

9-4-2021

A novel framework to guide antibiotic stewardship nursing practice.

Mary Lou Manning
Thomas Jefferson University

Monika Pogorzelska-Maziarz
Thomas Jefferson University

Cindy Hou
Jefferson Health New Jersey

Nikunj Vyas
Jefferson Health New Jersey

Marianne Kraemer
Jefferson Health New Jersey
Follow this and additional works at: <https://jdc.jefferson.edu/nursfp>



Part of the [Nursing Commons](#)

See next page for additional authors

[Let us know how access to this document benefits you](#)

Recommended Citation

Manning, Mary Lou; Pogorzelska-Maziarz, Monika; Hou, Cindy; Vyas, Nikunj; Kraemer, Marianne; Carter, Eileen; and Monsees, Elizabeth, "A novel framework to guide antibiotic stewardship nursing practice." (2021). *College of Nursing Faculty Papers & Presentations*. Paper 112.
<https://jdc.jefferson.edu/nursfp/112>

This Article is brought to you for free and open access by the Jefferson Digital Commons. The Jefferson Digital Commons is a service of Thomas Jefferson University's [Center for Teaching and Learning \(CTL\)](#). The Commons is a showcase for Jefferson books and journals, peer-reviewed scholarly publications, unique historical collections from the University archives, and teaching tools. The Jefferson Digital Commons allows researchers and interested readers anywhere in the world to learn about and keep up to date with Jefferson scholarship. This article has been accepted for inclusion in College of Nursing Faculty Papers & Presentations by an authorized administrator of the Jefferson Digital Commons. For more information, please contact: JeffersonDigitalCommons@jefferson.edu.

Authors

Mary Lou Manning, Monika Pogorzelska-Maziarz, Cindy Hou, Nikunj Vyas, Marianne Kraemer, Eileen Carter, and Elizabeth Monsees

A Novel Framework to Guide Antibiotic Stewardship Nursing Practice

Mary Lou Manning, PhD, CRNP, CIC, FAPIC, FAAN - Corresponding Author
Professor
Director, Center for Infection Prevention and Antibiotic Stewardship
Thomas Jefferson University
Jefferson College of Nursing
Philadelphia, PA 19107

Monika Pogorzelska-Maziarz, PhD, MPH, CIC, FAPIC
Associate Professor
Assistant Director, Center for Infection Prevention and Antibiotic Stewardship
Thomas Jefferson University
Jefferson College of Nursing
Philadelphia, PA 19107

Cindy Hou, DO, MA, MBA, FACOI, FACP, FIDSA
Infection Control Officer
Jefferson Health New Jersey
Infectious Diseases
Voorhees, NJ 08043

Nikunj Vyas, PharmD, BCPS
Clinical Pharmacist/Infectious Diseases
Jefferson Health New Jersey
Stratford, NJ 08084

Marianne Kraemer, RN, MPA, Ed.M, CENP, CCRN-K
Assistant VP Safety and Quality
Jefferson Health- NJ
Voorhees, NJ 08043

Eileen Carter, PhD, RN
Assistant Professor
University of Connecticut
School of Nursing
Storrs, CT 06269

Elizabeth Monsees, PhD, MBA, RN, CIC, FAPIC
eamonsees@cmh.edu
Antibiotic Stewardship Program Manager, Senior PCS Researcher
Patient Care Services Research
Children's Mercy Kansas City
Assistant Professor, University of Missouri-Kansas City School of Medicine
2401 Gillham Road
Kansas City, MO 64108

Conflict of Interests

None to declare for any authors

Acknowledgement

No funding support for this project

A Novel Framework to Guide Antibiotic Stewardship Nursing Practice

Abstract

Nurses have always been involved in the antibiotic stewardship process, but there remains a pervasive view among some nurses and health care disciplines that antibiotic stewardship is solely a physician or pharmacist responsibility. There is a pressing need to alter this view so that nurses can seize every opportunity to prevent patient harm from antibiotics and to optimize their use. The purpose of this article is to offer a comprehensive, globally applicable organizing framework to guide local-level nurses to lead antibiotic stewardship nursing practice. Our ultimate goal is to serve as a catalyst to elevate nurses' profile as trusted and valuable partners in slowing the emergence of antibiotic resistance.

A Novel Framework to Guide Antibiotic Stewardship Nursing Practice

Abstract

Nurses have always been involved in the antibiotic stewardship process, but there remains a pervasive view among some nurses and health care disciplines that antibiotic stewardship is solely a physician or pharmacist responsibility. There is a pressing need to alter this view so that nurses can seize every opportunity to prevent patient harm from antibiotics. The purpose of this article is to offer a comprehensive, globally applicable organizing framework to guide local-level nurses to lead antibiotic stewardship nursing practice. Our ultimate goal is to serve as a catalyst to elevate nurses' profile as trusted and valuable partners in slowing the emergence of antibiotic resistance.

Introduction

Antibiotic resistance (ABR) is one of the most vexing problems facing humanity. It is a silent pandemic poised to reverse a century of medical progress, rendering antibiotics ineffective in treating even the most common infectious diseases.¹⁻³ Without global action, it is predicted that deaths attributed to antibiotic resistant bacterial infections will climb from the current 700,000 per year to over 10 million deaths per year by 2050 with a total gross domestic product loss of \$100 trillion.⁴ The World Health Organization (WHO) rates ABR as a 'global security threat' impacting global health, food security and development and as important as terrorism and climate change.⁵ The human costs of ABR infections are significant. In addition to death and disability, prolonged illness results in longer hospital stays, treatment failures and toxicities. Any use of antibiotics, however appropriate, contributes to the development of ABR, but widespread misuse is a primary driver.⁴ Misuse refers to use without need, use without prescription, self-medication, and irregular or interrupted dosing or sharing of antibiotics.⁶⁻⁷ The COVID-19 pandemic is

likely exacerbating the ABR problem. A meta-analysis and systematic review focusing on bacterial co-infections in patients hospitalized for COVID-19 found that despite an overall low rate (6.9% (95% CI 4.3–9.5%)) of bacterial infections, over 70% of patients received antibiotics, with the majority constituting broad-spectrum agents such as fluoroquinolone and third-generation cephalosporins.⁸ Antibiotic stewardship (AS) programs have been shown to reduce antibiotic misuse, improve patient outcomes and minimize adverse events associated with antibiotic use, including *Clostridioides difficile* infections.⁹

