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Enhancing Nursing Competencies in Antimicrobial and Diagnostic Stewardship through Continuing Education

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ABSTRACT

Background: Antimicrobial resistance (AMR) is a global health threat, and nurses play a critical role in antimicrobial stewardship (AMS) and diagnostic stewardship. However, gaps in knowledge and practice persist.

Aim: To evaluate the effectiveness of a structured continuing education program in improving nurses' competencies in AMS and diagnostic stewardship.

Methods: A quasi-experimental pre-post study was conducted among 252 nurses across India. Participants completed a 25-item pre-test, attended a three-hour interactive online training, and then completed a post-test. The program emphasized integrated stewardship, including culture collection before antimicrobials, monitoring therapy duration, catheter removal, accurate drug reconstitution, and microbiological diagnostic test sample collection best practices.

Results: Mean scores improved significantly from 11.2 to 17.0 out of 25 ($p < 0.001$). Domain-wise analysis showed substantial gains in specimen collection (e.g., urine culture indications improved from 25% to 75%), blood culture practices, and specimen handling. Knowledge of pharmacokinetic and pharmacodynamic principles improved significantly, with correct dosing for major antibiotic classes from 32% to 68% and accurate IV reconstitution increasing from 35% to 68%. AMS domain scores increased from 42% to 58%, reflecting better understanding of culture-before-antibiotic principles, therapy de-escalation, and adverse effect recognition. However, surgical site infection (SSI) prevention showed mixed outcomes, with declines in postoperative antibiotic continuation (59% to 41%) and wound handling (61% to 39%), indicating persistent misconceptions requiring targeted reinforcement.

Conclusion: Structured education enhances nurses' AMS and diagnostic stewardship knowledge, but single-session interventions are insufficient for lasting change. Future programs should include regular refreshers, case-based learning, and audit-feedback to sustain improvements and integrate stewardship into routine nursing workflows.

Introduction

Antimicrobial resistance (AMR) continues to rise at an alarming pace, posing one of the most significant threats to global health. Nurses, as frontline providers, play a pivotal role in antimicrobial stewardship (AMS) by administering antimicrobial agents (AMA), monitoring patient responses, and educating families [1]. Their responsibilities extend beyond antimicrobial administration to include critical stewardship functions such as obtaining cultures before the first dose of antimicrobials, monitoring therapy duration to prevent unnecessary exposure, and advocating for timely removal of invasive devices like catheters to reduce infection risk [2-5]. These actions directly influence patient safety and AMR patterns.

Nurses also ensure accurate reconstitution of antimicrobials, adherence to manufacturer instructions, and correct administration techniques, including loading doses, extended infusions, and adjusting dosing frequency based on renal and hepatic function [6,7]. Accurate reconstitution is important because improper dilution or mixing can compromise drug stability, reduce therapeutic efficacy, and increase the risk of adverse effects or treatment failure. These pharmacokinetic and pharmacodynamic considerations are essential for optimizing therapeutic efficacy and minimizing toxicity [8]. Nurses must also adapt dosing schedules according to renal function changes and utilize point-of-care equations for creatinine clearance [9].

Beyond antimicrobial administration, nurses have an emerging role in diagnostic stewardship, a critical complement to AMS. Nurses with knowledge of diagnostic stewardship principles can select appropriate diagnostic tests, ensure correct specimen collection and handling, interpret preliminary results, and promptly communicate critical alerts to clinicians. This proactive involvement enables timely and accurate clinical decisions, reducing unnecessary antibiotic exposure and improving patient outcomes [10-12]. Gupta et al. (2025) demonstrated that targeted diagnostic stewardship training for nurses significantly improved adherence to best practices in specimen collection, timely reporting, and interpretation of diagnostic alerts [13]. Their study reported a marked reduction in scores for inappropriate cultures and improved turnaround times for critical results, reinforcing the value of nurse-led diagnostic stewardship initiatives in combating AMR [14]. Effective diagnostic stewardship requires collaboration and communication among healthcare professionals, and empowering nurses through ongoing education enhances clinical judgment, supports interprofessional collaboration, and ultimately improves patient care. Recent evidence underscores this impact.

