Good Nursing Is Good Antibiotic Stewardship

Successful stewardship depends on nurses' ongoing vigilance.

ABSTRACT

Resistance to antibiotics has increased dramatically in the United States, with serious associated medical, social, and economic consequences. The most promising approach to this national crisis is a new understanding of the need for the careful and responsible use of antibiotics, both for the benefit of society and for the optimal care of each patient. This multidisciplinary approach, called antimicrobial stewardship, has typically involved specialists but not necessarily nurses, who perform numerous antibiotic-related activities daily and should be an integral part of antimicrobial stewardship programs. In this article, we use patient examples to review several stewardship activities and illustrate how nurses are essential to the appropriate use of antibiotics.

Keywords: antibiotic resistance, antimicrobial stewardship, infectious disease, nursing stewardship

In May 2016, a woman presented to a clinic in Pennsylvania and was found to have a urinary tract infection (UTI) due to an organism resistant to the antibiotic colistin, with a transferable resistance marker (or plasmid) that had previously been observed in China but had never been isolated in the United States. The woman had not traveled to China or anywhere outside the country. She had had no contact with anyone who had traveled to Asia. The microorganism's unusual resistance was repeatedly tested and confirmed by the laboratory at the Walter Reed Army Institute of Research in Silver Spring, Maryland. Reporting this story, the *New York Times* ran the following headline: "Infection Raises Specter of Superbugs Resistant to All Antibiotics."[1]

Antibiotic-resistant infections have become commonplace—not only in hospitals but in the community, even in schools and gyms.[2-4] In fact, the Centers for Disease Control and Prevention (CDC) has reported that antibiotic-resistant infections affect more than 2 million people annually in the United States, resulting in more than 23,000 deaths and potentially in excess of $20 billion in direct care costs and $35 billion in lost productivity.[5] The CDC has called this a "significant threat to public health,"[5] phrasing echoed by the World Health Organization, which has referred to antibiotic resistance as "a major threat to public health."[6]

AN ANTIBIOTIC RESISTANCE CRISIS

Any nurse working today can attest to the fact that multidrug resistant organisms are a part of daily hospital microbiology reports and inpatient isolation precautions. Bacterial resistance to antibiotics, however, is not a new phenomenon. Sir Alexander Fleming, the Scottish physician and researcher who discovered penicillin, famously warned in his 1945 acceptance speech for the Nobel Prize in Medicine that "the thoughtless person playing with penicillin treatment is morally responsible for the death of the man who finally succumbs to infection with the penicillin-resistant organism. I hope this evil can be averted."[7] We have seen Fleming's cautionary prediction become a global reality.

The use and overuse of antibiotics, both in health care and agriculture, has fueled this explosion in antibiotic resistance. Antimicrobial medications have enabled people to survive potentially lethal infections, such as pneumonia and postpartum sepsis. But the current abundance of antibiotics is allowing more resistant bacteria to emerge and become human pathogens.[8] In a sense, we are the victims of our own success.

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The perception of antibiotics and other antimicrobials as "miracle drugs"[9] has led to inadvertent changes in society's attitudes toward antibiotic use. That prompted pharmaceutical companies to market antibiotics for conditions—such as colds, bronchitis, and sinusitis—for which they generally are not effective. This created a practice in which an increasing number of broad spectrum antibiotics are used to treat patients who have fevers, for instance, but not necessarily conditions that should be managed with antibiotics. Antibiotics were reassuring, soothing physicians' anxieties and meeting patients' expectations. Thus, broad spectrum antibiotics became the easiest choice when treating patients who had just about any condition.