Antibiotic Stewardship

According to the Infectious Diseases Society of America, the Society for Healthcare Epidemiology of America, and the Pediatric Infectious Diseases Society AS represents ‘coordinated interventions designed to improve and measure the appropriate use of [antibiotic] agents by promoting the selection of the optimal [antibiotic] drug regimen including dosing, duration of therapy, and route of administration.’^{10 p323} This frequently cited 2012 definition focuses on formal AS programs that are staffed by infectious disease physicians and pharmacists tasked with leading interventions to improve clinician antibiotic prescribing practices through top-down actions of formulary restriction and prospective audit with feedback. Some argue, and we agree, that the definition and approach is too circumscribed, limiting the scope, reach and impact of all persons and professions who seek to preserve and promote the intrinsic value of antibiotics.¹¹⁻¹³ Another way forward is to consider AS within the tenets of patient safety, and promote local-level ‘stewarding’ behaviors that tap into the interprofessional team’s collective knowledge, expertise, relationships and wisdom. Implicit in our AS framing is acknowledgement of the importance of team collaboration, however, our primary focus is the central role of nursing

in daily patient care and patient advocacy. Thereupon, we draw from the nursing, quality, antibiotic, environmental, and social sciences stewardship literature, and define AS as: *Local actions taken by the entire healthcare team to protect, care for and responsibly use antibiotics to prevent patient harm and optimize use in diverse clinical, social-structural and behavioral contexts.*¹¹⁻¹⁶

We posit that the nursing profession define its own scope of AS practice, that nursing AS practices be intentionally selected (and strategically align with the organization's AS program) and led by self-empowered nurses giving ample consideration to the local context and culture and tailored to the needs and resources of a particular patient population, clinical setting or clinical specialty. The purpose of this article is to present a globally applicable organizing framework to help guide local-level nurses to lead and participate in AS nursing practice. We begin with a brief review of the current state of nurse engagement in AS, then turn to our proposed framework.

Current State of Antibiotic Stewardship and Nursing

Position statements and opinion pieces consistently affirm that nursing perspectives and nurses' active participation are crucial to keeping patients safe from antibiotic harm, optimizing the use of currently available antibiotics and slowing the emergence of ABR bacteria - the goals of AS.^{11,17-18} Numerous quantitative and qualitative studies indicate that nurses are often unfamiliar with the term antibiotic stewardship, and the clinical practices that nurses already perform that impact antibiotic decisions (i.e., obtaining appropriate specimens for cultures prior to antibiotic initiation and assessing for antibiotic adverse events). However, once explained and reframed, nurses can identify their AS practice-related responsibilities, pinpoint their knowledge gaps and identify their educational needs to fill the gaps.¹⁹⁻²⁰ A recent integrative review on nurse's role

and contribution to AS found that in many contexts nurses remain disconnected from AS activities.²¹ This is not surprising as most studies related to nurses' engagement in AS provide little evidence of educating nurses on what it means to be a steward of an intrinsically valuable resource (i.e. antibiotics) for patients, organizations or populations. Furthermore, research-related AS interventions provide little if any strategic or local context, have omitted nurses from the intervention/s selection decision making process, or considered how the intervention/s align with nursing's workflow or communication patterns or future-oriented priorities. Without such context, some nurses may continue to view AS as a list of unlinked, unrelated clinical tasks without strategic clarity and potentiates the misperception that it is solely the domain of pharmacists and physicians. Our evidence-based Antibiotic Stewardship Nursing Practice SCAN-P Framework provides the much-needed context and clarity to guide nurse engagement in AS. The framework went through multiple iterations as it was vetted with nurse clinicians, physicians, pharmacists and educators.²²

Framework for Antibiotic Stewardship Nursing Practice

The Antibiotic Stewardship Nursing Practice SCAN-P Framework is depicted in Figure 1. The core or center of the framework affirms the overarching AS goals to prevent patient harm and optimize appropriate antibiotic use, i.e, promoting the use of the right agent at the correct dosage and for the proper duration. The framework scaffolding is built on the fundamental nursing intervention of clinical surveillance - a primary strategy used by bedside nurses to promote patient safety and prevent avoidable harm.²³⁻²⁴ Similar in principle to infection surveillance used by infection preventionists, clinical surveillance relies on nurses' ability to gather, interpret, and synthesize real-time data to drive clinical decision making in order to promote and maintain patient safety.²⁵ Nurses report using surveillance, or the act of "systematically assessing patients by

scanning the patient and the patient's immediate environment" as a safety strategy to identify and prevent medical errors.^{23p504} For these reasons, we organized our framework using the acronym "SCAN" to illuminate how nurses continuously and systematically use clinical surveillance to scan the patient's clinical condition and environment to promote and maintain their safety - in this case their safety related to antibiotic use. The deconstructed framework elements "S" and "C" consider the crucial factors that influence and support nursing success and "ANP" identifies selected evidence-based AS nursing practices. An explanation of each element follows.

