

Review

Integrating bedside nurses into antibiotic stewardship: A practical approach

Elizabeth A. Monsees PhD, MBA, RN, CIC¹ , Pranita D. Tamma MD, MHS², Sara E. Cosgrove MD, MS³,
Melissa A. Miller BSN, MD, MS⁴ and Valeria Fabre MD³

¹Patient Care Services Research, Children's Mercy Hospital, Kansas City, Missouri, ²Department of Pediatrics, Johns Hopkins University School of Medicine, Baltimore, Maryland, ³Department of Medicine, Division of Infectious Diseases, Johns Hopkins University School of Medicine, Baltimore, Maryland and ⁴Center for Quality Improvement and Patient Safety, Agency for Healthcare Research and Quality, Rockville, Maryland

Abstract

Nurses view patient safety as an essential component of their work and have reported a general interest in embracing an antibiotic steward role. However, antibiotic stewardship (AS) functions have not been formally integrated into nursing practice despite nurses' daily involvement in clinical activities that impact antibiotic decisions (e.g., obtaining specimens for cultures, blood drawing for therapeutic drug monitoring). Recommendations to expand AS programs to include bedside nurses are generating support at a national level, yet a practical guidance on how nurses can be involved in AS activities is lacking. In this review, we provide a framework identifying selected practices where nurses can improve antibiotic prescribing practices through appropriate obtainment of *Clostridioides difficile* tests, appropriate urine culturing practices, optimal antibiotic administration, accurate and detailed documentation of penicillin allergy histories and through the prompting of antibiotic time outs. We identify reported barriers to engagement of nurses in AS and offer potential solutions that include patient safety principles and quality improvement strategies that can be used to mitigate participation barriers. This review will assist AS leaders interested in advancing the contributions of nurses into their AS programs by discussing education, communication, improvement models, and workflow integration enhancements that strengthen systems to support nurses as valued partners in AS efforts.

(Received 6 December 2018; accepted 15 December 2018)

Broadening the reach of antibiotic stewardship (AS) activities to include nurses has recently been recognized as important for the success of antibiotic stewardship programs (ASPs) by the American Nurses Association (ANA) and by the Centers for Disease Control and Prevention (CDC).^{1,2} Concomitantly, accrediting and federal agencies have issued calls for interdisciplinary AS perspectives, indicating the need for nursing participation.^{3,4} The growing number of position statements and endorsements for nurses as AS partners is encouraging, but practical guidance of how to best integrate nurses into AS is lacking. Here, we present specific examples of the potential role of bedside nurses in AS activities, and we provide a framework for integrating bedside nurses into AS activities.

Existing AS work by nurses

Work in long-term care settings focusing on the integration of nurses in initiatives to improve antibiotic use have proven successful; several such examples can be found in the literature. A behavioral intervention targeting frontline nurses and prescribers, consisting of education about appropriate indications for urine culture and algorithms for clinical decision support, resulted in sustained reductions in the

inappropriate treatment of asymptomatic bacteriuria in long-term care residents.⁵ Similarly, a clinical algorithm to assist nurses, as well as other providers, in deciding appropriate indications for urine cultures in patients with indwelling urinary catheters successfully reduced overtreatment of asymptomatic bacteriuria.^{6,7} Additionally, a clinical pathway designed for nurses in managing nursing home residents with lower respiratory tract infections resulted in fewer hospitalizations and healthcare costs without affecting clinical outcomes.⁸

Data are limited, however, regarding the role of the bedside nurse in AS activities in the acute-care setting. Recent studies have shed light on nursing perceptions of their potential contribution to AS efforts in hospitals, their perceived limitations to accomplish their role as stewards, and suggestions to overcome these limitations.^{9–11} When the role of bedside nurses in making AS interventions was examined, nurses reported a high degree of confidence with certain practices, such as assessing for antibiotic-associated adverse drug reactions, obtaining cultures prior to antibiotic initiation, and participating in patient and family education about appropriate antibiotic use.⁹ Conversely, nurses were less confident or reluctant to initiate a 48-hour antibiotic time-out⁹ or to de-label patients with penicillin (PCN) allergies.¹¹