At the same time, there has been a strong economic incentive for pharmaceutical companies to invest in developing new medications for conditions, such as hypertension, heart disease, arthritis, and diabetes, that require lifelong treatment, unlike antibiotics, which are given for a limited course. The simultaneous overuse of older antibiotics along with the drying up of the antibiotic pipeline has resulted in a problem that has been described by the Infectious Diseases Society of America as "bad bugs, no drugs."[9]

STEWARDSHIP PLANNING

A recent CDC report demonstrated that despite, or perhaps in part because of, concern about resistant organisms, antibiotic overuse in hospitals has continued.[10] An analysis of antibiotic prescribing among 296 inpatients treated in 36 hospitals found that a majority received at least some antibiotics during a given hospitalization, and, on review, the authors concluded there were "opportunities to improve" antibiotic prescribing practices in more than 37% of cases.[10]

After this antibiotic crisis was recognized, practitioners in infectious disease, pharmacy, infection control, and microbiology put forward suggestions to salvage the benefits of these valuable antibiotics.[11] Such actions included optimizing the selection, dosing, and duration of antibiotic therapy in patients; deescalating, or narrowing, initial broad empiric therapy in response to clinical and laboratory results; and reducing adverse events, including secondary superinfections.[12] The Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America created guidelines for the development of antimicrobial stewardship programs.[11]

The only immediately available solution to the problem of increasing antimicrobial resistance is an approach that utilizes antibiotics in the most judicious manner to achieve the best clinical results, while limiting the development and spread of multidrug resistant pathogens. Antimicrobial stewardship is a programmatic approach to the thoughtful use of antibiotics to accomplish these goals. Stewardship programs have been developed over the past 15 years with participation from infectious disease, pharmacy, microbiology, and infection control professionals.[13] Until recently, one group of health professionals had been missing from antimicrobial stewardship programs: staff nurses.

It is unclear why the bedside nurse had been left out of stewardship planning and operation. Antimicrobial stewardship, from its very beginnings, was presumed to be multidisciplinary, and nurses were briefly mentioned in structural documents for antimicrobial stewardship programs developed by the Institute for Healthcare Improvement for the CDC in 2012.[14] However, their role has never been broadly integrated into these programs, nor have their antimicrobial stewardship functions ever been clearly delineated. This presumably unintentional oversight may have been in part because infection control preventionists, most of whom are nurses, were already included in antimicrobial stewardship programs, albeit primarily in an epidemiological capacity.[15]

A survey of nurse educators revealed that they believe nurses need more current education on antimicrobial stewardship in general and on antibiotics and microbiology in particular.[16] But because nurses are not typically prescribers of antibiotics, they often don't see themselves as participants in antimicrobial stewardship programs.[17]

Although they may not recognize it, staff nurses are already performing many critical antimicrobial stewardship functions.[18] Interestingly, when surveyed about antimicrobial stewardship performance, nurses have told us they do not view themselves as antimicrobial stewardship stakeholders.[16] But when questioned as to whether they actually perform specific stewardship functions, they usually respond in the affirmative.[19]

HOSPITAL INPATIENT SCENARIOS

An examination of a typical inpatient stay reveals considerable overlap between traditional bedside nursing activities and important daily antimicrobial stewardship actions,[18] as illustrated in the following patient scenarios. (All cases are composites based on the experience of one of us, RNO.)

Inpatient admission. When a patient is admitted through the ED, she or he is triaged, and isolation precautions are initiated if appropriate (see Table 1[18]). Although isolation guidelines are considered the purview of the infection preventionist, it is the admitting staff nurse who initially performs tasks related to these guidelines. She or he also performs medication reconciliation and enters information about the patient's

drug allergy history (including allergy to antibiotics) into the pharmacy section of the electronic health record (EHR). Early and appropriate cultures are typically ordered by the physician but obtained by the nurse before being sent to the microbiology laboratory in a process in which errors in collection can occur.[20] Timely antibiotic ordering and administration are included in the Joint Commission's National Hospital Inpatient Quality Measures and the Centers for Medicare and Medicaid Services' performance measures and are often viewed as the physician's responsibility.[21, 22] However, it's important to note that the staff nurse receives the order for the antibiotics, administers the medication, records the dose and timing, and monitors the effects of treatment and any adverse events.[18]