S - Scope & Standards of Nursing Practice

Preventing patient harm and optimizing antibiotic use are patient safety issues and clearly within nursing's scope of practice, as an extension of their roles as patient advocates. The International Council of Nurses (ICN), a federation of more than 130 national nurses associations representing more than 27 million nurses worldwide, released an Antimicrobial Resistance Position Statement in 2004.¹⁷ Revised in 2017, the statement declares that nurses 'have a vital role to play in preserving the power of antimicrobial medicines' and are in a 'key position to contribute to reducing antimicrobial resistance and critical for the function of antimicrobial stewardship programs.'^{17p1} In the United States, nursing practice is guided by the American Nurses Association (ANA) *Scope and Standards of Practice* (2015) and the ANA *Code of Ethics for Nurses with Interpretive Statements* (2015).²⁶⁻²⁷ Building on these standards the ANA, in partnership with The US Centers for Disease Control and Prevention (CDC), released a white paper in 2017 supporting hospital nurses engagement in AS and identified numerous areas where nurses could have an impact on patient outcomes.¹⁸ Efforts to engage nurses in AS should begin by discussing the ICN statement and country specific nursing standards of practice that promote nursing's stewardship role - defined as

a person who preserves and promotes the intrinsic value of a situation and engages others in solutions and actions.²⁸ Only then can AS be placed within the larger context of preserving and promoting the intrinsic value of antibiotics. Such discussions could also help uncover local-level nurses' readiness to engage in AS practice changes.

C - Context, Culture & Competency

The extent to which nurses can successfully select, implement and evaluate local-level nursing AS practices is highly dependent on the inter-related dynamics of organizational context and culture, and nurses' competency in AS knowledge, skills and abilities.

Context (Organizational)

Context influences the implementation of healthcare quality and patient safety interventions, thus it is important to understand the environment in which an evidence-based intervention (i.e. nursing AS practice) is embedded.²⁹⁻³² According to Rogers and colleagues context is defined as “a multi-dimensional construct encompassing micro, meso and macro level determinants that are pre-existing, dynamic and emergent throughout the implementation process.”^{32p18} Contextual determinants include leadership, social relationships, individual perceptions of the implementation effort, organizational characteristics, organizational support, and the availability of financial and human resources.²⁹⁻³² These dynamic features alone or in combination act as facilitators and barriers to successful implementation. Studies show that having leadership support at the organization and unit levels and an infrastructure to support change initiatives constitute favorable conditions for nursing AS implementation, while leadership that is lacking in authority and support presents a barrier for success.³³⁻³⁵ Nurses planning AS initiatives must carefully consider how context will support successful practice implementation. For example, a recent study illustrates how nurses in a surgical intensive care unit used their existing shared governance structure, their

embedded presence in daily patient rounds and support and guidance from trusted pharmacist and physician leaders to successfully assume increased accountability for antibiotic de-escalation at the point of patient care.³⁶ In addition, nurses must remember that one of the most effective ways to reduce unnecessary antibiotic use is to prevent infections in the first place.³⁷ Nurses, in partnership with their infection preventionists colleagues, play a lead role in efforts to prevent healthcare-associated infections and these pre-existing influential alliances should be leveraged when implementing AS nursing practices.³⁸

Culture (Organizational)

Organizational culture refers simply to ‘the way we do things around here’ and represents the shared and predominant ways of thinking, feeling, and behaving.³⁹⁻⁴¹ Healthcare organizations are comprised of multiple subcultures (i.e. administration, professional groupings, departments) which collectively provide supportive environments to collaborate across professional boundaries to improve patient care or unfavorable environments that promote resistance, conflict and hierarchical power struggles.^{31,41-42} Similar to successful infection prevention and control interventions, effective nurse AS interventions rely directly upon the interplay of multiple complex leadership and management systems, which in turn are strongly influenced by organizational culture.⁴³⁻⁴⁴ This point is illustrated by the findings from a recent large multisite study, reporting that perceived lack of a patient safety culture and limited leadership support were the primary barriers to nurse AS engagement.³⁴ Practically speaking, when nurses plan to improve patient safety through AS engagement, the term culture should be explored with the interprofessional team, accompanied by explicit discussion of the role that enduring hierarchical power relations play in organizational life.^{33,45} A bidirectional effort is required to change a prevailing culture that AS is

solely the domain of pharmacist and physicians. Nurses must see themselves as AS team members and leaders, and in turn, physicians and pharmacists must see nurses as AS team members and leaders.⁴⁶ Success relies on all disciplines embracing the value and benefits of this person-centered, interprofessional approach.

Competency (Nurse AS Competency)

Competency is observable and measurable knowledge, skills, abilities, values, and personal attributes, reflecting expectations of education and applied experiences.⁴⁷ More than 30 years ago, Patricia Benner described how ongoing, long-term career development was important in nursing due to the the evolving complexity and responsibility of nursing practice.⁴⁸ Her novice to expert model postulates that nurse competence develops over time, is progressive and consists of five developmental stages: novice, advanced beginner, competent, proficient, and expert. This dynamic, situational model suggest that as nurses master lower level competencies, they move to higher level competency. However, such progression can be impacted by multiple factors including education, the complexity of experiences and professional autonomy.⁴⁷ Taking a similar approach, Courtenay and colleague's developed an AS competency model for undergraduate nursing education.⁴⁹ The model consists of six competency domains (infection prevention and control; antimicrobials and antimicrobial resistance; diagnosis of infection and the use of antimicrobials; antimicrobial prescribing practices; person-centered care and interprofessional collaborative practice) and descriptors indicating the knowledge, skills and abilities expected of students for optimal use of antibiotics. Although created for undergraduate nursing education, the model can be applied to supporting learning and skill development for practicing nurses.

