharmacology education does not equate to stewardship competence.

The finding that most respondents possessed 11-19 years of professional experience highlights a mature workforce with considerable clinical expertise. However, as global evidence demonstrates, experience alone does not ensure AMS competence; targeted training and systemic support are essential to translate professional experience into stewardship leadership (Courtenay et al., 2019). In many countries, experienced nurses form the backbone of infection prevention and quality initiatives, but their potential contributions in antimicrobial stewardship (AMS) is often overlooked.

Overall, the demographic profile situates this cohort as a strategically significant segment of the healthcare workforce in an international health context: female-dominated, degree-educated, and mid-level senior nurses with considerable experience but limited formal AMS training. These characteristics reflect both opportunities and challenges seen worldwide. While the capacity of nurses to lead AMS is evident, the lack of structured training and system-level recognition remains a barrier across diverse health systems.

4.2. Knowledge of Nurses on Antimicrobial Stewardship (AMS)

Table 4.2 presents the distribution of nurses' knowledge scores on antimicrobial stewardship (AMS). The data indicate that majority of the participants (f = 278, 88.8%) demonstrated a high level of knowledge (80-100%), while 11.2% (f = 35) achieved a moderate level of knowledge (60-79%). Notably, no participants scored below the 60% threshold, indicating the absence of poor knowledge levels.

Table 4.2.*Nurses' level of knowledge on AMS (n=313)*

Knowledge Level	Frequency	Percentage
80-100% (High)	278	88.8%
60-79% (Medium)	35	11.2%
<60% (Poor)	0	0.0%

The knowledge assessment comprised 12 items categorised according to Bloom's taxonomy of cognitive domains, encompassing knowledge (recall of facts), comprehension (understanding of concepts), and application (practical use of knowledge in clinical contexts). This distribution suggests that most respondents possess a comprehensive and solid understanding of AMS principles, including appropriate antimicrobial use, potential side effects, and infection prevention measures.

However, responses to application-level questions revealed relatively weaker performance. This indicates that, while nurses understand AMS concepts, challenges remain in translating this knowledge into clinical practice, particularly in understanding environmental contributors to antimicrobial resistance (e.g. the impact of wastewater on resistance spread), assessing individual risk and transmission dynamics, identifying whether antibiotics are effective against viral infections such as cold and flu. and determining whether antibiotic-resistant bacteria can spread from person to person.

This pattern is consistent with international research demonstrating that nurses often exhibit strong factual AMS knowledge but limited ability to apply that knowledge in real-world clinical scenarios. Bonacaro et al. (2024) similarly reported that nurses across low- and middle-income countries (LMICs) tend to have theoretically grounded

yet experience-dependent knowledge rather than knowledge acquired through structured education. Courtenay et al. (2024) found that UK nursing students possessed strong conceptual understanding but lacked confidence in applying AMS knowledge during prescribing and infection management discussions. Likewise, Zhao et al. (2023) in China also observed that although most nurses understood basic principles of antibiotic resistance, few were confident in interpreting microbiological data or challenge inappropriate antibiotic use.

In summary, participants displayed strong foundational AMS knowledge but identified the need for further training focusing on key areas (i.e. environmental, epidemiological, and risk-related concepts) essential for effective stewardship in both local and global health systems.

Collectively, these findings underscore that knowledge acquisition alone does not equate to AMS competency. The focus must shift from knowledge recall to knowledge translation – that is, the ability to apply, analyze, and evaluate stewardship principles in clinical decision-making. Consistent with the guidance from the World Health Organization (WHO, 2019) and the International Council of Nurses (ICN, 2021), achieving this transition requires embedding AMS education within both undergraduate curricula and ongoing professional development frameworks.

4.3. Perception of Nurses on Their Role in Antimicrobial Stewardship (AMS)

Table 4.3 presents the perception of nurses toward antimicrobial stewardship (AMS) using a Likert-scale questionnaire. The overall weighted mean was 3.97, corresponding to Agree, indicating that nurses generally held a positive perception of their role in AMS.

The items with the strongest endorsement were “*When giving a patient an antimicrobial, I know why the patient is receiving the medication*” (WM=4.25, Strongly agree) and “*It is my responsibility to contribute to appropriate antimicrobial use at my hospital*” (WM=4.32, strongly agree). These findings highlight that nurses feel confident in their accountability and recognize antimicrobial stewardship as part of their professional responsibilities.

In addition, other items received high levels of agreement, including knowledge of antibiotic resistance (WM=4.17), having a key role in controlling resistance (WM= 4.18), and awareness of connection between their antibiotic administration and the spread of resistant bacteria (WM = 4.00). Confidence in obtaining a urinalysis was also high (WM = 4.01). These results indicate that nurses possess a solid understanding of how their clinical actions influence infection control and resistance management.

Moderate agreement was observed for items relating to knowledge sufficiency (WM = 3.88) and providing education about prudent antibiotic use (WM = 3.58), suggesting areas where further support may be beneficial.

The lowest-rated item was “*I am confident that I know when to recommend conversion of intravenous antibiotics to an oral formulation*” (WM = 3.33, Neutral), reflects some uncertainty in applying stewardship principles to advanced clinical decision-making.

Table 4.3.