Despite this central responsibility, many nurses report gaps in AMS knowledge, confidence, and practical application. Traditional training often emphasizes theoretical principles; however, translating these principles into everyday clinical decision-making remains challenging in busy, high-pressure healthcare environments [8]. Continuing education aims to bridge this gap. A comprehensive, structured, and evidence-based in-service AMS training not only strengthens nurses' understanding of AMA use but also equips them with the skills needed to implement stewardship practices reliably and safely [15].

A systematic review by Bos et al. & Mittal et al (2023) found that bedside nurses already lead in specimen collection, drug management, monitoring, prompting review, and patient education, making them essential stewards in everyday practice [16-17]. Similarly, Monsees et al. (2019) provided guidance to better integrate nurses into stewardship highlighting allergy history documentation, time-outs, and optimal administration [18].

Integrated stewardship i.e., combining diagnostic and antimicrobial stewardship, is essential to optimize antimicrobial therapy. The current program was designed using insights from studies,

reinforcing both diagnostic accuracy and antimicrobial optimization, thereby strengthening nurses' influence across the care continuum [13-16].

This study aimed to evaluate the effectiveness of a structured continuing education program in improving nurses' competencies in antimicrobial and diagnostic stewardship by translating theoretical knowledge into clinical practice. The objectives were to identify baseline gaps in AMS and diagnostic stewardship knowledge, implement an integrated training program on antimicrobial stewardship strategies for nursing practice.

Methods:

Study Design: A quasi-experimental pre-post study was conducted to evaluate the impact of educational intervention on the knowledge and practices of nurses in India regarding antimicrobial stewardship. Participants were invited to join the program through email and social media channels.

An online questionnaire consisting of 25 multiple choice case scenario-based questions was designed and pilot tested to ensure its validity and reliability. This testing phase involved assessing the questionnaire's clarity, relevance, and appropriateness in measuring the desired outcomes. Necessary modifications or adjustments after testing were made to the questionnaire to improve its effectiveness accordingly.

The training sessions encompassed several key topics including AMS principles - fundamentals of AMS in nursing, best nursing practices and innovations, Diagnostic Stewardship - an overview; considerations when ordering tests, diagnostic approach in acute febrile illness, UTI, skin, and soft tissue infections practice, key challenges and opportunities for integrating AMS into daily nursing practice from critical care/ intensive care unit (ICU) and in patients department (IPD) environments by highlighting real-world case studies and success stories. To enhance interactivity, participants were encouraged to actively engage by sharing their responses in the chat box and question & answer session at the end of each session. The educational programme received accreditation from the Nursing Council.

Participants attending the webinar were invited to complete an online survey via Google Forms at the start of the session. A pre- and post-test tool was developed in accordance with CHERRIES guidelines for internet-based surveys to ensure a comprehensive assessment of awareness and understanding [19]. Participation was entirely voluntary, with no adverse consequences for non-participation. Confidentiality was maintained throughout, as responses were anonymous and based on non-identifiable data. Given that the activity was an educational improvement initiative involving no risk to participants, the study was exempted from ethical review under the ICMR Guidelines for Ethical Review of Human Participants (2017) [20].

Data analysis: Each question was given a score of 1 for correct answer and 0 for incorrect answer. For questions with multiple correct choices, a score of 1 was given when all the correct choices were selected and incorrect not selected otherwise a score of 0 was given. Descriptive statistics such as frequency, percentage, mean, and standard deviation were derived. Pre and post-test scores were paired using unique identifiers and compared using the Wilcoxson Rank-test (non-parametric distribution). All those participants who did not submit both the pre and post-test were excluded from the analysis.

Results:

A total of 274 practicing nurses attended the session, out of which 252 completed both pre-and post-test. Demographic characteristics are given in Table 1. The demographic characteristics of the pre-test group and in the post-test group were comparable. Participants from all over India spanning 11 states though majority of participants were from 3 states namely Delhi, Meghalaya and Sikkim.