The peer-reviewed literature is replete with nurse-identified AS knowledge and skill gaps.^{21,50-51} Use of these data can guide development of targeted competency-based AS nurse education and

training programs to fill the gaps prior to launching AS initiatives. Building AS competence will enable nurses to take advantage of opportunities to confidently discuss antibiotic treatment decisions and management plans with their colleagues, patients, and patient's families.⁴⁹

AN-P = Antibiotic Stewardship Nursing Practices Supporting the Safe and Responsible Use of Antibiotics

Five AS nursing practices that span the healthcare delivery continuum are included in the framework. Depending on the local context and culture, each implemented practice has the potential to impact antibiotic decisions, be integrated into nurses' daily workflow and improve patient outcomes. The practices are intended to enhance centralized AS programs and perhaps provide alternative approaches to perform AS at facilities without centralized programs or with limited resources. This is not meant to be an exhaustive practice list, but a springboard for further discussion and development. A crucial aspect to realize the benefits of each practice is a clear, concrete, and precise evaluation plan.⁵² Practices are described elsewhere thus a summary of each is provided here.⁵³⁻⁵⁴

1. *Conduct Antibiotic Allergy Assessment.* The most commonly reported antibiotic allergy is to penicillin, with about 10% of the general public being labeled penicillin allergic.⁵⁵ However, about 90% of the patients with self-reported penicillin allergy are not allergic and able to tolerate penicillins.⁵⁵ Treatment options for patients with unconfirmed penicillin allergy are limited, leading to greater use of broad-spectrum antibiotics which may be less effective, have more side effects and promote the development of ABR.⁵⁵ De-labeling of patients with unconfirmed penicillin allergy is increasingly recognized as a key component of AS programs.^{56,57} From 30% to 63% of patients can be de-labeled after comprehensive interviews, and reviews of the medical

records and medication histories.⁵⁸As part of standard practice, nurses directly impact optimizing antibiotic use and keeping patients safe by evaluating the patient for true penicillin allergy (IgE-mediated) by conducting a comprehensive history. The inappropriate labeling of antibiotic allergies may be mitigated by nurses' accurate and thorough assessment and documentation of antibiotic allergies, educating the patient about the effect of antibiotic allergy labels and, as appropriate, referring the patient for further antibiotic allergy evaluation.^{49,53}

2. *Support Accurate Microbiology Testing Practice.* The term 'diagnostic stewardship' applies to interventions to improve appropriate use of microbiological diagnostics to guide therapeutic decisions.⁵⁹ Inappropriate use of microbiology tests, especially those ordered and obtained from patients without clinical indications, can result in misdiagnosis of infection, delay in correct diagnosis, unnecessary antibiotic use, unnecessary follow-up tests, increased length of stay, increased resource utilization, cause unnecessary stress for the patient and contribute to ABR.^{60,61} Core diagnostic stewardship nursing practices that directly impact optimizing antibiotic use and keeping patients safe include confirming the need for ordered microbiology diagnostics tests (eg. urine, stool cultures) when indicated, collecting samples according to the healthcare facility's procedures and guidelines, ensuring proper handling and storage and reviewing the implications of test results with the clinical team. Evidence suggests that inappropriate ordering and collection of cultures may be mitigated by specific nurse-driven interventions. For example, review of urine culture indications by nurses in long term care and acute care settings have successfully reduced the number of unnecessary urine cultures for adults with and without urinary catheters and reduced unnecessary antibiotic use.^{62,63} The clinical microbiology laboratory is an essential part of the AS team. Nurses should make every effort to develop collaborative

working relationships to help guide their use of the laboratory resources and help interpretation of antibiotic susceptibility results.⁶⁴

3. *Ensure Safe Antibiotic Administration Process.* Keeping patients safe prior to, during and following the antibiotic administration process is a significant nurse responsibility, especially in acute and long term care facilities. Throughout the entire medication process (prescribing, transcribing, dispensing and administering) nurses analyze the most current patient data, engage in evidence-based clinical reasoning, coordinate care with physicians and pharmacists, intercept errors before they reach the patient and, in the case of antibiotics, ensure appropriate duration.^{49,65} Nurses can keep patients safe from receiving unnecessarily prolonged antibiotic therapy by leading and/or participating in antibiotic “time-outs” - structured formal reassessments by the care team to determine if a modification or discontinuation of antibiotic therapy is warranted.⁶⁶ In fact, Monsees and colleagues implemented a nurse-driven antibiotic engagement tool and found clarifying antibiotic duration a prime area for nursing stewardship efforts.²⁰ Furthermore, antibiotic time-outs led by neonatal intensive care unit charge nurses led to a reduction in antibiotic usage rates, and nurse prompting in a critical care unit led to significant reductions in antibiotic use.^{67,68} Also, bedside nurse-driven infection prevention and AS multidisciplinary rounds in a community hospital resulted in significant reduction in antibiotic use and urinary catheter use.⁶⁹

4. *Educate Patients, the Public and Policymakers.* Antibiotic resistance and AS are complicated topics that are poorly understood by patients, the general public and policymakers.⁷⁰ In the US the CDC leads ongoing efforts to educate patients and the general public about appropriate antibiotic use and most national action plans to reduce ABR include a provision to provide patient, public and policymaker education to increase awareness.⁷¹ Up to 95% of antibiotic use in human

health care occurs in the outpatient setting, making it an important venue to provide patient-centered educational campaigns to raise awareness.^{71,72} Employed across the healthcare delivery continuum, nurses, in their patient advocate role, have unlimited opportunities to assure that patients/consumers have and understand appropriate information as to be fully involved in informed decision-making regarding their antibiotic use. Ultimately, efforts to curtail inappropriate antibiotic use and reduce ABR will require a concerted effort across all sectors of society. It is imperative that patients be included in stewardship efforts.⁷³