Leveraging nurses' experience into AS strategies

As part of their daily work, nurses perform a number of activities that influence antibiotic prescribing decisions. A comprehensive

Author for correspondence: Elizabeth A. Monsees, Email: eamonsees@cmh.edu; Valeria Fabre, Email: mfabre1@jhmi.edu

Cite this article: Monsees EA, et al. (2019). Integrating bedside nurses into antibiotic stewardship: A practical approach. *Infection Control & Hospital Epidemiology*, 40: 579–584, <https://doi.org/10.1017/ice.2018.362>

list of such activities have been outlined in a White Paper developed by the ANA and the CDC.¹ Through collaborative efforts with the Agency for Healthcare Research and Quality (AHRQ) Safety Program for Improving Antibiotic Use,¹² which strives to improve the decision-making by frontline clinicians, including nurses, we consider the following practices, in which bedside nurses could play a key role in improving antibiotic prescribing practices, to have priority:

Ensuring appropriate *Clostridioides difficile* testing

Given their extensive direct patient contact, nurses are instrumental in identifying changes in the bowel habits of patients. Ensuring appropriate documentation of bowel movements (number and description) ensures accurate clinical interpretation both to make a clinical diagnosis of diarrhea and to evaluate clinical response. Accurate documentation also increases the likelihood that *C. difficile* testing is limited to patients with appropriate signs and symptoms of *C. difficile* infection (CDI). Studies have shown poor correlation between human sniffing ability and CDI.¹³ Therefore, education may be necessary to ensure that testing is not based on the smell of bowel movements if the patient does not have a clinical picture consistent with CDI. Furthermore, nurses can alert prescribers when patients are receiving concomitant laxatives or tube feedings that can cause diarrhea when *C. difficile* testing is being considered. Preferably, reviewing the receipt of relevant medications and tube feeding should occur prior to testing, but these alternative causes for diarrhea should be reported to prescribers even if the *C. difficile* test is positive. Additionally, educating nurses regarding certain diagnostic test limitations may be beneficial to promote appropriate *C. difficile* testing. For example, some commonly used tests detect the presence of the gene that produces the *C. difficile* toxin(s) but not toxin production; hence, the distinction between carrier status and infection relies on clinical evaluation. Treating asymptomatic *C. difficile* carriers is not recommended because it may alter the patient's protective intestinal flora or provoke *C. difficile* toxin production.

Ensuring appropriate indications prior to obtaining specimens for urine culture

Major factors driving unnecessary antibiotic use are inappropriate testing due to isolated changes in color or smell of urine (ie, "dark," "cloudy," or foul-smelling urine) or vague symptoms such as fatigue and the poor practice of testing urine from the catheter collection bag. Treatment of asymptomatic patients is a significant contributor to antibiotic misuse. Education focusing on the signs and symptoms of a urinary tract infection and the 2 primary indications for treatment of asymptomatic bacteriuria,¹⁴ which include pregnancy and urologic procedures expected to cause mucosal bleeding (eg, transrectal biopsies, transurethral prostatectomies), will enhance nurses' confidence in identifying inappropriate indications for urine cultures and will facilitate communication with providers when urine cultures are not needed. By preventing unnecessary urine cultures, nurses can prevent exposing patients to unnecessary antibiotics and their associated adverse events (eg, CDI, antibiotic resistant bacteria, and antibiotic-associated adverse drug events).

Ensuring optimal antibiotic administration

Conversion of patients from intravenous (i.v.) to oral antibiotics can minimize the need for vascular lines (and the need for outpatient parenteral therapy) and reduce the length of stay, without compromising clinical care in many clinical situations. In several

infectious diseases, oral step-down therapy is recommended when the patient improves, such as pneumonia and skin and soft-tissue infections. Nurses can aid in the transition of i.v. antibiotic therapies to the oral route by prompting providers when patients are tolerating oral feeding or other oral medications. When i.v. therapy is required, nurses are essential in ensuring the appropriate timing for therapeutic drug monitoring when monitoring is needed (eg, vancomycin, aminoglycosides). Nurses can also report observations and issues with vascular sites (eg, phlebitis) and difficulties encountered with vascular access (eg, sluggish or hard to flush lines) to trigger consideration of oral therapies if appropriate.