Table 1: Demographic characteristics of the participants

Characteristics	Study group N = 252 (%)
Educational Qualification	
Diploma	89 (35)
Graduate	90 (36)
Post-Graduate	65 (26)
Super specialization	8 (3)
Experience in years	
< 1 year	17 (7)
1-5 years	98 (39)
5-10 years	52 (20)
10-15 years	50 (20)
>15 years	35 (14)
Healthcare setting	
Government/Public health facility	175 (69)
Corporate hospital	32 (11)
Charitable/non-government organization	25 (10)
Nursing home/private clinic	15 (5)
Field work/community health	5 (5)

Pre-test and post-test scores averaged 11.2 ± 3.63 (SE 0.228) and 17.0 ± 5.94 (SE 0.374) out of 25 (range 4-25), respectively, showing a significant improvement ($p < 0.001$) after the training.

Table 2 presents domain-wise comparison of nurses' knowledge before and after the structured continuing education program on antimicrobial and diagnostic stewardship.

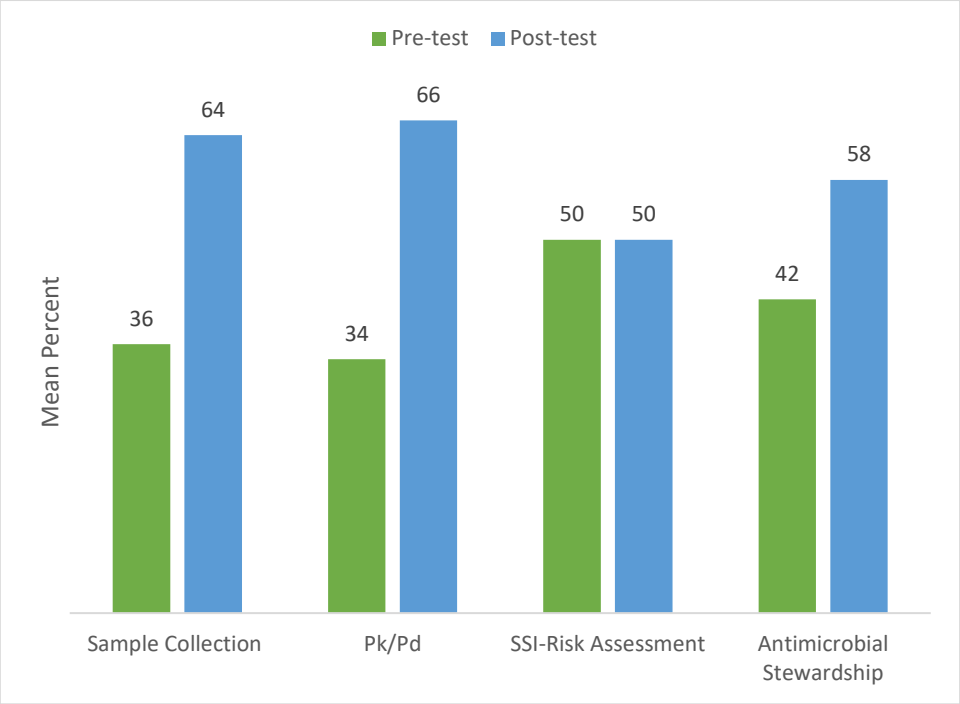
Table 2: Domain-wise comparison of nurses' knowledge before and after the structured continuing education program on antimicrobial and diagnostic stewardship.