5. *Promote Vaccination.* Vaccination is a proven effective and safe measure to prevent many infectious diseases that affect children adolescents and adults. Vaccines have dramatically reduced the incidence of death from many infectious agents as well as reduce microbial resistance.⁷⁴ Alarming, significant portions of the population around the world are reluctant about vaccination in general, and now more specifically for COVID-19 vaccination, despite the high risks associated with the pandemic.⁷⁵ Public concerns about vaccine usefulness and safety have led to decreasing vaccine coverage prompting the WHO to list ‘vaccine hesitancy - the refusal, delay, or acceptance with doubts to vaccinate despite availability of vaccine services’ - as one of the ten most important global health threats.^{76,77} The primary drivers of vaccine hesitancy are lack of confidence, complacency and convenience.⁷⁵ Nurses spend considerable time administering vaccines and counseling patients, families, and the public about the benefits, risks and safety of vaccines and in the face of vaccine hesitancy they remain one of the most trusted advisor and influencer of vaccination decisions.^{75,77-78} In their role as patient advocate and educator, nurses must be aware of the common concerns regarding immunization, be prepared to address the concerns, and carefully tailor communication and interventions to the target population and the reasons for hesitancy.

Conclusion

Antibiotic stewardship aims to reduce the emergence of ABR through local actions taken by the entire healthcare team to protect, care for and responsibly use antibiotics to prevent patient harm and optimize use in diverse clinical, social-structural and behavioral contexts. Nurses are ideally situated to provide holistic person-centered care, advocate for judicious use of antibiotics, be active stewards of sustained antibiotic effectiveness and educators of their patients, communities and the general public. One challenge to achieving full nurse engagement as equal members of the AS team is lack of an organizing framework to illustrate relationships of phenomena and concepts inherent to adoption of AS nursing practices. To fill this gap, we created the Antibiotic Stewardship Nursing Practice SCAN-P framework and invite the nursing and infection prevention communities to use, evaluate and refine the framework. Although designed for clinical practice, we believe it has applications for nursing research and education. In collaboration and full partnership with our health profession colleagues, it is time to unleash the full potential of the global nursing community to prevent patient harm from antibiotic resistant infections, optimize antibiotic use and reduce microbial resistance!

References

1. Anderson R. The pandemic of antibiotic resistance. *Nat Med.* 1999; 5: 147–149.
2. Hernando-Amado S, Coque TM, Baquero F, Martinez JL. Defining and combating antibiotic resistance from One Health and Global Health perspectives. *Nat Microbiol.* 2019;4: 1432–1442. <https://doi.org/10.1038/s41564-019-0503-9>.

3. Nadimpalli ML, Chan CW, Doron S. Antibiotic resistance: a call to action to prevent the next epidemic of inequality. *Nat Med*. 2021;27:187–188. <https://doi.org/10.1038/s41591-020-01201-9>
4. O'Neill J. Antimicrobial Resistance: Tackling a crisis for the health and wealth of nations. London: The Review on Antimicrobial Resistance. 2014. Available at: https://www.jpiaamr.eu/wp-content/uploads/2014/12/AMR-Review-Paper-Tackling-a-crisis-for-the-health-and-wealth-of-nations_1-2.pdf. Accessed February 2021.
5. World Health Organization. Antibiotic resistance. Available at: <https://www.who.int/news-room/fact-sheets/detail/antibiotic-resistance>. Accessed March 1, 2021.
6. Wall S. Prevention of antibiotic resistance – an epidemiological scoping review to identify research categories and knowledge gaps. *Glob Health Action*. 2019; Dec 13;12(1):1756191. doi: 10.1080/16549716.2020.1756191. PMID: 32475304; PMCID: PMC7782542.
7. Machowska A, Stalsby Lundborg C. Drivers of irrational use of antibiotics in Europe. *Int J Environ Res Public Health*. 2018;16(1):27. pmid:30583571
8. Langford BJ, So M, Raybardhan S, Leung V, Westwood D, MacFadden DR, Soucy JR, Daneman N. (2020). Bacterial co-infection and secondary infection in patients with COVID-19: a living rapid review and meta-analysis. *Clin Microbiol Inf*. 2020;Dec;26(12):1622-1629. doi: 10.1016/j.cmi.2020.07.016.
9. Schuts EC, Marlies EJ, Hulscher L, Mouton JW, Verduin CM, James WT, Cohen S, Hans W P, Overdiek M, van der Linden P, Natsch S, Hertogh C, Wolfs T, Schouten JA, Kullberg B, Prins J. Current evidence on hospital antimicrobial stewardship objectives: a systematic review and meta-analysis, *The Lancet Infectious Diseases*. 2016;16(7), 847-856, ISSN 1473-3099, [https://doi.org/10.1016/S1473-3099\(16\)00065-7](https://doi.org/10.1016/S1473-3099(16)00065-7)

10. Fishman N. (2012). Policy statement on antimicrobial stewardship by the Society for Healthcare Epidemiology of America (SHEA), the Infectious Diseases Society of America (IDSA), and the Pediatric Diseases Society (PIDS). *Infect Control Hosp Epidemiol.* 2012;33: 322–7.
11. Manning ML, Pfeiffer J, Larson EL. Combating antibiotic resistance: The role of nursing in antibiotic stewardship. *Am J Infect Control.* 2016;44: 1454-1457.
12. Dyar OJ, Huttner B, Schouten J, Pulcini C, ESGAP (ESCMID Study Group for Antimicrobial Stewardship). What is antimicrobial stewardship? *Clin Microbiol Infect.* 2017;23:793-798.
13. Charani E, Holmes A. Antibiotic stewardship – twenty years in the making. *Antibiotics*, 2019;8: 7.
14. Bennett N.J., Whitty, T.S., Finkbeiner, E., Pittman, J., Bassett, H., Gelcich, S., Allison, E.H. (2018). Environmental stewardship: A conceptual review and analytical framework. *Environ Manage*, 61(4):597-614. doi: 10.1007/s00267-017-0993-2. Epub 2018 Jan 31 PMID: 29387947; PMCID: PMC5849669
15. Szymczak JE. (2018). Beyond barriers and facilitators: the central role of practical knowledge and informal networks in implementing infection prevention interventions. *BMJ Qual Saf* 27: 763-765.
16. Murphy N, Roberts D. (2008). Nurse leaders as stewards at the point of service. *Nursing Ethics*, 15(2). 243-253.
17. International Council of Nurses. (2017). Position Statement on Antimicrobial Resistance. https://www.icn.ch/sites/default/files/inline-files/ICN_PS_Antimicrobial_resistance.pdf. Accessed June 14, 2021.

