Antimicrobial stewardship involves optimizing antibiotic use while using cost-effective interventions to minimize antibiotic resistance and control Clostridium difficile. An effective hospital-wide antimicrobial stewardship program (ASP) should be led by an infectious disease (ID) physician. The ASP team needs full and ongoing financial support for the ASP from the hospital administration. The ID clinician leader should have special expertise in various aspects of antimicrobial therapy, that is, pharmacokinetics, resistance, pharmacoeconomics, and C difficile. The ASP ID team leader and ID-trained clinical pharmacist staff are responsible for customizing ASP interventions to the hospital’s unique set of antibiotic use-related concerns.

Antimicrobial stewardship programs aim to reduce costs, optimize therapeutic outcomes, and reduce antimicrobial resistance. Reductions of antimicrobial resistance are the most elusive because emergence and spread of resistant bacteria involves antimicrobial selective pressure and lapses in infection control techniques. The relationship between antimicrobial usage and resistance is not always direct. The understanding of which techniques are most effective is limited because many studies are descriptive or quasi-experimental. Recent meta-analyses or systematic reviews of stewardship programs offer encouragement that some interventions reduce overall antimicrobial selective pressure and, where associated with infection control interventions, affect resistance rates in individual institutions.

Antimicrobial resistance (AR) is one of the most serious public health threats today, which has been accelerated by the overuse and misuse of
Antimicrobials in humans and animals plus inadequate infection prevention. Numerous studies have shown a relationship between antimicrobial use and resistance. Antimicrobial stewardship (AS) programs have been shown to improve patient outcomes, reduce antimicrobial adverse events, and decrease AR. AS programs, when implemented alongside infection control measures, especially hand-hygiene interventions, were more effective than implementation of AS alone. Targeted coordination and prevention strategies are critical to stopping the spread of multidrug-resistant organisms.

Antibiotic Stewardship: Strategies to Minimize Antibiotic Resistance While Maximizing Antibiotic Effectiveness

Cheston B. Cunha and Steven M. Opal

Empiric therapy of the septic patient in the hospital is challenging. Antibiotic stewardship is concerned with optimizing antibiotic use and minimizing resistance. Clinicians should avoid overcovering and overtreating colonizing organisms in respiratory secretions and urinary catheters. Empiric therapy should take into account the prevalence of multidrug-resistant organisms in the hospital setting. The most effective resistance prevention strategy is to preferentially select a low resistance potential antibiotic, which should be administered in the highest possible dose without toxicity for the shortest duration to eliminate the infection.

Creative Collaborations in Antimicrobial Stewardship: Using the Centers for Disease Control and Prevention’s Core Elements as Your Guide

Priya Nori, Yi Guo, and Belinda Ostrowsky

Antimicrobial stewardship program (ASP) success and growth rely on recurring collaborations with partners within the health care system, such as administration, clinical services, infection prevention, pharmacy, the medical school, and microbiology. These collaborations present valuable opportunities for development of hospital policies, institutional guidelines, and educational curriculum. External opportunities for collaboration may be less frequent but equally valuable. These collaborations are facilitated by health system partnerships with national quality organizations, neighboring ASPs, and the Department of Health. All collaborations present novel opportunities for policy development, research initiatives, and expanding the regional ASP footprint.

Role of Education in Antimicrobial Stewardship

Inge C. Gyssens

The ability to treat infectious diseases with antimicrobials is an essential component of medical management. Antimicrobial therapy is based on the characteristics of the patient, drug, microorganisms causing the infection, and colonizing flora. Prudent antibiotic use is the only option to delay the emergence of resistance. Training in infectious diseases and knowledge of the principles of responsible antibiotic prescribing and uses must be improved. To change practice, health care professionals should be educated at all levels of their training.
Antibiotic stewardship programs (ASPs) play a crucial role in controlling the emergence of resistant organisms, reducing rates of *Clostridium difficile* infections and associated hospital length of stay, promoting judicious use of antibiotics, and minimizing associated adverse events. There is a significant overlap between the goals of infection control programs and ASPs, and both programs can benefit from a synergistic relationship. Hospital epidemiologists can support these programs by providing leadership support, sharing surveillance data, bridging gaps between ASPs and departments such as microbiology, integrating educational programs with ASPs, sharing outbreak alerts, and assisting with the development of treatment algorithms.