Domain	Intent	Correct answer	
Specimen Collection	Assess knowledge of blood culture collection (peripheral vs. central line)	41.41%	58.59%
	Assess knowledge of correct practices for blood culture collection and identify misconceptions	32.94%	61.11%
	Test understanding of clinical criteria for ordering urine cultures	25.11%	74.89%
	Check knowledge of correct urine sampling technique with an indwelling urinary catheter	44.63%	55.37%
	Assess awareness of proper stool specimen handling and storage for *Clostridioides difficile*	35.67%	64.33%
	Evaluate knowledge of correct wound specimen collection	33.47%	66.53%
SSI Risk Assessment	Gauge understanding of SSI prevention measures (Skin preparation)	46.73%	53.27%
	Gauge understanding of SSI prevention measures (Glycaemic control)	42.57%	57.43%

Domain	Intent	Correct answer	
	Gauge understanding of SSI prevention measures (Lack of normothermia)	45.96%	54.04%
	Gauge understanding of SSI prevention measures (Peri-surgical antimicrobial prophylaxis)	46.15%	53.85%
	Gauge understanding of SSI prevention measures (Continuation of antibiotics post-operatively)	58.73%	41.27%
	Gauge understanding of SSI prevention measures (Wound handling)	61.17%	38.83%
Pharmacokinetics-Pk/Pharmacodynamics-Pd)	Assess knowledge of appropriate dosing regimen (Beta-lactam antibiotic)	35.00%	65.00%
	Assess knowledge of appropriate dosing regimen (Aminoglycosides)	43.00%	57.00%
	Assess knowledge of appropriate dosing regimen (Fluoroquinolones)	44.18%	55.82%
	Assess knowledge of appropriate dosing regimen (Meropenem)	35.02%	64.98%
	Assess knowledge of appropriate dosing regimen (Piperacillin Tazobactam)	15.65%	84.35%
	Evaluate adherence to manufacturer instructions for reconstitution of antimicrobial	32.25%	67.75%
Antimicrobial Stewardship	Reinforce importance of culture collection prior to antibiotics	44.90%	55.10%
	Check understanding of narrowing therapy based on sensitivity report	42.90%	57.10%
	Evaluate recognition of adverse effects and appropriate response	46.02%	53.98%
	Test ability to detect inappropriate antibiotic selection (wrong drug-bug combination)	33.33%	66.67%
	Reinforce principles of reducing unnecessary antibiotic exposure duration	47.16%	52.84%
	Assess prioritization skills in sepsis management	35.63%	64.37%
	Highlight importance of accurate documentation	41.08%	58.92%

Nurses' knowledge of specimen collection improved significantly after training, with correct responses rising from 25-45% pre-test to 55-75% post-test. Figure 1 depicts significant improvements in specimen collection and PK/PD knowledge, AMS actions following a structured continuing education program on antimicrobial and diagnostic stewardship, while SSI Risk Assessment remained largely unchanged, highlighting areas requiring targeted reinforcement.

Table 3 depicts the common pitfalls observed and the best practices in sample collection, surgical site infection control and antimicrobial use.



Pk/Pd Pharmacokinetics/pharmacodynamics

Figure 1: Mean domain-wise percentage scores of nurses in pre-test and post-test following a structured continuing education program on antimicrobial and diagnostic stewardship.

Table 3: Common pitfalls and best practices in sample collection, surgical site infection control and antimicrobial use

Domain	Common Pitfalls	Best Practice
Blood Culture	• Drawing from central venous catheter assuming it's acceptable if cleaned or <48 hours old. • Collecting quickly without proper antisepsis.	Obtain sample via peripheral venipuncture after proper skin antisepsis to minimize contamination.
Urine Culture	• Ordering culture for cloudy urine or sediments alone. • Collecting urine from drainage bag or distal tubing.	Indication: Pelvic discomfort or flank pain. Collection: Clamp briefly, clean sampling port, aspirate urine using sterile syringe.
Pus/Wound Sample	• Sampling necrotic tissue or mixing necrotic and healthy areas. • Swabbing necrotic tissue for "broad profile."	Aspirate pus exclusively from the non-necrotic, inflamed area for accurate pathogen identification.
Stool Sample Storage	• Keeping sample at room temperature during delay. • Freezing immediately or heating to preserve toxin activity.	Refrigerate the sample if delay exceeds 2 hours to maintain toxin integrity.
SSI Risk Assessment	• Underestimating factors like skin prep, glycemic control, normothermia. • Overestimating continuation of antibiotics post-op.	High contribution factors: Skin preparation, glycemic control, peri-surgical prophylaxis. Avoid unnecessary post-op antibiotics.
Pharmacology (PK/PD)	• Using once-daily dosing for beta-lactams or meropenem. • Continuous infusion for aminoglycosides.	Beta-lactams & meropenem: Extended infusion. Aminoglycosides & fluoroquinolones: Once-daily dosing for efficacy and safety.
Antimicrobial Stewardship (AMSP)	• Starting antibiotics before collecting cultures. • Continuing broad-spectrum therapy despite culture results. • Missing start/stop dates in documentation.	Collect cultures before antibiotics. De-escalate based on sensitivity. Document start and anticipated stop dates clearly.