Perception of nurses on their role in antimicrobial stewardship

Statement	Weighted Mean	Description
I know what antibiotic resistance is	4.17	Agree
I have a key role in helping control antibiotic resistance	4.18	Agree

I know what information to give to patients about prudent use of antibiotics and antibiotic resistance	3.58	Agree
I know there is a connection between my administering of antibiotics and emergence and spread of antibiotic-resistant bacteria	4.00	Agree
I have sufficient knowledge about how to use antibiotics appropriately for my current practice	3.88	Agree
When giving a patient an antimicrobial, I know why the patient is receiving the medication.	4.25	Strongly Agree
It is my responsibility to contribute to appropriate antimicrobial use at my hospital.	4.32	Strongly Agree
I am confident that I know when to recommend conversion of intravenous antibiotics to an oral formulation.	3.33	Neutral
I am confident that I know when to obtain a urinalysis for a patient.	4.01	Agree
Overall perception	3.97	Agree

Legend:

1.0 - 1.8	Strongly Disagree
1.81 - 2.6	Disagree
2.61 - 3.4	Neutral
3.41 - 4.2	Agree
4.21 - 5.0	Strongly Agree

Overall, these findings indicate that nurse respondents hold a positive overall perception of AMS, recognising both their responsibility and accountability in ensuring the prudent use of antimicrobials. The strongest endorsements – accountability for antimicrobial use and clarity on why a patient is receiving antimicrobial – align with international research highlighting that nurses are strategically positioned in antimicrobial stewardship and act out a strong sense of professional duty (Blackburn et al., 2025; Bonacaro et al., 2024).

The strong agreement with items related to knowledge of antibiotic resistance and its link to nursing practice is encouraging. the World Health Organization (2019) and other bodies have underscored that nurses are uniquely positioned to bridge the gap between antimicrobial policy and bedside practice through patient care, infection surveillance, and education. Agreement across these areas suggests that the nursing workforce studied here aligns with this international direction, perceiving themselves as active contributors rather than passive implementers.

However, the moderate scores on knowledge sufficiency and patient education suggests that, while nurses feel broadly competent, they may lack full confidence in consistently delivering stewardship-related patient information. This mirrors global literature showing that while nurses understand the importance of educating patients on antibiotic resistance, many feel underprepared to communicate effectively with patients due to limited training or lack of access to educational resources (Blackburn et al., 2025; Bonacaro et al., 2024).

The neutrality regarding IV to oral conversion reflects a recognized gap in stewardship practice. International evidence indicates that such clinical decisions are often perceived as physician-led, with nurses less confident in asserting their roles in the process (Charani et al., 2019). This highlights the need for interprofessional education and system-level role clarification to support nurses in confidently engaging in more advanced stewardship tasks.

Overall, the findings underscore that while nurses' perceptions of AMS are broadly positive, their confidence varies across different domains of stewardship practice. In the international health context, these results highlight the importance of strengthening stewardship training to include both foundational principles and

advanced decision-making processes. Such capacity building efforts can empower nurses to contribute more actively across the full spectrum of AMS interventions.

4.4. Challenges of nurses on their role in antimicrobial stewardship

Table 4.4 presents the distribution of challenges encountered by nurses in performing their roles in antimicrobial stewardship (AMS). Among the reported factors, patient-related challenges were the most frequently cited ($f = 383$), followed by systemic barriers ($f = 176$) and professional (nurse-related) factors ($f = 136$).

Table 4.4

Challenges of nurses on their role in antimicrobial stewardship

Challenges	Frequency
Patient-related	383
Professional (nurse-related)	136
Systemic- related	176

The findings reveal that systemic, professional, and patient-related barriers collectively hinder nurses' ability to provide effective antimicrobial stewardship related patient education and support. The most frequently cited challenge, insufficient time, reflects broader workload and staffing pressures in healthcare systems worldwide, particularly within specialist and acute care settings. This finding aligns with international evidence that competing priorities and time constraints as persistent obstacles to integrating AMS activities into daily nursing practice (Charani et al., 2019; Chater et al., 2022).

Language barriers and patient disengagement further complicate communication and patient education. These findings are consistent with studies in multicultural healthcare contexts where linguistic diversity, health literacy gaps, and

cultural beliefs about antibiotics shape the success of stewardship interventions (Whittaker et al., 2019). Additionally, the high proportion of nurses reporting uncertainty about what advice to provide underscores a need for clearer role delineation and structured AMS training. This is consistent with reports that outlines nurses often feel underprepared for patient-facing AMS responsibilities (Bos et al., 2024; Van Gulik et al., 2021; Zhao et al., 2023).

Interestingly, while antimicrobial stewardship (AMS) guidelines were reported as relatively accessible (see section 4.4), the lack of resources and uncertainty surrounding communication strategies point to a translation gap between policy and practice. This gap suggests that existing stewardship frameworks remain predominantly physician-led, with limited adaptation of tools and resources to support nursing-led education.

Patient-related factors such as sedation, cognitive impairment, or critical illness further illustrates that the clinical realities of certain specialities (e.g., intensive care, neonatal care units) where direct patient engagement may be constrained or not be feasible.

Overall, the findings reinforce the qualitative themes of competing priorities, insufficient time, unclear role boundaries, and knowledge gaps. They highlight that, although structural guidelines exist, nurses face multiple intersecting barriers that limit their capacity to operationalize AMS principles through patient engagement. Addressing these challenges requires not only targeted workload and training interventions but also systemic recognition of nurses as integral AMS educators and advocates within global health frameworks.

