Joint Commission Resources

Dear Executive:

On behalf of Joint Commission Resources and Ortho McNeil, I am pleased to present you with the toolkit *What Every Health Care Executive Should Know: The Cost of Antibiotic Resistance.*

This publication is designed to provide chief executives and their leadership teams with the information and tools they need to initiate, promote, and sustain an effective program to reduce antibiotic resistance and multi-drug resistant organisms (MDROs) in hospitals. The toolkit addresses the clinical and financial cost of antibiotic resistance, transmission challenges within the hospital, antibiotic stewardship programs and methods to create sustainable change with improved approaches to risk reduction.

The guide and accompanying CD provide the latest science and strategies and can be adapted for hospitals of various sizes and complexity that are addressing the challenges of MDROs such as methicillin resistant *Staphylococcus aureus* (MRSA) and organisms such as *Clostridium difficile* (CDI).

Although key messages are aimed at health care executives, the toolkit provides specific resources meant to be deployed at *all* levels of the organization, beginning with senior leaders where many decisions are made, mid-level clinical and administrative management where decisions are implemented and frontline staff where they are directly applied. We encourage you to share chapters with others in your organization.

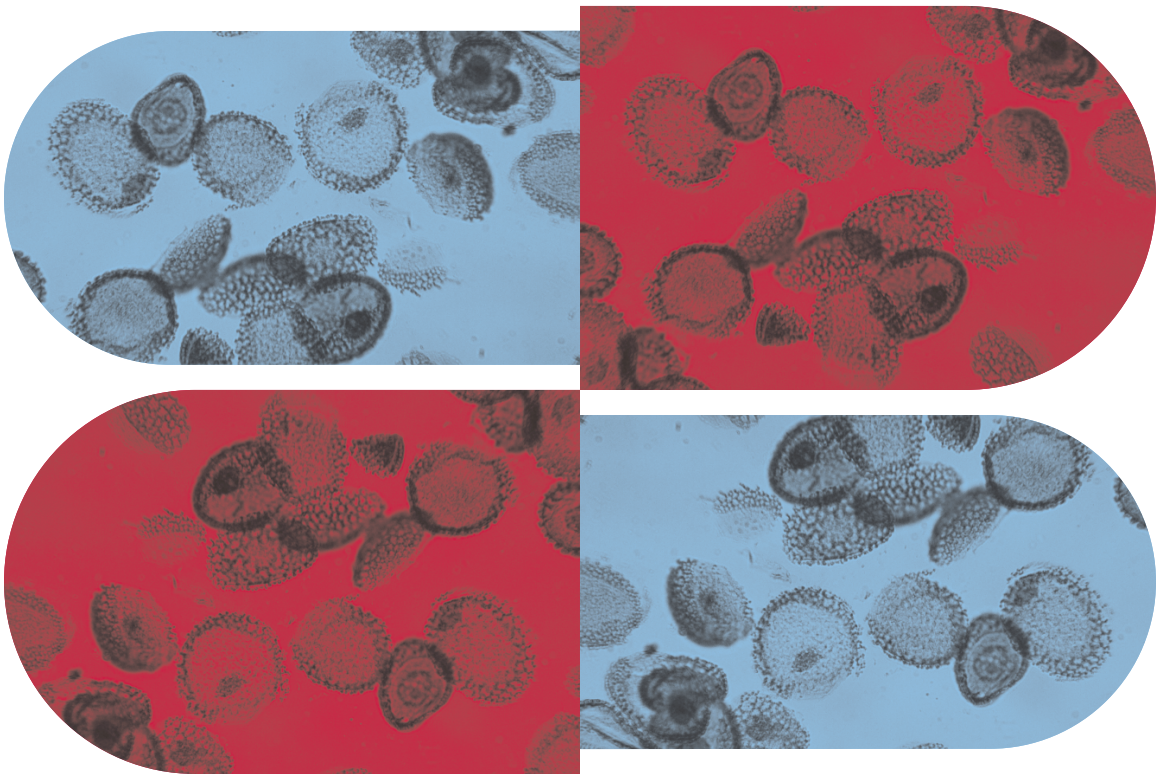
I am proud to offer this complimentary toolkit to organizations around the globe to proactively reduce antibiotic resistance and prevent serious infections.