Obtaining and documenting accurate penicillin allergy histories

Allergic reactions to penicillin (PCN) are commonly reported; however, true PCN allergy is rare (only 1% of the general population is actually allergic to PCN).¹⁵ In other words, most people who believe they have PCN allergies do not have IgE-mediated reactions to PCN.

Anaphylaxis, a severe type of allergic reaction, to PCN is extremely rare (<0.01% of the US population). Patients with a PCN allergy label have worse patient outcomes¹⁶⁻¹⁸ (eg, higher risk of treatment failure of bacterial infections and adverse events including CDI and surgical site infections) compared to patients without a PCN allergy label, likely because the former group receives therapy that deviates from recommended firstline options. When nurses obtain allergy histories, key elements such as specific reactions to antibiotics, timing of reactions, date of reactions, and severity of the reactions are critical for antibiotic decision-making and appropriate use.

Specific details on reactions that should be elicited include describing (1) the specific antibiotic instead of drug class wherever possible (eg, cephalexin rather than cephalosporins), (2) the specific reaction (eg, nonraised flat rash, not simply "rash"), (3) the severity of the reaction (eg, hospital admission, respiratory failure), (4) when the reaction occurred in relation to drug administration (eg, immediately after or several days later), and (5) the patient's age at the time of the reaction. An allergy consultation is especially recommended, if available, for patients who report anaphylaxis or hives that occurred in the remote past because patients may overcome hypersensitivity to penicillin over time and thus become candidates for penicillin testing.

When there is discrepancy between a documented allergy history and the patient verbal report, nurses can notify providers or pharmacists for resolution and treatment considerations if nurses are uncomfortable making changes in the chart. After the nature of the allergy is clarified, nurses can update the medical record as appropriate. Many reported reactions represent side effects (eg, isolated fatigue, nausea, and headache) and should not prevent a patient from receiving the most appropriate antibiotic. Nurses are well-positioned to notify clinicians of allergy labels that have been placed in error, and as patient safety advocates, they can promote patient understanding by discussing the importance of PCN allergy clarification and the rationale for Allergy consult evaluations for questionable cases. Additional key points regarding reviewing PCN allergy histories are shown in Box 1.

Nurses can refer to and adopt educational algorithms, clinical guides, and scripts¹⁹ to increase their participation in antibiotic optimization strategies. Box 2 provides an example on how to conduct an allergy history.

Box 1: Additional Key Points Regarding Reviewing Penicillin Allergy Histories

- 80% of patients overcome an allergy after 10 years and may be able to safely receive penicillin (PCN). These patients should be further evaluated.
- It is essential to distinguish hives (wheals with a pale center that typically appear within minutes to hours of antibiotic administration and represent a true allergic reaction) from nonhives rash.
- The most common type of rash to PCN or cephalosporins is a non-allergic rash that appears after many days of antibiotic use, usually affects the trunk and extremities, does not affect eyes/mouth. The rash may feel rough to touch. This type of rash does not contraindicate future antibiotic use.
- Because PCN cross reactivity (ie, the chance that the patient will have the same reaction if exposed to another antibiotic) with other antibiotics within the family is variable, a PCN allergy history does not contraindicate the use of all other cephalosporin or carbapenem antibiotics.