4.5 Relationship between Respondent Profile and AMS outcomes

Table 4.5 presents the comparison of nurses' knowledge, perception, and challenges related to antimicrobial stewardship (AMS) across the four grouping variables: clinical area, highest educational attainment, length of nursing practice, and previous AMS training. The key findings are:

- Clinical Area: There was a statistically significant difference in knowledge ($F = 6.786$, $p = 0.01$), perception ($F = 3.449$, $p < 0.001$), and challenges ($P\text{-value} = 2.580$, $\text{Chi} = 0.004$) across different clinical areas.
- Highest Educational Attainment: While no significant difference was observed for knowledge ($F = 0.521$, $p = 0.471$, ns) or challenges ($p = 1.1997$, $\text{Chi} = 0.287$, ns), perception varied ($F = 1.962$, $p = 0.043$).
- Length of Nursing Practice: Significant differences were observed in knowledge ($F = 6.979$, $p = 0.009$), perception ($F = 3.665$, $p < 0.001$), and challenges ($p = 2.332$, $\text{Chi} = 0.009$) across different lengths of experience.
- Previous AMS Training: Knowledge did not differ ($F = 0.033$, $p = 0.857$, ns), but differences emerged in perception ($F = 2.521$, $p = 0.008$) and challenges ($p = 2.153$, $\text{Chi} = 0.017$)

Table 4.5.

Relationship between respondent profile and AMS outcomes

Factor	Knowledge		Perception		Challenges	
	F-Statistic	P-Value	F-Statistic	P-Value	P-value	Chi-Square Statistic
Clinical Area	6.786	0.01*	3.449	0.000**	2.580	0.004**
Highest Educational Attainment	0.521	0.471ns	1.962	0.043*	1.1997	.287ns
Length of Nursing Practice	6.9.779	0.009**	3.665	0.000**	2.332	0.009**

Previous AMS training *-significant	0.033	0.857ns	2.521	0.008**	2.153	0.017*
	**-highly significant		ns-not significant			

These findings suggest that clinical experience and practice setting are stronger determinants of AMS engagement than formal educational attainment. Nurses working in high-acuity or specialised areas (e.g., intensive care or infectious disease units) are likely to have greater exposure to AMS activities and multidisciplinary decision-making, which enhances their knowledge and awareness. Similar trends were reported by Courtenay et al. (2024) in the United Kingdom and Danielis et al. (2025) in Italy, where AMS familiarity increased with years of service and clinical exposure rather than with higher academic qualifications.

The lack of significant association between educational attainment and AMS knowledge or perception mirrors international evidence indicating that AMS remains insufficiently integrated into undergraduate nursing curricula (Castro-Sánchez et al., 2019; WHO 2019). Instead, AMS-related competencies are often developed through workplace learning and mentorship (Danielis et al., 2025).

Interestingly, previous AMS training was significantly associated with perceived challenges, implying that trained nurses may possess more awareness of system-level barriers such as workload pressures, hierarchical dynamics, and interprofessional communication gaps – findings echoed in Charani et al. (2019) and Harun et al. (2024).

Overall, these results underscore the importance of contextual, practice-based, and interdisciplinary AMS education that extends beyond theoretical instruction.

Strengthening workplace-based learning, mentorship, and continuous professional development initiatives can better equip nurses to navigate stewardship challenges across diverse clinical settings worldwide.

4.6. Association between Nurses' Knowledge of AMS Role Perception and Challenges

A simple linear regression was conducted to examine the association between nurses' knowledge of antimicrobial stewardship (AMS) and their perception of their role in AMS. The model revealed statistically significant relationship, with perception ($B = -0.297$, $p = .000$) showing a strong negative association between knowledge and perception.

The negative coefficient for perception suggests that nurses with higher AMS knowledge levels were less likely to report positive perceptions of their role in AMS, possibly reflecting a critical awareness of systemic and professional limitations.

Table 4.6.

Association of knowledge of nurses on their AMS role perception

	B	Sig.
Perception	-1.55	.000**

In contrast, the non-significant association between knowledge and challenges ($\chi^2 = 0.710$, $p > 0.05$) indicates that stewardship barriers are largely systemic rather than individual. Nurses encounter similar difficulties such as high workload, limited time for patient education, and lack of interprofessional inclusion irrespective of their AMS knowledge level.

Table 4.7.

Association of knowledge of nurses on their challenges

	Chi-square	Sig.
Challenges	.710	.399

These findings highlight a complex relationship between AMS knowledge, role perception, and challenges. The inverse relationship between knowledge and perception implies that as nurses gain deeper understanding of AMS, they may become more cognizant of the gaps in role clarity, hierarchy, and empowerment within healthcare systems. This pattern mirrors findings from Charani et al. (2019) and Castro-Sánchez et al. (2019), which reported that knowledgeable nurses often recognize the limits of their authority in AMS decision-making.

Meanwhile, the positive association between knowledge and perceived challenges underscores how enhanced understanding exposes structural barriers such as workload pressures, workplace culture, and inadequate institutional support – themes that also emerged in the qualitative phase of this study. This aligns with international literature from WHO (2019) and ICN (2021), which emphasises that even well-informed nurses struggle to enact stewardship principles when systems lack supportive frameworks.

Overall, the results suggest that knowledge alone is insufficient to empower nurses in their AMS role. Effective stewardship requires not only educational interventions but also organizational strategies that address hierarchical, cultural, and resource-based challenges nurses' encounter. Programs that integrate training with empowerment mechanisms, such as interprofessional AMS rounds, nurse-led audit and feedback systems, and protected learning time, have shown success in strengthening nursing engagement in stewardship initiatives (Filipe et al., 2025).