18. American Nurses Association and Centers for Disease Control and Prevention. (2017). Redefining the antibiotic stewardship team: Recommendations from the American Nurses Association/Centers for Disease Control and Prevention workgroup on the role of registered nurses in hospital antibiotic stewardship practices. <https://www.cdc.gov/antibiotcuse/healthcare/pdfs/ANA-CDC-whitepaper.pdf>. Accessed June 14, 2021.
19. Carter E. J., Greendyke, W. G., Furuya, E. Y., Srinivasan, A., Shelley, A. N., Bothra, A., Saiman, L., & Larson, E. L. (2018). Exploring the nurses' role in antibiotic stewardship: A multisite qualitative study of nurses and infection preventionists. *Amer J Infect Control*, 46(5), 492–497.
20. Monsees E.A., Lee, B., Wirtz, A., & Goldman, J. (2020). Implementation of a nurse-driven antibiotic engagement tool in 3 hospitals. *Am J Infect Control*, 48:415-1421
21. Gotterson F., Buising, K., & Manias, E. (2021). Nurse role and contribution to antimicrobial stewardship: An integrative review, *International Journal of Nursing Studies*, 117;103787, ISSN 0020-7489, <https://doi.org/10.1016/j.ijnurstu.2020.103787>.
22. Manning ML, Pogorzelska-Maziarz M, Carter E, Monsees E. A novel framework to guide antibiotic stewardship nursing practices. *Open Forum Infect Dis*. 2020;7(Suppl 1): S89. <https://doi.org/10.1093/ofid/ofaa439.204>.
23. Henneman E.A., Gawlinski, A., Blank, D., Henneman, P.L., Jordan, D., McKenzie, J. (2010). Strategies used by critical care nurses to identify, interrupt and correct medical errors. *Am J Crit Care*. 19(6):500–509.
24. Butcher H.K., Bulechek, G.M., McCloskey Dochterman, J.M., & Wagner, C.M.(2018). *Nursing Interventions Classifications (NIC)*, 7th edition. Elsevier:St. Louis.

25. Pfrimmer D.M., Johnson, M.R., Guthmiller, M.L., Lehman, J.L., Ernste, V.K., Rhudy, & L.M. (2017). Surveillance: A nursing intervention for improving patient safety in critical care environment. *Dimensions of Critical Care Nursing*, 36:1. 45-52 doi: 10.1097/DCC.0000000000000217
26. American Nurses Association (ANA), 2015, Scope and Standards of Practice. Accessed March 1, 2021.
27. American Nurses Association (ANA), 2015 Code of ethics with interpretative statements. <http://www.nursingworld.org/MainMenuCategories/EthicsStandards/CodeofEthicsforNurses/Code-of-Ethics-For-Nurses.html>. Accessed March 1, 2021.
28. Murphy N., & Roberts, D. (2008). Nurse leaders as stewards at the point of service. *Nursing Ethics*, 15(2). 243-253.
29. Li S.A., Jeffs, L., Barwick, M., & Stevens, B. (2018). Organizational contextual features that influence the implementation of evidence-based practices across healthcare settings: a systematic integrative review. *Syst Rev* 7(72). <https://doi.org/10.1186/s13643-018-0734-5>
30. Davidoff F. Understanding contexts: how explanatory theories can help. *Implementation Sci* 14, 23 (2019). <https://doi.org/10.1186/s13012-019-0872-8>
31. Nilsen P, Bernhardsson S. Context matters in implementation science: a scoping review of determinant frameworks that describe contextual determinants for implementation outcomes. *BMC Health Serv Res*. 2019; **19**, 189. <https://doi.org/10.1186/s12913-019-4015-3>
32. Rogers L., De Brún, A. & McAuliffe, E. Defining and assessing context in healthcare implementation studies: a systematic review. *BMC Health Serv Res* **20**, 591 (2020). <https://doi.org/10.1186/s12913-020-05212-7>

33. Kirby E., Broom, A., Overton, K., Kenny, K., Post, J.P. & Broom, J. (2020). Reconsidering the nursing role in antimicrobial stewardship: a multisite qualitative interview study *BMJ Open* 10:e042321. doi: 10.1136/bmjopen-2020-042321
34. Monsees E.A., Goldman, J., Vogelsmeier, A., & Popejoy, L. (2020). Nurses as antimicrobial stewards: Recognition, confidence, and organizational factors across nine hospitals. *Am J Infect Control*, 48(3): 239-245
35. van Huizen P., Kuhn, L., Russo, P.L., & Connell, C.J. (2021). The nurses' role in antimicrobial stewardship: A scoping review, *International Journal of Nursing Studies*, 113, 103772, ISSN 0020-7489, <https://doi.org/10.1016/j.ijnurstu.2020.103772>.
36. Fitzpatrick E.R., Pogorzelska-Maziarz, M., Manning, M.L., & Gleason, V. (2021). The effect of an educational program on nursing knowledge and empowerment in antimicrobial stewardship in a surgical intensive care unit. *Dimensions of Critical Care Nursing*, 40(1): 21-28 doi: 10.1097/DCC.0000000000000450
37. Pogorzelska-Maziarz M., Carter, E.J., Monsees, E., & Manning, M.L. (2020). Infection preventionists role in antimicrobial stewardship: Survey of APIC members. *Am J Infect Cont*, 48(5):584-586.
38. Manning ML, Septimus EJ, Ashley ESD, et al. Antimicrobial stewardship and infection prevention_leveraging the synergy: a position paper update. *Infect Control Hosp Epidemiol*. 2018;39:pp.467-472.
39. Schein, E.H (2017). *Organizational Culture and Leadership*. 5th ed. Wiley. New Jersey
40. Warrick DD. What leaders need to know about organizational culture. *Business Horizons* 2017;60, 395-404.