Box 2: Nurse-to-Patient Script on Clarifying Allergies to Penicillin

- “What exactly happened when you took penicillin? How old were you when you experienced this reaction? What antibiotics have you taken after that? Have you seen an Allergy specialist?”
- I’m going to review your health information with the healthcare team. Sometimes your health care team may decide to give you an antibiotic even though you reported an allergy. This is because while many people report a history of being allergic to penicillin, most people who report an allergy to penicillin are not truly allergic. Also, a person with a true allergy may outgrow the allergy and can safely receive penicillin. It’s important to us that you receive the best therapy to treat your illness so we will work with you to address your concerns.” (Modified from Summer et al.¹⁹)

Prompting an antibiotic time out

Ensuring that appropriate durations of antibiotic therapy are being prescribed is a core component of AS. Antibiotic therapies may be prolonged beyond the recommended window for several reasons (eg, treatment end date is missing during patient transfer between units or teams, a system to address anticipated antibiotic duration and current day of therapy on a daily basis is lacking). Nurses can prevent patients from receiving unnecessarily prolonged antibiotic therapy by prompting the primary team to verbalize the planned duration of therapy. In Box 3, we present the “Four Moments of Antibiotic Decision-Making Adapted for Nursing.”²⁰ Although the framework is focused on prescribers, it can be easily adopted by all individuals in the antibiotic decision-making process, such as those who administer or dispense antibiotics. This team-based approach ensures a critical review of an antibiotic prescription and improves antibiotic utilization.

Key elements needed to integrate nurses into AS efforts

Education, communication strategies, and implementation models strategically embedded into work processes are primary components for formal nurse integration into AS activities. Leadership, including both physician and nursing leaders, supporting a workplace culture that fosters nurses’ participation and encourages them to play an active role in AS processes is key to the implementing and sustaining a number of AS interventions.^{21,22} In this section, we summarize the key elements required to integrate nurses into AS activities.

Enhancing education

Nurses have identified limited formal education on antibiotics and microbiology as a barrier to AS.^{9–11,23–25} Prescribers and pharmacists should make a concerted effort to discuss with bedside nurses

Box 3: Four Moments of Antibiotic Decision Making²⁰ Adapted for Nursing

- (1) Does the patient have an infection that requires antibiotics?
- (2) Have appropriate cultures been ordered before starting antibiotics? What empiric therapy should be initiated?
- (3) A day or more has passed. Can antibiotics be stopped? Can therapy be narrowed? Can a change be made from IV to oral therapy?
- (4) What duration of antibiotic therapy is needed for the patient’s diagnosis?

why specific antibiotic treatment plans are being recommended for patients and when this does not happen, nurses should feel empowered to solicit these answers. Over time, this on-the-job learning will result in a broadened knowledge base about the spectrum of activity, potential drug interactions, and associated adverse drug events of specific antibiotics. In addition, these unstructured educational encounters may foster open communication and shared learning.

To enhance nurses’ contributions to AS, nurses should be offered the opportunity to learn more about microbiology reports and susceptibility testing, and to understand the difference between colonization and infection. The United Kingdom’s National Health Service (NHS) and the Scottish Antimicrobial Prescribing Group have developed an educational workbook targeting nurses and midwives that includes an overview of microbiology and antibiotic resistance.²⁶ Computer-based learning modules for new hires or retraining purposes can be considered. A member of the ASP can collaborate with a nurse with an interest in AS and develop educational material for nurses.

Strengthening communication

Education should not be limited to clinical content but include other core components of AS, such as effective communication and teamwork. Barriers to including nurses in AS activities are often related to issues with unit culture, such as not being included in rounds, not having their input recognized or actively sought, and power differentials between disciplines.⁹ In a recent survey querying healthcare system infection prevention and control administrators on nurse engagement, respondents frequently stated that nurses need confidence to question providers on antibiotic management.²⁵ Strategies to enhance conversation between teams may neutralize potential communication challenges. The SBAR (situation, background, assessment and recommendation) tool provides a framework for organizing information in a clear and concise format. This communication style has been successfully used in healthcare to improve patient outcomes.^{27–29} We encourage bedside nurses to adopt this tool to strengthen communication with prescribers. Using the aforementioned practice of appropriate indications for *C. difficile* testing, we provide a clinical example of effective communication using SBAR in Box 4.

The AHRQ Safety Program for Improving Antibiotic Use¹² relies on both improvements in understanding the best practices in managing common inpatient infections and on improving teamwork, communication, and respect among healthcare providers. It encourages clinicians to recognize the opinions of the bedside nurse in formulating plans related to obtaining cultures and antibiotic treatment and also empowers nurses to feel comfortable voicing their concerns. The program consists of a series of webinars and other resources targeting both nursing and other clinicians to provide guidance on developing a collegial environment in which the common goal of optimizing patient care is a priority. These webinars and resources are expected to be publicly available in the summer of 2019.