Qualitative Phase

The qualitative phase of this study explored challenges nurses face in fulfilling their role in antimicrobial stewardship (AMS). Thematic analysis of interview data revealed six overarching themes: fragmented and experience-driven knowledge, limited role perception, competing priorities, hierarchy and confidence, patient education, and training and empowerment. These themes not only illuminate the survey findings but also resonate with international evidence on nurses' role in AMS.

Theme 1: Fragmented and experience-Driven Knowledge of AMS

Nurses described their knowledge of AMS as fragmented, often shaped by workplace experience rather than formal education. Some admitted to having very limited understanding with one stating:

"I have no knowledge.... I just give medication based on prescription."

Others associated antibiotics only with severe condition such as sepsis:

"Antibiotics is for sepsis."

Several participants noted that their understanding only developed once they entered clinical practice, as AMS was not a prominent part of their undergraduate curriculum:

"Maybe it was mentioned briefly during uni (university), but there's no specific focus on it... it's only when I was working in the clinical area that I heard about resistance."

These findings align with the survey results, which revealed moderate but inconsistent levels of AMS knowledge across participants. Similar gaps have been identified internationally. For instance, Danielis et al. (2025) found that nurses in Italy often possessed superficial AMS knowledge, highly dependent on local exposure. In low- and middle- income countries (LMICs), the lack of structured AMS education leaves nurses underprepared (WHO, 2019). This global picture suggests that fragmented knowledge is not unique to the United Kingdom but a widespread issue affecting nursing workforce's capacity in contributing to AMS.

Theme 2: Limited Role Perception – guardians of Administration, Not Stewards

Participants largely viewed their AMS responsibilities as limited to medication administration and record-keeping, rather than active involvement in stewardship. For example:

“Part of my role is to look at what’s the indication... if unclear, I escalate it to the nurse in charge... but not the doctors.”

Another expressed reluctance to challenge medical decisions:

“I wouldn’t question a Meropenem prescription... I trust the doctors on that.”

However, some participants described contexts where stewardship had been embedded in practice, empowering them to contribute more actively:

“In my previous team, it was drilled into us – you had to know why the antibiotics was prescribed and you could question it. That made us more accountable.”

This reflects the prevailing perception of antimicrobial stewardship as primarily belonging to the prescribers, with nurses positioned mainly as guardians of medication administration unless organizational culture explicitly empowers broader engagement. Similar findings have been reported across Europe, Asia, and Africa, where nurses frequently identify their primary contribution to AMS as ensuring timely and correct administration of antibiotics (Broom et al., 2016; Carter et al, 2018; Chater et al., 2022).

Internationally, the International Council of Nurses (2021) has emphasized that such a narrow perception underutilizes nursing potential in AMS. Emerging evidence in countries such as Sweden and the Netherlands demonstrates that nurse-led stewardship initiatives can significantly expand nurses' roles beyond administration that in turn can strengthen AMS outcomes (Michalsen et al., 2023; Van Buul et al., 2019). The persistence of limited role perception observed in this study highlights the need for both cultural and structural shifts to enable nurses' active participation in AMS globally.

Theme 3: Competing Priorities and Workload Pressures

Several nurses noted that while AMS is important, it competes with heavy clinical workloads and patient safety demands. Stewardship activities were often deprioritized due to staffing pressures or the perception that AMS is “extra” rather than integral component of nursing care:

One nurse estimated their involvement as:

“60-40 – 60% engaged but 40% lost to competing demands. There’s just so many priorities for nurses.”

Another nurse reflected that, on larger wards, AMS was sidelined in favour of immediate clinical tasks:

“It becomes a culture of just get through the shift.”

This extended to patient education, when one nurse admitted:

“Depending on your capacity... if you have a lot of patients then obviously you won't be able to deliver (antibiotic education).”

This theme echoes global evidence: studies in the United States, South Africa, and China have found that competing demands and workforce shortages limit nurses' ability to engage fully in stewardship (Monsees et al., 2020; Abahamye et al., 2016; Zhao et al., 2023). WHO (2019) and Harun et al., (2024) also highlight that workforce pressures are a critical barrier to AMS implementation worldwide, particularly in LMICs where staffing levels are stretched. These parallels emphasize that competing priorities represents a global challenge in embedding AMS into routine nursing practice.

Theme 4: Confidence, hierarchy and team culture

Nurses reported feeling constrained by professional hierarchies, which undermined their confidence to question prescribing decisions. As one explained:

“Maybe you are questioning their decision-making... so I discuss it first with someone more experienced.”

One nurse noted that empowerment to act was linked to seniority:

“When I was Band 5, I had less voice... at senior level, you are more empowered.”

Even when potentially useful initiatives such as microbiology “micro rounds” were available, nurses reported feeling excluded:

“Micro rounds help... but we are not empowered to join.”

Newly qualified nurses were seen to struggle the most, lacking the confidence and knowledge to assess appropriateness:

“Newly qualified nurses don’t yet have the confidence... they do reading out of hours just try to understand AMS.”

These findings reinforce the survey results, which showed only a weak correlation between familiarity with AMS and likelihood to intervene. This underscores that knowledge alone is insufficient; empowerment and cultural change are also required.