Sincerely,

Barbara M. Soule, RN, MPA, CIC
Practice Leader, Infection Prevention and Control Services
Joint Commission Resources/Joint Commission International

What Every Health Care Executive Should Know:

The Cost of Antibiotic Resistance



Edited by Stephen Weber, M.D., M.S., and Barbara M. Soule, R.N., M.P.A., C.I.C.

Joint Commission Resources

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CHAPTER 1

Antibiotic Resistance: Patients and Hospitals in Peril

Stephen Weber, M.D., M.S.
Barbara M. Soule, R.N., M.P.A., C.I.C.

Why is the issue of antibiotic resistance important to you and your organization?

In the intensive care unit (ICU) of a large academic medical center, a nurse noticed a number of insects crawling on the open surgical wound of a patient. Expert consultation revealed that the insects were common houseflies at various stages of development. After investigation, the organization determined that the infestation was probably the result of a single housefly that passed through the hospital's entrance and made its way to the ICU.

Although the affected patient suffered no clinical consequences of the infestation and ultimately made a full recovery from his surgery, his family was upset and demanded action. Nursing, physician, and administrative leadership held an emergency meeting, and the chief executive officer (CEO) ordered a full investigation to ensure that this would not happen again.

On the same day the nurse observed the houseflies, two other patients in the ICU were battling bloodstream infections caused by methicillin-resistant Staphylococcus aureus *(MRSA), another had been placed on precautions because of the isolation of vancomycin-resistant* Enterococcus *(VRE), and a fourth died of overwhelming sepsis caused by a highly resistant gram-negative bacterium. No complaints were received from these patients or their families, no special meetings were called, the CEO was not informed, and no new measures were implemented.*

Could this happen at your institution?

Background: MDROs Are a Growing Problem

Over the past two decades, the incidence of infections among hospital patients caused by strains of bacteria that are resistant to conventionally used antibiotics has continued to rise, despite widespread efforts to control their spread.[1] These multidrug-resistant organisms (MDROs), which once affected only the most critically ill patients, have increasingly been identified as the cause of infection among an even larger population of considerably less ill patients. In the case of MRSA, resistance has even been observed among patients in the community without prior contact with the health care system.[2,3] These cases have received intensive attention in the medical literature and the popular press.

The proliferation of MDROs is largely believed to be driven by two major factors. First, antibiotic misuse or overuse by physicians and other prescribers has the unintended but ultimately predictable effect of selecting strains of bacteria that are able to evade the desired killing action of the drugs. These otherwise uncommon resistant organisms, genetically equipped to survive exposure to even powerful antibiotics, can reproduce and ultimately dominate the population of bacteria colonizing and infecting vulnerable individuals.

The second factor that has contributed to the explosion of MDROs is the transmission of antibiotic-resistant strains from individuals colonized or infected with these organisms to others. Most commonly, this so-called horizontal transmission occurs in health care facilities. In a hospital setting, the frequency with which individuals carry resistant bacteria is normally far greater than in the general population (outside of the hospital), making spread more likely.[4] More importantly, transmission is greatly facilitated by the intensity of contact between providers and patients and exacerbated by the failure of health care workers and others to comply with even the most basic methods of prevention, such as hand hygiene.

Recognition of these factors has informed the development and validation of evidence-based methods to prevent the emergence and spread of MDROs in both clinical and nonclinical settings. First, understanding the role that antibiotic *exposure* plays in precipitating the emergence of new resistant strains has led to the development and promotion of institutional and community policies that regulate the use of antibiotics that are likely to contribute to antibiotic resistance. These strategies range from restrictions on the prescription of some agents to marketing and promotional campaigns designed to temper the frequently intense but unrealistic demand for these drugs among patients in some outpatient settings.[5]

Second, a host of measures have been studied, validated, disseminated, and even legislated to prevent the *transmission* of MDROs. Principal among these tools are measures designed to serve as barriers to the transmission of MDROs by health care workers or from one patient to another. These include campaigns to improve persistently inadequate rates of hand hygiene performance,[6] address contamination of equipment,[7] identify appropriate isolation procedures, and implement aggressive surveillance strategies designed to detect previously unknown colonization among patients so that appropriate precautions can be implemented.[8]

Table 1-1

Preventing Antimicrobial Resistance in Health Care Settings

The Centers for Disease Control and Prevention's (CDC's) Campaign for Preventing Antimicrobial Resistance In Health Care Settings promotes four main strategies for clinicians and educators to use to prevent resistance among different groups of patients. For hospitalized adults these include the following:

1. Prevent infections	Step 1. Vaccinate Step 2. Get the catheters out
2. Diagnose and treat infections effectively	Step 3. Target the pathogen Step 4. Access the experts
3. Use antimicrobials wisely	Step 5. Practice antimicrobial control Step 6. Use local data Step 7. Treat infection, not contamination Step 8. Treat infection, not colonization Step 9. Know when to say "no" to "vanco" Step 10. Stop antimicrobial treatment
4. Prevent transmission	Step 11. Isolate the pathogen Step 12. Break the chain of contagion

Full text and tools for the campaign are provided by the CDC and can be found at http://www.cdc.gov/drugresistance/healthcare/ha/12steps_HA.htm.