Box 4: Effective Communication Using the SBAR Tool

Situation: “Mrs. Flint is currently experiencing abdominal discomfort and watery stools.”

Background: “She is a 69 year-old woman with hypercholesterolemia and mild anemia who was admitted last night after a syncopal episode at her local grocery store. She was treated for a UTI 2 months ago with ciprofloxacin.”

Assessment: “Mrs. Flint reports taking laxatives at home because she is chronically on iron supplements. Her home bowel regimen has been continued in the hospital.”

Recommendation: “Even though she has a risk factor for *C. difficile*, I wanted to make sure you knew she is on laxatives. Should we stop the laxatives and reassess the need for *C. difficile* testing at a later time?”

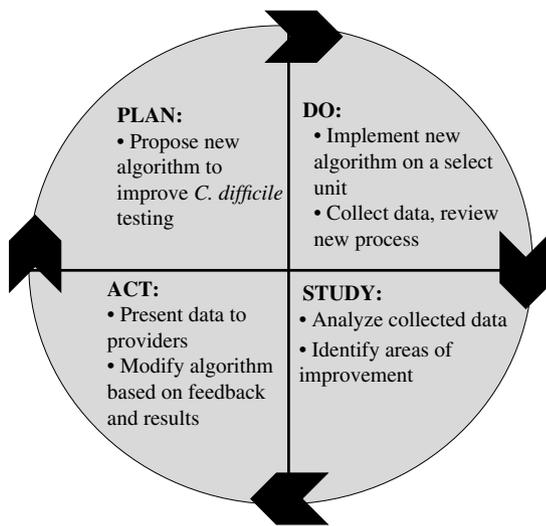


Fig. 1. The plan, do, study, act cycle.³⁰

Using an improvement model

When sufficient resources are available, nurses can partner with other clinicians in identifying additional targeted interventions that may be necessary to improve diagnostic testing or antibiotic use. The Plan-Do-Study-Act (PDSA)³⁰ framework for quality improvement can be considered a guide to implement such interventions (Fig. 1). For example, it can be used to implement an intervention to improve *C. difficile* testing:

Step 1. Plan: An algorithm with indications for appropriate *C. difficile* testing is developed, particularly with input from nurses who are primarily responsible for specimen collection. A plan to collect the data is established (eg, generate a list of all *C. difficile* tests in the electronic medical record during a specific time period).

Step 2. Do: The *C. difficile* algorithm is implemented on a select unit, ideally with high *C. difficile* ordering rates. A nurse champion in partnership with an AS leader provides support during the pilot process (eg, reviews cases with bedside nurses, seeks feedback on the algorithm, and identifies barriers to implement the algorithm).

Step 3. Study: A proportion or all *C. difficile* tests are reviewed for appropriateness. The number of *C. difficile* test orders is plotted on a run or statistical process control chart every week or month and is reviewed on a regular basis to evaluate impact of the intervention (algorithm). Depending on resources, the numerator can be the number of tests or the number of appropriate tests (standardized to the number of tests ordered).

Box 5: Elements to Consider Before Intervention

- Assess organizational culture
- Address organizational barriers
- Tailor education based on observed practice deficits
- Develop a usable intervention
- Solicit feedback from nurses and identify a nurse champion to help develop education on proposed intervention
- Consider train the trainer or other team-based modalities
- Secure nursing and physician stakeholders support

Step 4. Act: Modifications to the algorithm are based on results and feedback. For example, if upon review of cases, receipt of laxatives is missing from the algorithm, the algorithm can be modified to include recent laxative use. Perform staff education to ensure optimal intervention implementation and compliance. Expand the intervention to additional units.