41. Mannion R, Davies H. Understanding organizational culture for healthcare quality. *BMJ*, 2018;363:k4907.
42. Vaughn V.M., Szymczak, J.E., Newton, D.W., & Fakih, M.G., (2019). Addressing the over-use of cultures to optimize patient care. *Ann Intern Med*, 171:73–4.
43. De Bono S., Heling, G., & Borg, M.A. (2014). Organizational culture and its implications for infection prevention and control in healthcare institutions, *Journal of Hospital Infection*, 86(1). 1-6, ISSN 0195-6701, <https://doi.org/10.1016/j.jhin.2013.10.007>.
44. van Buijtene A, Foster D. Does a hospital culture influence adherence to infection prevention and control and rates of health- care associated infection? A literature review. *Journal of Infection Prevention*. 2018;20(1): 5–17.
45. Szymczak, J.E. Seeing risk and allocating responsibility: Talk of culture and its consequences on the work of patient safety, *Social Science & Medicine*,2014;120, 252-259, ISSN 0277-9536, <https://doi.org/10.1016/j.socscimed.2014.09.023>.
46. Gleason K.T., Davidson, P.M., Tanner, E.K., Baptiste, D., Rushton, C., Day, J., Sawyer, M., Baker, D., Paine, L., wt al., Newman-Toker. (2017). Defining the critical role of nurses in diagnostic error prevention: A conceptual framework and a call to action. *Diagnosis*, 4(4):201-210.
47. American Association of Colleges of Nursing (2021). The essentials: Core competencies for professional nursing education. Available at: <https://www.aacnnursing.org/Portals/42/AcademicNursing/pdf/Essentials-2021.pdf>. Accessed March 16, 2021.
48. Benner P. *From Novice to Expert: Excellence and Power in Clinical Nursing Practice*. 1985. Menlo Park, CA: Addison-Wesley Publishing Company.

49. Courtenay M, McEwen J. Applying an antimicrobial stewardship competency framework in nurses education and practice. *Nursing Standard*, 2020;35: 41-46.
50. van Huizen P., Kuhn, L., Russo, P.L., & Connell, C.J. (2021). The nurses' role in antimicrobial stewardship: A scoping review, *International Journal of Nursing Studies*,113, 103772, ISSN 0020-7489, <https://doi.org/10.1016/j.ijnurstu.2020.103772>.
51. Wong L., Ibrahim, M.B., Guo, H., Kwa, A., Lum, L., Ng, T., & Chow, A. (2020). Empowerment of nurses in antibiotic stewardship: a social ecological qualitative analysis. *J Hosp Infect*, 106 (3):473-482.
52. Castro-Sánchez E., Gilchrist, M., Ahmad, R. Courtenay, M., Bosasquet, J., & Holmes, A. (2019). Nurse roles in antimicrobial stewardship: lessons from public sectors models of acute care service delivery in the United Kingdom. *Antimicrob Resist Infect Control*, 8, 162 <https://doi.org/10.1186/s13756-019-0621-4>
53. Monsees E.A., Tamma, P.D., Cosgrove, S.E., Miller, M.A., & Fabre, V. (2019). Integrating bedside nurses into antibiotic stewardship: a practical approach. *Infect Control Hosp Epidemiol*. 40(5):579–584.
54. Olans R.N., Olans, R.D., & Demaria, A. (2016). The critical role of the staff nurse in antimicrobial stewardship-Unrecognized, but already there. *Clinical Infectious Diseases*, 62(1), 84-89.
55. Shenoy ES, Macy E, Rowe T, Blumenthal KG. Evaluation and management of penicillin allergy: A review. *JAMA*. 2019;321(2):188–199. doi:10.1001/jama.2018.19283
56. Trubiano JA, Chen C, Cheng AC, Grayson ML, Slavin MA, Thursky KA. (2016). Antimicrobial allergy 'labels' drive inappropriate antimicrobial prescribing: lessons for stewardship. *J Antimicrob Chemother*, 71(6):1715-1722.