In addition, many established infection prevention strategies—particularly those designed to prevent common device-related infections (including central line–related bloodstream infection and ventilator-associated pneumonia), while not specifically targeting MDRO—have the benefit of reducing the risk of infection from all pathogens.

The Centers for Disease Control and Prevention (CDC) has promoted a comprehensive campaign to reduce antimicrobial resistance in health care organizations. The program consists of four basic approaches (see Table 1-1, above). It also provides multiple tools for health care providers and educators and is modified for various populations, including adult, pediatric, and dialysis patients.

Impact of MDROs on the Health Care System

Despite widespread awareness and frequently intensive application of the above-mentioned strategies, the prevalence and incidence of infections caused by MDROs continues to increase.[1] For example, diarrhea caused by *Clostridium difficile* has increased several-fold at some organizations,[9] and more aggressive strains have emerged. Other recent reports describe a dramatic increase in the number of patients affected by MRSA[10] and particularly poor outcomes from invasive disease.[3] The consequences of these trends have exacted an enormous

toll on the U.S. health care system. MDROs have been associated with increased risk of worsened clinical outcomes, including increased risk of death in some patient populations.[11–13] The dramatic increase in the frequency of infections caused by MDROs, the higher risk of death associated with each such infection, and the lack of promising new pharmaceutical agents to treat these infections pose significant challenges to the health care system.

The economic consequences of MDROs are also disturbing and are felt most acutely by individual institutions. The average cost of caring for a patient with an infection caused by an MDRO is certainly greater than the cost of caring for a patient without infection and is also often two times greater than the cost of caring for a patient with an infection caused by an organism that is susceptible to antibiotics.[14–15] Many of these costs are associated with the prolonged lengths of inpatient hospital stay associated with the management of patients colonized or infected with an MDRO. As a result, the costs associated with caring for these patients are due not only to the direct costs of managing infection (e.g., diagnostic assays and newer, more powerful antibiotics) but also to the indirect opportunity costs such as lost wages or stays in extended care.[16] For example, patients with infections caused by MDROs are likely to occupy hospital beds for extended periods of time, limiting throughput and potentially impacting an organization's bottom line.

The clinical and economic pressures of managing resistance have been magnified in the past several years, and increasingly, the suboptimal performance in controlling MDROs in acute care hospitals and other clinical settings has drawn scrutiny from inside and outside the health care industry. Vocal and organized advocates for higher standards for patient safety and clinical quality are demanding greater transparency and commitment to the control and prevention of infections caused by MDROs, particularly MRSA. These efforts have placed mounting pressure on health care facilities. For example, pay-for-performance initiatives have been proposed that would limit reimbursement for infection among hospital patients caused by MRSA.[17]

New legislative and regulatory demands at the local, state, and federal levels are compelling the development of expanded clinical and administrative infrastructure and resources to meet the demands of additional data collection, surveillance, and reporting (often to the general public). For the most part, however, these legislative and regulatory mandates have not been accompanied by the allocation of new funding or modified reimbursement to support the required programs and initiatives.

Finally, increased media and public attention surrounding MDROs can pose a threat to institutions through increased medical liability and decreased market perception. Although these various initiatives and trends may appear overwhelming to leaders at even the most well-resourced organizations, at this point, it is clear that the costs of *not* acting are far too great (see Table 1-2 on page 5).

Table 1-2

Rationale for MDRO Control

Clinical consequences of MDROs	Worsened patient morbidity and mortality
Economic consequences of MDROs	Increased costs of managing individual patients, opportunity costs, and costs of control programs
Legislative mandates	Increasing numbers of U.S. states require specific surveillance strategies; many more promote or mandate public reporting
Pay-for-performance measures	Proposals to include MRSA in CMS programs linked to decreased hospital reimbursement
Public image and reputation	Patient advocacy groups and media increasingly focused on MDRO preparedness
Medicolegal liability	Lawsuits linking MRSA infection with hospital/provider neglect

MDRO, multidrug-resistant organism; MRSA, methicillin-resistant *Staphylococcus aureus*; CMS, Centers for Medicare & Medicaid Services.