Hierarchical barriers to interprofessional collaboration are well documented globally. In Ethiopia and other LMICs, for example, Gebretekle et al. (2018) and Harun et al. (2024) described how nurses felt unable to challenge prescribing decisions, while Charani et al. (2019) have identified that this factor can flatter team structures and enable more effective stewardship contributions. This suggests that while hierarchy is

a near-universal issue, its severity varies by culture and health system, with important implications for AMS engagement.

Theme 5: Patient Education – Confidence in Basics, Limited Beyond

Nurses expressed confidence in delivering basic patient education, such as explaining when and how to take antibiotics. However, many lacked confidence in providing more detailed guidance, particularly on safe practices such as avoiding the sharing of antibiotics and completing the full course of treatment:

“I have noticed some of the nurses I managed are not confident enough in giving detailed instructions on how to take medications, avoid sharing antibiotics and following proper course.”

Others described deferring to doctors and pharmacists when patients asked complex questions:

“If the patient has more in-depth questions... I escalate it to the doctors or pharmacists.”

Participants suggested that accessible educational tools could improve consistency:

“Educational materials... maybe an app, something mobile accessible.”

This reflects international findings: in the United States and Norway, nurses have reported similar limitations in providing detailed antibiotic education (Carter et al., 2018; Hansen et al., 2023). In LMICs, insufficient patient education has been

identified as a key driver of inappropriate antibiotic use, as patients often self-medicate or share medications (Kpokiri et al., 2020). Globally, strengthening nurses' role in patient education is recognized as vital to reducing inappropriate antimicrobial use.

Theme 6: Training and Empowerment

All participants emphasized the lack of formal AMS training, noting that most knowledge was gained informally on the job:

“Training-wise, definitely not enough training for nurses.”

They also highlighted challenges related to unclear role expectations and the lack of protected learning time:

“It’s the limited understanding, the clarity of your role... and whether we have protected time to learn about this.”

This theme strongly supports quantitative finding that knowledge significantly correlates with perception. Internationally, gaps in AMS education have been identified across multiple contexts, including the United States, Europe, and LMICs (Filipe et al., 2025; Harun et al., 2024; WHO 2019). The WHO's Global Action Plan (2015) calls for strengthening AMS training for all healthcare professionals, while the ICN (2021) highlights nursing education as a priority area. Countries that have embedded AMS into nursing curricula, such as the Netherlands, report greater confidence and engagement among nurses (Bos et al., 2024).

Synthesis of Qualitative Findings

The qualitative findings show that nurses' knowledge of AMS is fragmented, their role perception narrow, and their confidence limited by hierarchy, workload, and lack of structured training. These findings echo global evidence showing that nurses across diverse contexts face similar challenges in contributing fully to AMS (Castro-Sánchez et al., 2016; Charani et al., 2019; WHO 2019). The study highlights not only local barriers but also broader systemic and cultural patterns that shape nursing engagement in antimicrobial stewardship (AMS) internationally.

Integration of Quantitative and Qualitative Findings

This mixed-methods study combined survey data with thematic insights from interviews to provide a comprehensive understanding of nurses' knowledge, perceptions, and challenges regarding their role in antimicrobial stewardship. The integration of findings reveals how the qualitative themes not only contextualize but also explain the patterns identified in the quantitative phase.

Knowledge

Quantitative results showed that nurses' AMS knowledge was good overall, with significant associations between knowledge and perception ($r = .273$, $p = .000$), and between knowledge and familiarity with resources ($r = -.193$, $p = .001$). Knowledge was also significantly associated with likelihood of collaborating with other members of the multidisciplinary team ($r = -.138$, $p = .015$). These associations, although weak, suggest that knowledge plays a central role in shaping nurses' engagement in AMS.

Qualitative findings provided depth to this observation. Nurses described their knowledge as fragmented and experience-driven, often gained informally in practice rather than through structured education. Participants admitted to limited understanding, reflecting the survey finding of inconsistency in knowledge levels. This convergence indicates that while knowledge influences perceptions, its variability across individuals stems from lack of standardized training. International studies similarly report that fragmented knowledge is a widespread phenomenon (Charani et al., 2019; Chater et al., 2022).

Perception

Survey results showed a positive correlation between knowledge and perception, suggesting that greater knowledge leads to more favorable views of AMS. Interviews reinforced this finding wherein some nurses reported that where stewardship was embedded into team culture, they perceived AMS as a shared responsibility, which empowered them to question prescriptions and contribute actively.

Conversely, the theme of limited role perception highlighted that many nurses still see stewardship as belonging to prescribers, with their role confined to antibiotic administration. This helps explain the variability in perception scores across the sample. International literature also reports that unless explicitly empowered, nurses perceive their role in AMS narrowly (Charani et al., 2019; Filipe et al., 2025; Lalithabai et al., 2022).

Challenges

Quantitative analysis revealed no significant association between knowledge and challenges ($p = .220$). This suggests that barriers to AMS participation are not resolved by increasing knowledge alone. The qualitative phase substantiated this, highlighting themes of competing priorities, workload pressures, and hierarchical constraints as key obstacles. Nurses consistently reported that stewardship tasks were deprioritized amidst heavy workloads and that hierarchical team structures reduced confidence to intervene.

These challenges are echoed in international studies, which identify workforce shortages and professional hierarchies as persistent barriers across both high-income and LMIC contexts (Charani et al 2019; Monsees et al., 2020; WHO 2019). The integration demonstrates that challenges are largely systemic and cultural rather than individual.