For SSI risk assessment, the greatest improvement was in recognizing urine culture indications for catheterized patients (25.11% to 74.89%), with significant gains in identifying incorrect blood culture practices and proper *C. difficile* sample storage. Nurses' understanding of surgical site infection (SSI) prevention measures showed only modest improvement after training. Correct responses for skin preparation, glycaemic control, maintaining normothermia, and peri-surgical antimicrobial prophylaxis increased slightly from around 42-47% to 53-57%. However, knowledge declined for postoperative antibiotic continuation (from 58.73% to 41.27%) and wound handling (from 61.17% to 38.83%).

Nurses' understanding of antimicrobial dosing based on the pharmacokinetics/pharmacodynamics parameters and safe medication reconstitution/preparation improved after training. Correct dosing knowledge for major antibiotic classes (beta-lactams, aminoglycosides, fluoroquinolones, meropenem, and piperacillin-tazobactam) increased, and competency in IV antibiotic reconstitution rose from 32.25% to 67.75%. Pre-test scores in antimicrobial stewardship averaged 50%, revealing gaps in drug-bug matching, prioritization, and de-escalation. Even therapy duration scored below 50%, highlighting the need for targeted education and documentation reinforcement. Post-training, AMS scores improved to 58%.

Discussion:

This quasi-experimental study demonstrated a significant improvement in nurses' AMS and diagnostic stewardship knowledge, with mean scores significantly, a magnitude consistent with one group pretest/post-test nursing education studies that usually yield 20-30% point gains in knowledge and with a quality management education for specimen collectors [16, 21].

SPECIMEN COLLECTION AND DIAGNOSTIC PRACTICES.

Pre-training results revealed significant gaps in nurses' knowledge of culture collection and handling. Many failed to recognize the importance of drawing blood cultures before initiating antimicrobials, often preferring central lines over peripheral venipuncture and overlooking the need for adequate blood volume across multiple sets. Misconceptions such as believing blood culture bottles can be safely refrigerated during transport delays were common. Similarly, errors in urine culture practices such as collecting samples from drainage bags or ordering cultures based solely on cloudy urine or sediment, compromise diagnostic accuracy. Additional pitfalls included improper stool sample storage, such as leaving specimens at room temperature or freezing them immediately, which degrades toxin integrity, and incorrect pus culture sampling, where necrotic tissue was swabbed instead of aspirating pus from inflamed, viable areas. These deficiencies increase contamination risk, delay diagnosis, and lead to inappropriate antibiotic use, ultimately undermining patient safety and stewardship goals. Post-training improvements in correct responses for blood, urine, stool, and wound specimen practices align with best-practice guidance emphasizing culture collection before antimicrobials, peripheral venipuncture, proper storage protocols, and accurate sampling techniques to optimize detection and reduce contamination.

These improvements also reflect the synergy between diagnostic and antimicrobial stewardship described in the SHEA position paper, which notes how optimizing test ordering and interpretation strengthens the "Four Moments" of antibiotic decision-making and improves downstream prescribing. Similar education linked gains in performance have been reported in studies of blood specimen collection and related diagnostic practices, supporting that targeted training strengthens adherence to technique and reduces avoidable errors [16,18, 22-24].