With such a framework, the user: (1) increases the belief that the change will result in improvement, (2) examines how the proposed changes will lead to the desired improvement and whether the proposed change will work in the environment of interest, (3) addresses pockets of skepticism and fear of clinical adverse events with proposed changes through the implementation of small graded steps, (4) enhances the monitoring process to prevent major setback and loss of confidence, and (5) minimizes resistance upon implementation. Elements to consider before implementing a nurse-driven AS intervention are summarized in Box 5.

Evaluating opportunities for workflow integration

After examining opportunities to boost AS education and communication techniques and adopting an implementation model, we suggest exploring workflow to determine the efficacy of new job aids. For example, nurses in an emergency department examined work processes and produced a group A *Streptococcus* pharyngitis algorithm that endorsed nurse evaluation prior to prescriber evaluation to minimize the broad testing of children with upper respiratory infections.³¹ Following several PDSA cycles, injudicious testing was reduced by 23% without impacting unit efficiency. As discussed earlier, several low-resource educational interventions have been published, including urine culture algorithms to reduce the treatment of asymptomatic bacteriuria.^{7,32} Nurses should be part of the team that evaluates, advises, and collaborates on the development of potential AS job aids for them to be successful.

Barriers to integrating nursing into AS

The perception of medical hierarchical tradition has contributed to limiting the role of nurses in performing tasks that may be perceived as “interfering” with medication prescribing. Overcoming this obstacle is an important step in integrating nurses in AS activities and can be achieved by strengthening communication between bedside nurses and prescribers and by increasing nurses’ confidence in antibiotic functions through education and decision support algorithms or guides. The potential barriers to integrating bedside nurses in AS and potential solutions are summarized in Table 1.

Recent literature has revealed that nurses are receptive to strengthening their AS partnership and enthusiastically support their inclusion in programming efforts.^{9–11} Recommendations to expand ASPs with greater inclusion of bedside nurses is generating support at a national level.^{1,2} Initial steps to integrate nurses into

Table 1. Perceived Barriers to Antibiotic Stewardship (AS) by Acute-Care Nurses and Potential Solutions

Identified /Perceived Barrier	Potential Solution
Increased workload for nurses	<ul style="list-style-type: none"> • Develop an intervention that can be easily integrated into the existing scope of practice and workflow. Seek feedback from frontline nurses before implementing a change. • Provide scripts or develop algorithms to assist nurses in performing antibiotic functions more efficiently. • Develop patient educational material to facilitate conversation with nurses (eg, risks associated with unnecessary antibiotic use).
Lack of physician support	<ul style="list-style-type: none"> • Recruit nurse and physician leaders to discuss the key role nurses play in AS, ensure buy-in from unit leadership. • Leverage administrative support to demonstrate how the nursing profession broadens ASP scope, provide capital for educational resources, remove operational barriers, and position nursing as a partner in stewardship work. • Invite nurses to be part of ASP committee.
Limited knowledge	<ul style="list-style-type: none"> • Identify knowledge gaps from root cause analysis reviews, focus groups, or case review. • Customize education to nurses (education written in “nursing speak”).
Lack of experience or confidence	<ul style="list-style-type: none"> • Identify a unit champion with interest in the topic to serve as liaison between the bedside nurse and antibiotic stewardship program. • Share examples of previous successful nurse-led interventions that have occurred both in your institution as well as in the literature (some examples are discussed in the text). • Identify processes typically held by nurses (eg, handoff/transitions in care), where antibiotic information can be discussed.
Nurses’ input not valued	<ul style="list-style-type: none"> • Actively provide input during rounding process (eg, problems with the vascular device, difficulties taking medications by mouth, concerns from the family). • Utilize tools to facilitate bedside nurses’ communication to providers (eg, SBAR tool). • Dampen hierarchical perceptions through huddles or inviting questions and including real time education about therapeutic decision making to create a safe space for learning and cultivate a shared understanding about the care management plan. • Clear and explicit support for nurses’ role in antibiotic stewardship should be expressed by clinician leaders.

programming efforts include leveraging successful nurse leadership models and developing communication mechanisms to encourage nurses to speak up, participate actively in management discussions, and question practices, as appropriate.