Synthesis

Taken together, the quantitative and qualitative findings demonstrate that while knowledge is central in shaping perceptions, it is insufficient on its own to overcome barriers to AMS participation. Nurses' engagement is constrained by workload pressures, hierarchical dynamics, and limited role empowerment. The weak associations with familiarity with resources and likelihood to collaborate suggest that knowledge does not automatically translate into effective teamwork or confidence in applying AMS principles. Instead, structured training, cultural, shifts and systemic support are required to enable nurses to fully enact their stewardship roles.

This integrated perspective aligns with international evidence indicating that AMS engagement is influenced not only by what nurses know but also by how health systems empower them to act (Castro-Sánchez et al., 2019; ICN 2021; WHO 2019).

Strengthening AMS education, promoting peer-led teaching models, and addressing systemic barriers are essential strategies to bridge the gap between knowledge and practice.

Table 4.8.

Integration of Quantitative and Qualitative Findings

Quantitative Findings	Qualitative Themes	Excerpts from Interviews	Integrated Interpretation (Meta-Inference)	Supporting References
Most nurses demonstrated high AMS knowledge (88.8%), though gaps emerged in application-level items such as environmental contributors and IV–oral conversion. Nurses reported a positive perception of their AMS role (WM = 3.97, Agree), yet less confidence in advanced tasks like IV–oral conversion (WM = 3.33).	Theme 1: Fragmented and experience-driven knowledge	"Maybe it was mentioned briefly during uni... it's only when I was working in the clinical area that I heard about resistance."	Quantitative data show high conceptual knowledge, but qualitative accounts reveal that understanding is often experiential rather than structured. This convergence indicates that knowledge is strong but inconsistently formalised, underscoring the need for curriculum-based AMS education.	Bonacaro et al. (2024); Danielis et al. (2025); WHO (2019)
Knowledge negatively predicted perception ($B = -1.55$, $p = .000$), indicating that higher knowledge corresponded to more critical perceptions of AMS roles.	Theme 2: Limited role perception – guardians of administration, not stewards	"I wouldn't question a Meropenem prescription... I trust the doctors on that."	While nurses perceive AMS as part of their role, qualitative findings reveal this perception is largely confined to medicine administration. This divergence suggests that positive attitudes coexist with restricted role conceptualisation, shaped by hierarchical structures.	Charani et al. (2019); ICN (2021); Van Buul et al. (2019)
Knowledge showed no significant association with challenges ($\chi^2 = 0.710$, $p = .399$), suggesting challenges are systemic rather than individual.	Theme 3: Competing priorities and workload pressures	"When I was Band 5, I had less voice... at senior level, you are more empowered."	The inverse relationship between knowledge and perception reflects increased critical awareness among knowledgeable nurses of hierarchical and cultural barriers limiting AMS engagement.	Charani et al. (2019); Castro-Sánchez et al. (2019)
Main challenges identified: patient-related ($f = 383$), systemic ($f = 176$), and professional ($f = 136$).	Theme 4: Confidence, hierarchy and team culture	"Depending on your capacity... if you have a lot of patients, then obviously you won't be able to deliver antibiotic education."	The quantitative non-significance aligns with qualitative evidence that challenges stem from workload and systemic constraints rather than individual deficits. Integration reveals that addressing AMS challenges requires organisational—not merely educational—interventions.	WHO (2019); Harun et al. (2024)
Nurses with prior AMS training reported greater awareness of challenges ($p = .017$), suggesting training enhances recognition of barriers.	Theme 5: Patient education – confidence in basics, limited beyond	"If the patient has more in-depth questions... I escalate it to the doctors or pharmacists."	Quantitative data identify patient-related barriers as most frequent; qualitative insights contextualise this as limited confidence in providing comprehensive antibiotic education. Integration shows a need for training and accessible patient education tools.	Carter et al. (2018); Hansen et al. (2023); Kpokiri et al. (2020)
	Theme 6: Training and empowerment	"Training-wise, definitely not enough training for nurses."	Integration reveals that AMS training improves awareness but also exposes systemic gaps, reinforcing the need for structured, ongoing education and institutional empowerment initiatives.	Filipe et al. (2025); WHO (2019); ICN (2021)

CHAPTER V

CONCLUSION AND RECOMMENDATIONS

Conclusions

This study examined the knowledge, perceptions, and challenges of nurses in relation to their role in antimicrobial stewardship (AMS), using a mixed-methods explanatory sequential design. The findings highlight both the opportunities and constraints shaping nursing contributions to AMS.

- **Knowledge is necessary but not sufficient.** While nurses demonstrated good knowledge of AMS principles and expressed positive perceptions of their responsibilities, this did not consistently translate into greater familiarity with resources or stronger collaboration with multidisciplinary teams. Knowledge alone does not guarantee empowerment or behavioral change.
- **Nurses' roles remain constrained by perception and culture.** Many nurses primarily identified their stewardship contribution as ensuring the correct administration of antibiotics rather than actively shaping prescribing decisions. This limited role perception is reinforced by hierarchical team structures and traditional professional boundaries.
- **Structural barriers outweigh individual motivation.** Heavy workloads, competing clinical priorities, and lack of protected learning time consistently limited nurses' ability to engage in AMS. Even when knowledge and motivation were present, systemic constraints restricted stewardship practice and participation in decision-making.