Challenges Faced by Institutional Leadership

Health care executives must consider the growing threat posed by MDROs, along with an already lengthy list of hazards—real and perceived—faced at all institutions. As a result, the clinical and financial burdens of MDROs must be weighed against the impact of other organizational challenges. Unlike the financial implications of a disrupted supply chain or the clinical consequences of inadequate nurse staffing, which are readily measured, the impact of MDROs on an organization can be difficult to quantify. Even when the clinical and financial costs of MDROs can be accurately assessed, the development and deployment of a successful prevention and control campaign may be hindered by the challenge of identifying appropriate objectives, making up-front investments, and accurately and reliably measuring performance and program effectiveness. Ultimately, the likelihood of success is contingent upon the organization's overall state of readiness, which itself requires the alignment of culture and infrastructure, paired with the meaningful engagement of key stakeholders.

The circumstances surrounding MDRO control are seemingly becoming even more complicated for health care executives to navigate. Media reports about the dangers of MDROs, paired with increasingly common personal experiences, have had a profound influence on the outlook of institutional board members who are demanding answers—and often immediate action—from senior management. In addition, this increased public focus on MDROs has led to misinterpretation of data, unnecessarily prompting affected institutions to *conceal* at a time when *transparency* is most critical.

Table 1-3

Elements of an Effective MDRO Control Program

1. **MDRO and Infection Control Risk Assessment**
   Comprehensive evaluation of clinical and economic consequences of MDROs within the organization
2. **MDRO and Infection Control Performance Assessment**
   Quantitative examination of current practices (e.g., hand hygiene, compliance with isolation precautions) in order to identify opportunities for improvement
3. **Antibiotic Stewardship**
   Continuous assessment of prescribing practices and trends in resistance to direct interventions to optimize antibiotic use
4. **Transmission Control**
   Comprehensive and interdisciplinary program to limit the spread of MDROs between patients via unwashed hands, personal equipment, or the hospital environment
5. **Education**
   Comprehensive approach to educating both frontline staff and hospital leadership about the scope and consequences of MDROs and their particular role in preventing spread

MDRO, multidrug-resistant organism.

Pay-for-performance, regulatory, and even legislative measures have been adopted, challenging executives to undertake complex analyses to determine the return on investment of specific measures. Unfortunately, expert guidance to direct practical and effective implementation standards is lacking. The CDC guidelines for the control of MDROs offer a multitude of different strategies and interventions without detailed recommendations regarding implementation and prioritization.[18] Even at organizations where clinical and administrative leaders are actively collaborating to develop and deploy an MDRO control plan, forming a rational, effective, and efficient approach remains a challenge.

Overview of an Effective MDRO Control Plan

The development of an effective control plan (see Table 1-3, above) must begin with a detailed assessment of the clinical and economic risks of MDROs to the organization. However, as has previously been noted, it is difficult to compare the *potential* benefit of preventing infections caused by MDROs with the impact of another new clinical program or other patient safety initiatives, such as fall prevention or optimal disease management. Without adequate risk assessment, these decisions are apt to be made in an uninformed and potentially arbitrary fashion that may lead the organization down the wrong path for meeting requirements and reducing risk.

If effective *risk assessment* for MDROs is uncommon at many institutions, then comprehensive *performance assessment* is rarer still. Even at institutions with robust programs to prevent the emergence and spread of MDROs, surprisingly limited effort is generally given to testing the effectiveness and potential consequences of strategies that have already been adopted. Few organizations have maximized the potential of basic measures to control the spread of MDROs. For example, at the University Hospital in Geneva, the home base of many World Health Organization (WHO) initiatives to promote hand hygiene, it is reported that as many as one in three encounters between patients and health care workers are not accompanied by appropriate disinfection of the hands.[6] Moreover, given that some widely promoted measures to prevent the spread of MDROs have been associated in the medical literature with the unintended consequences of reduced patient satisfaction and safety,[19] it is critical to continually examine any institutional plan or program that is undertaken and sustained.