Case example. Kevin Burns, 32, a paraplegic for 11 years following a motorcycle accident, has had a permanent indwelling suprapubic catheter and several prior admissions for UTIs. He was brought to the ED with rigor, confusion, and a fever; his rectal temperature was 102.1° and his blood pressure was 80/50 mmHg. After blood and urine cultures were collected and sent to the laboratory, he was started on cefepime (Maxipime) and gentamicin and admitted on IV fluids. On reviewing the patient's medical record, Kelly Johnson, the admitting nurse, noted that the patient had been on contact precautions in the past. She then looked up his urine microbiology culture results from his last hospitalization, two months earlier. These revealed that the cultures had grown extended-spectrum β-lactamase (ESBL)–positive *Klebsiella pneumoniae*, which was resistant to both cefepime and gentamicin. Ms. Johnson called the infectious disease physician (who had planned a routine consultation for the following morning) and received a stat order for ertapenem (Invanz). The following day, both blood and urine cultures grew the multiresistant ESBL-positive *K. pneumoniae*.

In this case, a human error was made. In the hectic setting of a crowded ED, a previous microbiology report was overlooked. The patient was initially treated using a protocol for urosepsis that would be appropriate for most patients with sepsis and a suprapubic catheter. But it was the wrong choice for this patient. By taking the initiative to investigate why this patient required contact precautions, the staff nurse made a discovery leading to an intervention that dramatically affected her patient's care, preventing worsening sepsis and possible death. Her actions also prevented this resistant organism from being transmitted to another patient.

Inpatient stay. After a patient has been admitted, the staff nurse is generally seen as the primary bedside patient advocate and the monitor of patient safety (see Table 2[18]). Progress notes are also written by infectious disease physicians and hospitalists, and pharmacists perform antibiotic dose adjustments, but it is the nurse who is at the patient's bedside 24 hours a day, seven days a week.

Case example. Phyllis Monroe, a 45-year-old woman with severe osteoporosis, fell at home, sustaining a left hip fracture. She underwent an uneventful left hip nailing and was transferred to a rehabilitation facility three days later. The following week, methicillin-resistant *Staphylococcus aureus* (MRSA) wound and bloodstream infections developed. As a result, Ms. Monroe was transferred back to the hospital and to the care of her orthopedic surgeon. The orthopedist consulted with the infectious disease physician by telephone regarding the choice of antibiotic therapy. She was advised to order "vancomycin by pharmacy," an electronic order set developed to ensure optimal dosing and monitoring of IV vancomycin (Vancocin). The patient was taken to the operating room that evening for drainage of the wound.

Table 1. Inpatient Admission: Antimicrobial Stewardship Tasks and Functions Performed by Nurses[18]

Activity/Task	Person Responsible	Functions the Nurse Performs
Appropriate triage and isolation	Infection preventionist	Assesses the source of infection and appropriate precautions. An infection preventionist may subsequently be called for a consultation.
Accurate antibiotic allergy history	Pharmacist	Gathers information about the patient's allergy history, performs medication reconciliation, and records this in the medical record.
Early and appropriate cultures	Hospitalist, microbiologist	Obtains cultures before starting antibiotics and sends these to the microbiology laboratory. Monitors culture results and reports these to the physician.
Timely antibiotic initiation	Hospitalist, infectious disease specialist, pharmacist	Receives the orders, reviews the dose and timing of dose schedule for accuracy, checks for history of allergy, and administers antibiotics and documents administration.