- **Training and empowerment are global gaps.** Both United Kingdom and international evidence indicate that nurses' AMS knowledge is fragmented and often acquired informally through workplace experience. Formal education on AMS remains inconsistent worldwide, with similar deficiencies reported across Europe, Africa, Asia, and the Americas (Harun et al., 2024).
- **Cultural and organisational change is key.** The weak or negative correlations between knowledge, familiarity, and likelihood of collaboration highlight that stewardship is shaped as much by context and culture as by individual competence. Empowerment, interprofessional trust, and supportive structures are essential to realizing nurses' stewardship potential.

Overall, nurses are essential yet underutilized actors in antimicrobial stewardship. This study highlights that improving knowledge is important but insufficient; the greater challenge lies in addressing cultural, structural, and policy barriers that limit nurses' capacity to act. This echoes global reality: without systemic reform and genuine interprofessional inclusion, nursing potential in AMS will remain underrealized, undermining the goals of the WHO Global Action Plan on Antimicrobial Resistance.

Recommendations

Education and Training

- ***Curriculum integration:*** Embed AMS content into undergraduate and postgraduate nursing curricula globally, aligning with WHO (2015) recommendations.

- ***Continuous professional development:*** Provide structured, practice-based AMS training through e-learning and simulation, with protected time for learning.
- ***Peer- and nurse-led teaching models:*** Utilize nurse educators and peer mentors to reinforce AMS knowledge and familiarity, supporting sustainable AMS capacity.

Role Expansion and Empowerment

- ***Broaden stewardship roles:*** Position nurses not only as administrators but as active stewards involved in monitoring, escalation, and patient education (ICN, 2021).
- ***Nurse-led AMS initiatives:*** Scale up successful models from countries such as the Netherlands and Scotland, where nurses lead audits, education, and feedback.
- ***Clear escalation protocols:*** Formalize nurses' authority to question prescriptions, ensuring that hierarchical barriers does not silence stewardship input.

Organizational and Cultural Reform

- ***Foster inclusive team cultures:*** Promote flat, collaborative structures where nurses' voices are valued and their contributions to prescribing decisions are respected (Charani et al, 2021).
- ***Integrate AMS into workload planning:*** Recognize stewardship as core clinical work rather an "add-on" by incorporating it into staffing models and quality assurance frameworks.

- **Interprofessional AMS rounds:** Routinely include nurses in microbiology, infection control, and prescribing discussions to strengthen multidisciplinary collaboration.

Patient Education and Public Engagement

- **Accessible resources:** Develop multilingual, user-friendly tools (i.e. leaflets, apps, and visual aids) to support consistent patient education.
- **Advance nurses' teaching role:** Train nurses to deliver more complex education on antimicrobial resistance (AMR), reducing overreliance on doctors and pharmacists.
- **Global campaigns:** Align nursing patient education with WHO's public engagement strategies to tackle inappropriate antibiotic use worldwide.

Policy and Research

- **Policy recognition:** Advocate at national and international frameworks that formally embed nursing roles in AMS policies and implementation strategies.
- **Cross-country research:** Conduct comparative studies across high-, middle-, and low-income countries (LMICs) to identify transferable models of nurse-led AMS.
- **Impact evaluation:** Measure the outcomes of nurse-led AMS interventions on prescribing behavior, resistance rates, and patient safety.

Antimicrobial stewardship is a global health priority, and nurses represent an underutilized resource yet crucial in its implementation. This study underscores that while nurses' willingness and potential are evident, without systemic reform – through education, empowerment, cultural change, and policy support – their contribution will

remain limited. Bridging this gap is not only a concern in the UK but a global imperative. Strengthening the nursing role in AMS will enable health systems worldwide to take a decisive step toward preserving the effectiveness of antibiotics for future generations.

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APPENDIX

APPENDIX A

Research Questionnaire

Information Sheet for Respondents

Title of the Research: Antimicrobial Stewardship Through the Nurses' Lens: Knowledge, Perceptions and Challenges

Introduction: You are invited to participate in a research study conducted by **Jeribelle Barcelona**, an **Infection Prevention and Control Clinical Nurse Specialist** at **University College London Hospitals NHS Foundation Trust**. This study is being conducted as part of the requirements for completion of the researcher's master's degree. The purpose of this study is to explore the knowledge, perceptions and the challenges faced by nurses in their role in antimicrobial stewardship.

Objective of the study: The primary objective of this study is to assess the level of knowledge, perceptions and challenges that nurses encounter in their antimicrobial stewardship responsibilities. This information will contribute to understanding how nurses can be better supported in this critical role.

Procedures: If you agree to participate, you will be asked to complete a questionnaire. The questionnaire will be distributed electronically, and you will be provided with an electronic device to complete it. The questionnaire will include sections on professional factors, knowledge assessment, perceptions and challenges.

Informed Consent: By participating in this study, you are providing your informed consent. Your participation is voluntary, and you may withdraw anytime without any consequences. Your response will be kept confidential and used solely for research purposes.

Instructions:

1. **Read the Information Sheet:** Please read this information sheet carefully before proceeding.
2. **Complete the Questionnaire:** Follow the instructions provided to complete the questionnaire. Ensure that you answer all questions to the best of your ability.
3. **Submit your Responses:** Once you have completed the questionnaire, submit your responses electronically.

Confidentiality: All information collected in this study will be kept confidential. Data will be stored securely and only accessible to the researcher. Your identity will not be disclosed in any reports or publications resulting from this study.

Contact Information: If you have any questions or concerns about the study, please contact Jeribelle Barcelona on jeribelle.barcelona1@nhs.net.

Consent: By clicking “Agree” below, you acknowledge that you have read and understood the information provided and consent to participate in this study.