Nurses view patient safety as an essential component of their work; however, antibiotic functions have not been formally integrated into their practice. Nurses generally interact with patients before the AS team, often before primary prescribers, and they are responsible for specimen collection, obtaining initial antibiotic allergy data, and antibiotic administration. Nurses spend more time with patients and families than most other clinicians; therefore, they are usually the first to observe, document, and report infectious symptoms. Also, they are often the first and most consistent point of contact for patients and families with the healthcare team. Nurses are therefore in a unique position to influence antibiotic decisions in a number of ways and to ensure safe use of antibiotics. Nurses should be included as valued partners in AS efforts.

Author ORCIDs. Elizabeth A. Monsees,  0000-0001-5277-7469

Acknowledgments. The findings and conclusions in this document are those of the authors, who are responsible for its content, and do not necessarily represent the views of AHRQ. No statement in this report should be construed as an official position of AHRQ or of the US Department of Health and Human Services.

Financial support. This work was supported by the Agency for Healthcare Research and Quality (AHRQ) (HHSP2332015000201/HHSP23337003T)

Conflicts of interest. All authors report no competing interests relevant to this article.

References

1. American Nurses Association and Centers for Disease Control and Prevention. 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. Centers for Disease Control and Prevention website. <https://www.cdc.gov/antibiotic-use/healthcare/pdfs/ANA-CDC-whitepaper.pdf> Published 2017. Accessed August 9, 2018.
2. Core elements of hospital antibiotic stewardship programs. Centers for Disease Control and Prevention website. <https://www.cdc.gov/getsmart/healthcare/implementation/core-elements.html>. Published 2014. Accessed August 9, 2018.
3. Proposed rule: Hospital and critical access hospital (CAH) changes to promote innovation, flexibility, and improvement in patient care. Centers for Medicare and Medicaid Services website. <https://www.federalregister.gov/documents/2016/06/16/2016-13925/medicare-and-medicaid-programs-hospital-and-critical-access-hospital-cah-changes-to-promote>. Published 2016. Accessed August 15, 2018.
4. The Joint Commission Perspectives. Approved: New antimicrobial stewardship standard. The Joint Commission website. https://www.jointcommission.org/assets/1/6/New_Antimicrobial_Stewardship_Standard.pdf. Published 2016. Accessed October 20, 2018.
5. Zabarsky TF, Sethi AK, Donskey CJ. Sustained reduction in inappropriate treatment of asymptomatic bacteriuria in a long-term care facility through an educational intervention. *Am J Infect Control* 2008;36:476–480.
6. Naik AD, Skelton F, Amspoker AB, Glasgow RA, Trautner BW. A fast and frugal algorithm to strengthen diagnosis and treatment decisions for catheter-associated bacteriuria. *PLoS One* 2017;12:e0174415.
7. Trautner BW, Grigoryan L, Petersen NJ, *et al.* Effectiveness of an antimicrobial stewardship approach for urinary catheter-associated asymptomatic bacteriuria. *JAMA Intern Med* 2015;175:1120–1127.
8. Loeb M, Carusone SC, Goeree R, *et al.* Effect of a clinical pathway to reduce hospitalizations in nursing home residents with pneumonia: a randomized controlled trial. *JAMA* 2006;295:2503–2510.
9. Monsees E, Popejoy L, Jackson MA, Lee B, Goldman J. Integrating staff nurses in antibiotic stewardship: opportunities and barriers. *Am J Infect Control* 2018;46:737–742.
10. Greendyke WG, Carter EJ, Salsgiver E, *et al.* Exploring the role of the bedside nurse in antimicrobial stewardship: survey results from five acute-care hospitals. *Infect Control Hosp Epidemiol* 2018;39:360–362.
11. Carter EJ, Greendyke WG, Furuya EY, *et al.* Exploring the nurses’ role in antibiotic stewardship: a multisite qualitative study of nurses and infection preventionists. *Am J Infect Control* 2018;46:492–497.
12. AHRQ safety program for improving antibiotic use. Agency for Healthcare Research and Quality website. <https://safetyprogram4antibioticstewardship.org/page/AHRQ-Safety-Program-for-Improving-Antibiotic-Use>. Published 2017. Accessed October 3, 2018.