Table 2. Inpatient Stay: Antimicrobial Stewardship Tasks and Functions Performed by Nurses[18]

Activity/Task	Person Responsible	Functions the Nurse Performs
Progress reporting	Hospitalist, infectious disease specialist	Cares for the patient 24 hours a day, 7 days a week; monitors and communicates daily patient progress.
Antibiotic adjustment based on microbiology reports	Hospitalist, infectious disease specialist, microbiologist	Typically receives laboratory and radiology reports first; coordinates results and communicates them to the treating physicians.
Antibiotic dosing, culture and sensitivity reporting, and deescalation	Infectious disease specialist, microbiologist, pharmacist	Updates clinical and laboratory renal function results, drug levels, and preliminary and final microbiology results.
Adverse events	Hospitalist, pharmacist	Monitors and reports to the physician and pharmacist any adverse events, including diarrhea.
Antibiotic orders	Hospitalist, infectious disease specialist	Reviews patient's clinical status and changes in medications.
Antibiotic resistance	Infectious disease specialist, hospitalist, microbiologist	Reviews culture and sensitivity results and reports "bug–drug" mismatches. Time outs and antibiotic deescalation are used to reassess the patient's clinical status.
Superinfection and resistant infection	Infectious disease specialist, infection preventionist, microbiologist	Monitors patient response and initiates appropriate changes in isolation precautions.

The following morning, both the infectious disease physician and the orthopedic physician assistant (PA) conducted rounds, saw a "vancomycin by pharmacy" protocol flag in the patient's medication administration record, and assumed the drug was being given. However, the patient wasn't receiving antibiotic therapy. Per protocol, all preoperative medication orders are automatically discontinued by the physician order entry software and require renewal following surgery. The physician and PA had assumed the drug had been reordered postoperatively. The pharmacist, seeing that the patient's vancomycin dose had been cancelled, thought this had been done by the surgeon rather than automatically by the computer software, and assumed the patient no longer required vancomycin.

Shauna Wittier, a new graduate nurse, was concerned for her patient. She knew Ms. Monroe had been transferred back to the hospital specifically because of a MRSA infection. She also knew it had been more than 24 hours since Ms. Monroe's last vancomycin dose. The pharmacy told her the vancomycin had been discontinued, but during the last shift change she was told that Ms. Monroe was still receiving "vancomycin by pharmacy" dosing. Ms. Wittier telephoned the infectious disease physician who, although he couldn't determine what had happened, ordered a stat single dose of vancomycin until the problem could be sorted out.

Errors related to EHRs are seen with increasing frequency, and it's believed the true magnitude of this problem has not yet been fully defined.[23] Although information technology is an important component of antimicrobial stewardship, this case shows how nurses can protect a patient from the errors that can come from a computerized protocol. Only the common sense and observation of the bedside staff nurse allowed this error to be discovered and the mistake to be corrected. The computer protocols were adjusted, and the nurse was commended by the administration.

Inpatient discharge. The course of antibiotic management—and thus the level of acute nursing care—is determined by the patient's response. This is monitored by physicians with major input from the 24-hour observations of bedside nurses (see Table 3[18]). Without such collaborative evaluation and frequent antibiotic time outs—during which the health care team reassesses therapy based on newly available diagnostic information and the patient's clinical status—appropriate antibiotic adjustment and potential deescalation cannot efficiently take place.[24]

Such antibiotic assessments are one of the daily duties of case managers (a majority of whom are nurses), working with staff nurses.[25] Judgments regarding a patient's capacity to take oral antibiotics or a family's capacity to cope with outpatient antibiotic therapy can affect not merely length of stay but also patient

satisfaction and postdischarge success. Patient and family education by nurses, both during the hospital stay and upon discharge, can help prevent unnecessary antibiotic overuse.

Case example. Gerald Martin, a 65-year-old mason, ignored his persistent back pain for weeks, thinking it was an inevitable result of daily heavy lifting. When the pain suddenly worsened and he had difficulty walking because of leg weakness, he was admitted to the hospital. Spinal magnetic resonance imaging showed a collapsed L2 vertebra with increased bone marrow signal intensity, and a vertebral biopsy confirmed a diagnosis of vertebral osteomyelitis due to oxacillin-susceptible *S. aureus*. Because of a history of penicillin allergy (rash), the hospitalist treated him with IV vancomycin, and there was gradual improvement in his pain.