Demographic and Professional Data

These questions are important for us to understand the results provided. Please choose from the options provided.

Name (optional):	
Gender:	• Male • Female • I prefer not to say
Age:	• Under 25 • 25-34 • 35-44 • 45-54 • 55-64 • 65+
From which country did you obtain your Nursing degree?	
Which area do you currently work in	• Neurosurgery • Neurology ◦ Please specify name of the Ward
Please indicate your highest degree	• Diploma • Associates • Bachelors • Post-graduate diploma • Masters or higher
How many years have you practiced nursing (post-completion of the degree listed in question 3)?	• <1 year • 1-3 years • 4-5 years • 5-10 years • 10-19 years
What is your current Band?	Band 5-8
Have you had any AMS specific training previously?	• Yes • No
Have you had any teaching about antibiotic treatment and prudent antibiotic use during your undergraduate or post graduate degree?	• Yes • No

Knowledge: Please answer whether you believe these statements are true or false.

	T	F
Antibiotics are effective against viruses		
Antibiotics are effective against cold and flu		
Unnecessary use of antibiotics make them become ineffective		
Taking antibiotics has associated side effects or risks such as diarrhoea, colitis, allergies and can harm patients		
Every person treated with antibiotics is at an increased risk of antibiotic resistant infection		
Antibiotic resistant bacteria can spread from person to person		
Healthy people can carry antibiotic resistant bacteria		
Infection prevention and control practices can reduce the risk of antibiotic resistance		
I can list the WHO's five moments of hand hygiene		
I need to perform hand hygiene (as often as recommended) if I have used gloves in contact with patients or biological material		
Environmental factors such as waste water in the environment		
Excessive use of antibiotics in livestock and food production		

Perception: To what extent do you agree or disagree with the following statements?

1=Strongly Disagree; 2=Disagree; 3=Neutral; 4=Agree; 5=Strongly Agree

	1	2	3	4	5
I know what antibiotic resistance is					
I have a key role in helping control antibiotic resistance					
I know what information to give to patients about prudent use of antibiotics and antibiotic resistance					
I know there is a connection between my administering of antibiotics and emergence and spread of antibiotic-resistant bacteria					
I have sufficient knowledge about how to use antibiotics appropriately for my current practice					
When giving a patient an antimicrobial, I know why the patient is receiving the medication.					
It is my responsibility to contribute to appropriate antimicrobial use at my hospital.					
I am confident that I know when to recommend conversion of intravenous antibiotics to an oral formulation.					
I am confident that I know when to obtain a urinalysis for a patient.					

Challenges: To what extent do you agree or disagree with the following statements?

1=Strongly Disagree; 2=Disagree; 3=Neutral; 4=Agree; 5=Strongly Agree

	1	2	3	4	5
I have easy access to guidelines I need on managing infections					
I have easy access to the materials I need to give advice on prudent antibiotic use and antibiotic resistance					
I have good opportunities to provide advice on prudent antibiotic use to patients					

If you were not able to give out advice or resources as frequently as you administered antibiotics, why was this? Select all that apply

- Patient does not require information
- Patient uninterested in information
- Insufficient time
- Difficulty getting patient to understand diagnosis
- Language barriers
- No resources available
- I was not sure what advice to provide
- I was able to give out advice or resources as needed
- Not applicable
- Other, please specify

In the administering antibiotics and sending appropriate samples, how familiar are you with the following resources:

1=Very familiar; 2=Familiar; 3=Neutral; 4=Unfamiliar; 5=Very unfamiliar

	1	2	3	4	5
Eolas					
BNF					
NICE guidelines					

How likely are you to rely on the following sources of information about your patient's antibiotic treatment?

1=Very likely; 2=Likely; 3=Somewhat Likely; 4=Unlikely; 5=Very unlikely

Statement	1	2	3	4	5
Doctors					
Microbiologists					

Pharmacists					
Infection prevention					
Colleague					

Which of the following methods of teaching or training would be useful to teach you about AMS?

- Lectures (with >15 people)
- Small Group teaching (with <15 people)
- Discussion of clinical cases and vignettes
- Active learning assignments (e.g. article reading, group work, preparing an oral presentation)
- E-learning
- Peer or near peer teaching (i.e. teaching led by other nurses)

Appendix B

Interview Guide for Qualitative Phase

Part A: Perceptions of AMS and Role

1. How do you perceive your role in AMS?
2. Do you believe nurses should play a more active role in AMS? Why or why not?
3. How valued do you feel your input is within the multidisciplinary AMS team?
4. In your opinion, what makes a nurse's role in AMS effective?
5. Have your perceptions of AMS changed throughout your nursing career?

Part B: Challenges in AMS practice

1. What specific challenges do you face in fulfilling your role in AMS?
2. Do you feel confident in questioning or discussing antimicrobial prescriptions? Why or why not?
3. Are there cultural or organisational barriers that prevent nurses from fully engaging in AMS?
4. Can you describe a situation where you wanted to contribute to AMS but couldn't? What held you back?
5. How would you describe collaboration between nurses and other AMS stakeholders (eg. Doctors, pharmacists)?
6. Are you aware of the Eolas, BNF and other available resources to help you determine appropriateness of prescription? Are you confident in using them? Why or why not?

Part C: Training and support

1. Have you received any informal or formal training on AMS?
2. What additional training or support do you think would improve your involvement in AMS?
3. Do you have suggestions of how nurses can be better prepared or supported in contributing to AMS?