SSI PREVENTION AND WOUND HANDLING

While training led to overall progress in SSI prevention knowledge such as value of skin preparation, glycaemic control, normothermia, and peri-surgical prophylaxis, however, significant declines were observed in postoperative antibiotic continuation and wound handling responses. These gaps suggest persistent misconceptions that prolonged prophylaxis offers protection and that careful wound handling is less critical. Such misconceptions may stem from cognitive overload during the short, intensive session, where complex SSI topics were overshadowed by high-focus areas like culture collection and dosing. Another factor could be pre-existing misconceptions reinforced by entrenched local practices, making it harder to unlearn incorrect habits despite new information. Ambiguity in clinical guidelines and variability in institutional protocols may have contributed to confusion, as seen in similar studies where nurses struggled with antibiotic duration and wound care despite education [26].

Contemporary perioperative guidance stresses that correct timing/selection of prophylaxis, good glycaemic control, maintenance of normothermia, and gentle tissue handling reduce SSI risk, whereas extending antibiotics beyond 24 hours in clean or uncomplicated procedures offers no benefit and increases resistance/adverse events. In parallel, nursing focused stewardship resources emphasize

integrating these evidence-based practices into routine review points ("Four Moments") to de-escalate or discontinue therapy when appropriate [27].

PHARMACOKINETIC/PHARMACODYNAMIC (PK/PD) PRINCIPLES, DOSING STRATEGY, AND MEDICATION SAFETY

Pre-training there was limited understanding of application of pharmacokinetic/pharmacodynamic (PK/PD) principles in dosing strategies as revealed by the responses such as once-daily dosing for beta-lactams or continuous infusion for aminoglycosides. Post-training, nurses demonstrated significant improvement in correctly applying PK/PD principles to antimicrobial administration, including determining loading doses, using extended β-lactam infusions, and adjusting doses for renal or hepatic dysfunction. Indications for prolonged infusions for time-dependent β-lactams and daily reassessment of dosing in patients on continuous renal replacement therapy (CRRT) or with renal impairment to optimize drug exposure and reduce toxicity. Improvements in IV reconstitution competency are consistent with medication safety education and manufacturer linked stability/monitoring recommendations (e.g., vancomycin)[28-30]. Similar findings have been reported by Giannetta et al. (2021), who emphasized that structured education improves medication safety processes, and by Rybak et al. (2009), who highlighted the importance of therapeutic monitoring and correct reconstitution for drugs like vancomycin to optimize outcomes[28, 30]. Integration of practical bedside tools for estimating creatinine clearance and collaboration with pharmacists can further support accurate dose individualization, reducing the risk of toxicity and treatment failure.

CORE AMS ROLES AND DOCUMENTATION

Similarly, antimicrobial stewardship lapses, such as initiating antibiotics before cultures and failing to document start/stop dates, highlight process gaps that perpetuate inappropriate use. Post-training scores improved in stewardship domains Nurses are well positioned in questioning test necessity, ensuring proper culturing, initiating timely therapy for sepsis, and prompting IV to PO switches and "timeouts." Nonetheless, documentation of antimicrobial start/stop dates remains a process gap strongly associated with prolonged and inappropriate antibiotic use. Evidence shows that targeted interventions such as implementing 48-hour antibiotic review protocols significantly improve documentation rates and enable effective audit-feedback processes. Despite these gains, sustaining improvements requires structured pathways that formally integrate nurses into antimicrobial stewardship programs.(ASPs) [27, 31, 32].

Practical strategies include incorporating AMS checkpoints into electronic health records, using checklists for culture-before-antibiotic practices, and applying structured "Four Moments" review points to guide decision-making. Interprofessional collaboration is another cornerstone, where nurses work alongside pharmacists and physicians to optimize dosing and ensure timely de-escalation. Systematic reviews highlight that nurse-driven interventions, such as catheter removal bundles and culture collection protocols, significantly reduce infection risk and inappropriate antibiotic use [16,18]. Global toolkits from CDC and Johns Hopkins further recommend integrating case-based modules, audit-feedback loops, and competency-based training into nursing curricula to institutionalize stewardship practices [25, 33]. These structured pathways not only enhance compliance and documentation but also empower nurses as frontline stewards, improving patient safety and combating AMR.