13. Rao K, Berland D, Young C, Walk ST, Newton DW. The nose knows not: poor predictive value of stool sample odor for detection of *Clostridium difficile*. *Clin Infect Dis* 2013;56:615–616.
14. Nicolle LE. Antimicrobial stewardship in long term care facilities: What is effective? *Antimicrob Resist Infect Control* 2014;3:6.
15. Trubiano JA, Adkinson NF, Phillips EJ. Penicillin allergy is not necessarily forever. *JAMA* 2017;318:82–83.
16. Blumenthal KG, Lu N, Zhang Y, Li Y, Walensky RP, Choi HK. Risk of methicillin resistant *Staphylococcus aureus* and *Clostridium difficile* in patients with a documented penicillin allergy: population based matched cohort study. *BMJ* 2018;361.
17. Blumenthal KG, Ryan EE, Li Y, Lee H, Kuhlen JL, Shenoy ES. The impact of a reported penicillin allergy on surgical site infection risk. *Clin Infect Dis* 2018;66:329–336.
18. MacFadden DR, LaDelfa A, Leen J, *et al*. Impact of reported beta-lactam allergy on inpatient outcomes: a multicenter prospective cohort study. *Clin Infect Dis* 2016;63:904–910.
19. Sumner S, Forsyth S, Collette-Merrill K, *et al*. Antibiotic stewardship: the role of clinical nurses and nurse educators. *Nurse Educ Today* 2018;60:157–160.
20. Tamma PD, Miller MA, Cosgrove SE. Rethinking how antibiotics are prescribed: incorporating the four moments of antibiotic decision making into clinical practice. *JAMA* 2018;321. doi: [10.1001/jama.2018.19509](https://doi.org/10.1001/jama.2018.19509)
21. Manning ML, Pfeiffer J, Larson EL. Combating antibiotic resistance: the role of nursing in antibiotic stewardship. *Am J Infect Control* 2016;44:1454–1457.
22. Manning ML, Giannuzzi D. Keeping patients safe: antibiotic resistance and the role of nurse executives in antibiotic stewardship. *J Nurs Adm* 2015;45:67–69.
23. Monsees E, Goldman J, Popejoy L. Staff nurses as antimicrobial stewards: an integrative literature review. *Am J Infect Control* 2017;45:917–922.
24. Olans RN, Olans RD, DeMaria A Jr. The critical role of the staff nurse in antimicrobial stewardship—unrecognized, but already there. *Clin Infect Dis* 2016;62:84–89.
25. Manning ML, Pogorzelska-Maziarz M. Health care system leaders' perspectives on infection preventionist and registered nurse engagement in antibiotic stewardship. *Am J Infect Control* 2018;46:498–502.
26. Antimicrobial stewardship: educational workbook. National Health Service Education for Scotland website. https://www.nes.scot.nhs.uk/media/3408708/ams_workbook_april_2015_interactive_final.pdf. Published 2016. Accessed October 30, 2018.
27. Carroll TL. SBAR and nurse-physician communication: pilot testing an educational intervention. *Nurs Adm Q* 2006;30:295–299.
28. Leonard M, Graham S, Bonacum D. The human factor: the critical importance of effective teamwork and communication in providing safe care. *Qual Saf Health Care* 2004;13:i85–i90.
29. Beckett CD, Kipnis G. Collaborative communication: integrating SBAR to improve quality/patient safety outcomes. *J Healthc Qual* 2009;31:19–28.
30. Deming WE. *Out of the Crisis*. Cambridge, MA: Massachusetts Institute of Technology, Center for Advanced Engineering Study; 1986.
31. Norton LE, Lee BR, Harte L, *et al*. Improving guideline-based streptococcal pharyngitis testing: a quality improvement initiative. *Pediatrics* 2018;142.
32. Durant DJ. Nurse-driven protocols and the prevention of catheter-associated urinary tract infections: a systematic review. *Am J Infect Control* 2017;45:1331–1341.