Even for the CEO or senior manager equipped with timely and reliable information about MDRO risks and prevention performance, the need remains to determine how best to implement and optimize an effective institutional control plan. Because of the diverse clinical and economic impact of MDROs, a comprehensive strategy is required—one that cuts across clinical departments, service lines, and the domains of various managers and executives. How can an effective plan be conceived, implemented, and sustained? Perhaps more importantly, what steps need to be taken to ensure that an institution is prepared for such an undertaking and can sustain the necessary changes in practice, outlook, and even philosophy? Is there a culture of safety to support this endeavor? The development of an effective and comprehensive institutional MDRO control program is likely to test the improvement capacity of even the highest-performing organization. Ultimately, the optimal program will include adequate elements of risk and performance assessment, clear statements of goals and deliverables, and a plan to communicate the content and impact of the program both up the organizational hierarchy (to the board of governance, for example) and down to frontline staff.

Overview of the Toolkit

This toolkit aims to provide chief executives and their leadership teams with the information and tools needed to initiate, promote, and sustain an effective MDRO control program that is tailored to institutional needs as well as strengths and weaknesses. The guide and accompanying CD are uniquely designed for hospitals of all sizes and at all stages of MDRO control program development. This does *not* mean that one size fits all or that every institution will establish an identical (and generic) control program. Rather, organizational MDRO control plans are expected to vary considerably from facility to facility, a reflection of the unique challenges faced by each. Because of the variation in patients, institutions, and providers, even this toolkit is limited in scope (see Sidebar 1-1 on page 8).

The central role for risk and performance assessment in formulating a program that is uniquely tailored to your organization has already been discussed. Using the included

Sidebar 1-1

Scope and Limitations

Although the toolkit is designed to provide a comprehensive and practical overview of the control and prevention of MDROs for hospital executives, no single resource can cover all aspects of this continuously evolving field. In preparing this book and the accompanying tools, a number of important aspects of MDRO control had to be omitted. For example, the book contains limited discussions regarding pediatric care and the management of MDROs outside the acute care hospital setting (such as in long term care facilities and even in the community among healthy individuals).

It is also worth noting that difficult decisions had to be made in determining the breadth of drug-resistant pathogens discussed in the toolkit. Ultimately, the decision was made to focus not only on those pathogens that are most commonly associated with health care associated infections, but particularly those organisms that are most easily spread from patient to patient in hospitals—especially in the setting of antibiotic use, hence the inclusion of *Clostridium difficile*-associated diarrhea without discussion of infections with *Candida species.*

MDRO, multidrug-resistant organism.

practical risk assessment tools that actually quantify the clinical and financial tolls of MDROs at your institution, you will be best positioned to ensure that the resources to control MDROs are appropriately allocated. Moreover, by applying the tools for performance assessment that are also included, you will gain valuable insight into the extent to which established (and future) initiatives benefit your organization.

The modular approach to solutions described in detail in the section below is also a unique feature of this toolkit. Different aspects (risk assessment, transmission control, antibiotic stewardship) can be examined, resourced, and potentially implemented independent of one another. This recognizes not only the diversity among organizations in terms of resources, clinical and economic profiles, and existing programs but also acknowledges the varied resources that might need to be deployed to control MDROs. As discussed in the chapters that follow, a range of individuals, disciplines, and services will likely be called upon to participate in an effective control program in an institution.

The impact of MDROs and the potential effectiveness of control strategies are distributed both horizontally across clinical and nonclinical units at an institution and vertically from leadership to frontline staff. MRSA and other MDROs may be detected on everything from the hands of an unwary executive making management rounds, to the stethoscope of a nurse, to the dirty mop of an environmental services worker. As a result, the tools an organization uses to effect change will need to be distributed up, down, and across its hierarchy. Even if executive leadership institutes a policy regarding hand hygiene in conjunction with clinical leadership, unless frontline staff members are aware of the importance of this measure and are held accountable for performance, hand hygiene compliance will likely be low, and MDROs will continue to proliferate. Recognizing this need, this toolkit provides specific tools and

resources meant to be deployed at various levels of the organization, including senior management where many of these decisions are made, frontline staff, and the middle level of clinical and administrative leadership where actions are implemented.

Throughout the toolkit, a premium is placed on the specific quantification of risk, burden, benefit, harm, effectiveness, and success. Health care executives, like clinicians, have moved beyond an era of descriptive considerations and practices based on anecdotes. Payers, patients, and boards are demanding hard evidence.