INTEGRATED STEWARDSHIP AND IMPLICATIONS FOR PRACTICE.

Consistent with our integrated training approach, external evidence shows that combining rapid diagnostics with stewardship interventions shortens time to optimal therapy, increases de-

escalation, and improves outcomes in bloodstream infections [21,34]. More broadly, integration of the diagnostic and antimicrobial stewardship is associated with reductions in unnecessary testing and antibiotic exposure, reinforcing the need to embed laboratory linked Standard Operating Procedures (SOPs) (e.g., standardized blood culture collection and contamination monitoring) within nursing workflows. Nurse focused diagnostic stewardship training has reduced inappropriate cultures and improved turnaround times, confirming nurses' pivotal role across the diagnostic-therapeutic continuum[13,18,27,32,34].

Limitations:

This study used a quasi-experimental pre-post design without a control group, limiting causal inference; however, paired analysis was applied to reduce bias. The short, intensive training may have caused cognitive overload, especially for complex topics like SSI prevention. Reliance on knowledge-based questionnaires rather than direct observation may not fully reflect practice change; to mitigate this limitation scenario-based questions were used to simulate real decisions. Voluntary online participation may have introduced possible selection bias, mitigated by broad outreach across states and healthcare settings. Lack of long-term follow-up prevents assessment of retention; participants were given recorded sessions and supplementary materials for continued learning. These findings are expected to be broadly applicable across the South Asian region, given that the curriculum was grounded in globally accepted antimicrobial and diagnostic stewardship principles. Yet, despite these limitations, this study improved their knowledge and provides valuable insights into current nursing practices in the region and highlights persistent challenges in antimicrobial and diagnostic stewardship. These findings can inform the design of future continuing education programs, emphasizing targeted reinforcement, case-based learning, and practical skill development to address identified gaps.

Professional reviews note that AMS and diagnostic stewardship receive limited emphasis in standard nursing curricula, with these topics often covered superficially in pre-clinical courses and practical training sporadic or institution-specific activities are variably implemented, and nurses and clinical pharmacists remain largely untapped in existing programs[12,35]. Similarly, while global frameworks like the CDC's Diagnostic Excellence and Hospital API/CMS guidance stress the value of nurse engagement in test selection, interpretation, and communication, these roles are often not included in nursing education [36]. To address these limitations, expert toolkits such as those from Johns Hopkins and CDC recommend that nursing curricula integrate case-based modules on culture ordering, PK/PD dosing rationale, device removal protocols, and diagnostic reasoning skills early in training, reinforcing them with audits and point-of-care feedback [25,33,36]. In resource-limited settings, adapting CDC's Core Elements framework for nursing homes and outpatient care can help standardize stewardship components in formal education programs [25,27,33,37].

Conclusion:

Nurses play a leadership role in stewardship activities, including specimen collection, medication management, timely therapy review, and patient education. Structured, competency-based education significantly improved nurses' knowledge of antimicrobial and diagnostic stewardship. While knowledge improved significantly especially in culture collection and dosing strategies, some gaps remained such as limited role of post-operative antibiotics and wound handling in SSI prevention and documentation. A single session is insufficient for lasting change; future programs should include regular refreshers, case-based learning, and audit-feedback to sustain improvements and integrate AMS and diagnostic stewardship into routine nursing practice workflows. Interprofessional collaboration and structured protocols such as culture-before-antibiotic checklists and

documentation prompts can further strengthen nursing contributions to antimicrobial and diagnostic stewardship. Future interventions should prioritize case-based learning, simulation, and audit-feedback mechanisms to address persistent misconceptions and embed best practices into routine workflows.

Conflict of Interest:

The authors have no conflicts of interest to declare.

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Contribution:

SS led the conception and design of the study, organized the educational program, and wrote the manuscript. SJ contributed to drafting the first version, performed data analysis, and assisted in preparing the final manuscript. CBT performed data analysis. Other authors, including BR, LV, and VV, developed the contents of the educational module and reviewed and approved the final version of the manuscript.

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