For adequate antimicrobial stewardship, microbiology needs to move from the laboratory to become physically and verbally amenable to the caregivers of an institution. Herein, the authors describe the contributions of their microbiology department to the antimicrobial stewardship program of a large teaching hospital as 10 main points ranging from the selection of patients deemed likely to benefit from a fast track approach, to their clinical samples, or the rapid reporting of results via a microbiology hotline, to rapid searches for pathogens and susceptibility testing. These points should serve as guidelines for similar programs designed to decrease the unnecessary use of antimicrobials.

Rapid diagnostic testing has improved clinical care of patients with infectious syndromes when combined with antimicrobial stewardship. The authors review the current data on antimicrobial stewardship and rapid diagnostic testing in bloodstream, respiratory tract, and gastrointestinal tract infections. Evidence for the potential benefit of rapid tests in bloodstream infections seems strong, respiratory tract infections mixed, and gastrointestinal tract infections still evolving. The authors also review future directions in rapid diagnostic testing and suggest areas of focus for antimicrobial stewardship efforts.

Antibiotic stewardship programs are needed in all health care facilities, regardless of size and location. Community hospitals that have fewer resources may have different priorities and require different strategies when defining antibiotic stewardship program components and implementing interventions. By following the Centers for Disease Control and Prevention Core Elements and using the strategies suggested in this
article, readers should be able to design, develop, participate in, or improve antibiotic stewardship programs within community hospitals.

Role of the Pharmacist in Antimicrobial Stewardship 929
Diane M. Parente and Jacob Morton

The goals of antimicrobial stewardship are to optimize antimicrobial use to improve patient outcomes and minimize adverse consequences. A successful antimicrobial stewardship program is one that is multidisciplinary. Pharmacists are core members of antimicrobial stewardship and undertake multiple roles to accomplish the goals of the program. As antimicrobial stewardship continues to expand across the patient care continuum, pharmacists will serve a vital role in preserving the armamentarium of antimicrobials and improving quality of patient care.

The Pharmacoeconomic Aspects of Antibiotic Stewardship Programs 937
Cheston B. Cunha

Optimal antimicrobial therapy must take into account the key factors in antibiotic selection, that is, spectrum, tissue penetration, resistance potential, safety profile, and relative cost-effectiveness. The least expensive drug is usually accompanied by other concerns, such as high resistance potential, poor side-effect profile, pharmacokinetic properties that limit penetration into target tissue (site of infection), and/or suboptimal activity against the presumed/known pathogen. It is false economy to preferentially select the least expensive antibiotics solely because of its acquisition cost. Therapeutic failure and hidden costs may make an apparently less expensive antibiotic most costly in the end.

Antibiotic Stewardship Program Perspective: Oral Antibiotic Therapy for Common Infectious Diseases 947
Cheston B. Cunha

Traditionally, initial antibiotic therapy was administered intravenously (IV). Over the past 3 decades, there has been increased understanding, appreciation, and application of pharmacokinetic (PK) and pharmacodynamic (PD) principles in antibiotic therapy. The utilization of PK/PD parameters as applied to antimicrobial therapy has led to optimizing dosage regimens as well as increased awareness and experience with oral versus antibiotic therapy. When an oral antibiotic, given at the same dose as its IV formulation, results in the same serum/tissue levels, then oral antibiotics should be used whenever possible. When chosen carefully, oral therapy provides many benefits over IV therapy.

Role of Technology in Antimicrobial Stewardship 955
Derek N. Bremmer, Tamara L. Trienski, Thomas L. Walsh, and Matthew A. Moffa

Because of the increasing plague of antimicrobial resistance and antibiotic misuse, antimicrobial stewardship programs (ASPs) are now a mandatory entity in all US hospitals. ASPs can use technological advances, such as the electronic medical record and clinical decision support systems, to affect a larger patient population with more efficiency. In addition, through
the use of mobile applications and social media, ASPs can highlight and propagate educational information regarding antimicrobial utilization to patients and providers in a widespread and timely manner. In this article, the authors describe how technology can play an important role in antimicrobial stewardship.

Metrics of Antimicrobial Stewardship Programs

Amy L. Brotherton

Appropriate metrics are needed to measure the quality, clinical, and financial impacts of antimicrobial stewardship programs. Metrics are typically categorized into antibiotic use measures, process measures, quality measures, costs, and clinical outcome measures. Traditionally, antimicrobial stewardship metrics have focused on antibiotic use, antibiotic costs, and process measures. With health care reform, practice should shift to focusing on clinical impact of stewardship programs over financial impact. This article reviews the various antimicrobial stewardship metrics that have been described in the literature, evidence to support these metrics, controversies surrounding metrics, and areas in which future research is necessary.