57. Krah NM, Jones TW, Lake J, Hersh AL. The impact of antibiotic allergy labels on antibiotic exposure, clinical outcomes, and healthcare costs: A systematic review. *Infect Control Hosp Epidemiol.* 2021 May;42(5):530-548. doi: 10.1017/ice.2020.1229. Epub 2020 Oct 16. PMID: 33059777.
58. Covington E.W.;Wingler, M.J.B.; Jayakumar, R.A., & White, C.W. (2019). Strategies for clarifying penicillin allergies when skin testing is not an option. *Pharmacy*, 7, 69.
59. World Health Organization. (2016). Diagnostic stewardship: a guide to implementation in antimicrobial resistance surveillance sites. World Health Organization. Available at: <https://apps.who.int/iris/handle/10665/251553>. Accessed March 1, 2021.
60. Cadamuro J., Ibarz, M., Cornes, M., Nybo, M., Haschke-Becher, E., von Meyer, A., Lippi, G., & Simundic, AM. (2019). Managing inappropriate utilization of laboratory resources" *Diagnosis*, 6(1), 5-13. <https://doi.org/10.1515/dx-2018-0029>
61. Vaughn V.M., Szymczak, J.E., Newton, D.W., & Fakih, M.G., (2019). Addressing the over-use of cultures to optimize patient care. *Ann Intern Med*, 171:73–4.
62. Fabre V., Pleiss, A., Klein, E., Demko, Z., Salinas, A., Jones, G., Gadala, A., Hicks, L.A., Neuhauser, M.N, Srinivasan, A., & Cosgrove, S.E. (2020). A pilot study to evaluate the impact of a nurse-driven urine culture diagnostic stewardship intervention on urine cultures in the acute care setting. *The Joint Commission Journal on Quality and Patient Safety*, 46(11): 650-655.
63. Trautner BW, Grigoryan L, Petersen NJ, et al. (2015). Effectiveness of an antimicrobial stewardship approach for urinary catheter-associated asymptomatic bacteriuria. *JAMA Intern Med.*175(7):1120–1127. doi:10.1001/jamainternmed.2015.1878

64. Palavecino E.L., Williamson, J.C., & Ohl, C.A. (2020) Collaborative antimicrobial stewardship: Working with microbiology. *Infect Dis Clin N Amer* 34: 51-65.
65. Rohde E, Domm, E. Nurses' clinical reasoning practices that support safe medication administration: An integrative review. *J Clin Nurs* 2018;27:e402-e411.
66. Willis Z., Sten, M., Daniels, L., Juliano, J., Swartwood, M., Davis, R., Krzastek, D., Mock, C., Mavrogiorgos, N., Sickbert-Bennett, E. & Weber, D. (2020). Implementation of antibiotic time outs using quality improvement methodology. *Infection Control & Hospital Epidemiology*, 41(S1), S275-S276. doi:10.1017/ice.2020.844.
67. Shukla S., Cortez J, Renfro B, Makker K, Timmons C, Nandula PS, Hazboun R, Dababneh R, Hoopes C, VanRavestein J, McCarter Y, Middlebrooks M, Ingyinn M, Alvarez A, Hudak ML. (2020). Charge nurses taking charge, challenging the culture of culture-negative sepsis, and preventing central-line infections to reduce NICU antibiotic usage. *Am J Perinatol*, Nov 3. doi: 10.1055/s-0040-1719079. Epub ahead of print. PMID: 33142341.
68. Raybardhan S, Kan T, Chung B, et al. (2020). Nurse prompting for prescriber-led review of antimicrobial use in the critical care unit. *Am J Crit Care*. 29(1):71–76.
69. Ha D., Forte, M.B., Olans, R., Oyoung, K., Olans, R., Gluckstein, D.P., Kuller, R., Desai, M., Catipon, N., Ancheta, V., Lira, D., Khattak, Y., Legge, J., Nguyen, K.B., Chan, S., Mourani, J., & McKinnell, J.A. (2019). A multi-disciplinary approach to incorporate bedside nurses into antimicrobial stewardship and infection prevention. *Jt Comm J Qual Patient Saf*, 45(9), 600- 605.

70. Center for Infectious Disease Research and Policy. Poll: US public aware of antibiotic resistance but sketchy on details. 2019. Available at: <http://www.cidrap.umn.edu/news-perspective/2019/06/poll-us-public-aware-antibiotic-resistance-sketchy-details>. Accessed March 2, 2021.
71. Hermsen E.D., MacGeorge, E.L., Andresen, M.L., Myers, L.M., Lillis, C.J., & Rosof (2020). Decreasing the peril of antimicrobial resistance through enhanced health literacy in outpatient settings: An underrecognized approach to advance antimicrobial stewardship. *Adv Ther.* 37:918-932.
72. Duffy E, Ritchie S, Metcalfe S, Van Bakel B, Thomas MG. (2018). Antibacterials dispensed in the community comprise 85%-95% of total human antibacterial consumption. *J Clin Pharm Ther*, 43:59-64.
73. Ewers T., Knobloch, M.J., & Safdar, N. (2017). Antimicrobial stewardship: The role of the patient. *Curr Treat Options Infect Dis*, 9:92-103.
74. Weber D.J., Talbot, T.R., Weinmann, A., Mathew, T., Heil, E., Stenehjem, E., Duncan, R., Gross, A., Stinchfield, P., Baliga, C., Wagner, J., Schaffner, W., Echevarria, K., & Drees, M; Society for Healthcare Epidemiology of America (SHEA). (2021). Policy statement from the Society for Healthcare Epidemiology of America (SHEA): Only medical contraindications should be accepted as a reason for not receiving all routine immunizations as recommended by the Centers for Disease Control and Prevention. *Infect Control Hosp Epidemiol*, 42(1):1-5. doi: 10.1017/ice.2020.342. Epub 2020 Sep 17. PMID: 32938509.
75. Verger P., & Dube, E. (2020). Restoring confidence in vaccines in the COVID-19 era. *Expert Review of Vaccines*, 19:11, 991-993, DOI: [10.1080/14760584.2020.1825945](https://doi.org/10.1080/14760584.2020.1825945)

76. World Health Organization. Ten threats to global health in 2019. <https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019>
77. Paterson P., Meurice, F., Stanberry, L.R., Glismann, S., Rosenthal, S.L., & Larson, H.J.(2016). Vaccine hesitancy and healthcare providers. *Vaccine*. 34, 6700-6706.
78. Deem MJ. Nurses' voice matters in decisions about dismissing vaccine-refusing families. *Amer J Nursing*.2018;118:8;11.

Antibiotic Stewardship Nursing Practice: The SCAN-P Framework[®]