Martha Douglas, the nurse case manager, found Mr. Martin a place on a coveted spinal rehabilitation unit. Three days prior to transfer, however, he developed a bullous skin rash. It was assumed the rash was an allergic reaction to vancomycin, and his prescription was changed to IV daptomycin (Cubicin). The rehabilitation unit canceled the transfer, as its formulary (and Mr. Martin's insurance) did not cover daptomycin.

Ms. Douglas reassessed the situation. Because she knew that histories of penicillin allergy are often inaccurate, she approached the infectious disease physician. The physician, who hadn't yet been consulted in Mr. Martin's case, ordered a test dose of ceftriaxone under careful nursing observation. The patient developed no allergic symptoms and, as a result, was treated with ceftriaxone and received rehabilitation on the spinal unit followed by IV therapy at home. He was then able to return to work full time.

Histories of penicillin allergy are notoriously unreliable and poor predictors of true allergic reactions. Macy and Contreras showed that having a history of penicillin allergy leads to the use of broad spectrum antibiotics (and is thus associated with an increased selection of antibiotic-resistant organisms), increased length of stay, and increased hospital costs.[26] Nurses may encounter patients at several points during a hospital stay who are believed to have a penicillin or antibiotic allergy. Educating nurses on how to approach this situation, as highlighted in this scenario, can make them more successful patient advocates and family educators.[27]

NURSING AND ANTIMICROBIAL STEWARDSHIP

These patient scenarios illustrate how many daily nursing activities are intrinsically interwoven into the fabric of antimicrobial stewardship. Rather than viewing antimicrobial stewardship as yet another job to be saddled on the backs of nurses already burdened with other interdisciplinary efforts, nurses should view antimicrobial stewardship as a way to better understand the proper use of antibiotics. Nurses are already recognized as the primary bedside advocates and monitors of patient safety and progress. The nursing role also positions nurses to be at the center of—and facilitators of—communications among all the participants in antimicrobial stewardship programs.[18] Thus, teaching nurses about antibiotic resistance, antimicrobial stewardship, and new approaches to antibiotic management needs to be a part of basic nursing education.

There is a long tradition of nursing engagement in basic infection management, dating back to Florence Nightingale's pioneering crusade for innovations in infection control.[28] More recently, the successes of staff nurses in operationalizing nationwide campaigns to reduce central line–associated bloodstream infections

Table 3. Inpatient Discharge: Antimicrobial Stewardship Tasks and Functions Performed by Nurses[18]

Activity/Task	Person Responsible	Functions the Nurse Performs
Transition patients from IV to oral antibiotics and to outpatient antibiotic therapy	Case manager, infectious disease specialist, pharmacist	Monitors patient's clinical progress and capacity to take oral medications.
Length of stay: monitors patient's progress 24 hours a day, 7 days a week	Administrator, case manager, infectious disease specialist	Reviews patient's response to therapy and capacity for discharge to home and rehabilitation needs.
Patient education and medication reconciliation	Hospitalist, infectious disease specialist, pharmacist	Educates patient and family and performs discharge teaching.
Manages transition to outpatient visiting nurse service, skilled nursing facility, or long-term care facility as well as readmission to the hospital	Administrator, case manager, infection preventionist	Communicates patient's diagnosis, management, and medications to the nurse at the visiting nurse service, skilled nursing facility, or long-term care facility.

(CLABSIs) and catheter-associated UTIs (CAUTIs) demonstrate how nurses, when empowered, can excel as effectors of quality patient interventions.[29, 30]

The public regularly describes nurses as the most honest and ethical professionals.[31] This makes the nearly 3 million nurses in the U.S. workforce ideal ambassadors and communicators to the American public regarding the importance of antibiotic stewardship. Nurses should view antimicrobial stewardship as an integral part of nursing: good nursing *is* good stewardship, and good antibiotic stewardship *is* good nursing. ▼

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