The toolkit begins with two chapters designed to allow you to understand the burden of MDROs at your institution. In Chapter 2, "The Clinical Consequences of Antibiotic Resistance," Thomas Talbot, M.D., provides a comprehensive look at how to measure just how many sick patients are at your institution because of the failure to control MDROs. In Chapter 3, "The Financial Impact of Antibiotic Resistance," Keith Kaye, M.D., offers a unique and timely perspective on measuring the financial impact of MDROs at the institutional level. Gone are the days of "back of the envelope" calculations performed just before quarterly infection control meetings.

The tools for implementing change are discussed in the next two chapters. In Chapter 4, "Transmission Control to Prevent the Spread of MDROs in Health Care Facilities," Christopher Crnich, M.D.; Stephen Weber, M.D., M.S.; and Barbara M. Soule, R.N., M.P.A., C.I.C., outline effective strategies to prevent the spread of antibiotic resistance. In Chapter 5, "Antibiotic Stewardship," Paul Cook, M.D., discusses the importance of antibiotic stewardship. Managing the prescription of antibiotics at your institution can not only yield important benefits in reducing the pressures that might otherwise contribute to the emergence of resistant strains but also have enormous benefit to the institution's bottom line by minimizing the use of needless and expensive antibiotic therapy.

Of course, before such measures can be enacted, leadership must prepare the institution for such change. In Chapter 6, "Challenges on the Path to Higher Performance," David Boan, Ph.D., and Deborah Nadzam, R.N., Ph.D., offer a thoughtful review to guide health care executives in determining their organization's capabilities to make and sustain change related to antibiotic resistance.

Structure of the Chapters

Several unique aspects of this toolkit, including vertical integration and a modular format, are key to distinguishing it from others currently available. These unique factors are embedded in the chapters themselves. Each opens with fictional case study and then provides solid background information on the problem or intervention to be discussed. This background is designed to provide a broad overview primarily targeted at health care executives and other individuals with a relative lack of applied experience with the concepts and techniques discussed and without extensive clinical background.

The narrative discussion is punctuated by illustrative figures and tables, success stories, helpful hints, and links to other resources outside of this toolkit. Hopefully, these sidebars not only complement the primary narrative but will serve as inspiration for additional interventions and strategies. You are encouraged to share these within your organization.

The narrative will also point you to specific tools that are included on the accompanying CD. These tools were developed in conjunction with our expert authors and are designed to be of benefit across the organization. Where appropriate, specific examples for applying the tool are included to highlight how effective they could be in practice. In all cases, the focus is on practical tools that you can use to assess the threat of MDROs in your organization and establish or evaluate prevention and control strategies.

Finally, each of the chapters begins with a particular question—a simple query that captures the essence of what is at stake in the control of MDROs. If you are still not certain whether your institution needs to undertake a major initiative for MDRO control, the first step is not to realign institutional goals, reevaluate budget allocations, or even to convene a new task force or committee. Rather, you are invited to start by asking these simple questions to those at your institution who *should* know the answers. If you cannot get a satisfactory response, or if you find the results surprising or disappointing, read on.

References

1. National Nosocomial Infections Surveillance System: National Nosocomial Infections Surveillance (NNIS) System Report, data summary from January 1992 through June 2004, issued October 2004. *Am J Infect Control* 32:470–485, Dec. 2004.
2. Liu C., et al.: A population-based study of the incidence and molecular epidemiology of methicillin-resistant *Staphylococcus aureus* disease in San Francisco, 2004–2005. *Clin Infect Dis.* 46:1637–1646, Jun. 2008.
3. Klevens R.M., et al.: Active Bacterial Core surveillance (ABCs) MRSA Investigators. Invasive methicillin-resistant *Staphylococcus aureus* infections in the United States. *JAMA* 298:1763–1771, Oct. 2007.
4. Harris A.D., et al.: Co-carriage rates of vancomycin-resistant *Enterococcus* and extended-spectrum beta-lactamase-producing bacteria among a cohort of intensive care unit patients: Implications for an active surveillance program. *Infect Control Hosp Epidemiol* 25:105–108, Feb. 2004.
5. Dellit T.H., et al.: Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America guidelines for developing an institutional program to enhance antimicrobial stewardship. *Clin Infect Dis* 44:159–177, Jan. 2007.
6. Pittet D., et al.: Effectiveness of a hospital-wide programme to improve compliance with hand hygiene. *Lancet* 356:1307–1312, Oct. 14, 2000.
7. Dancer S.J.: Importance of the environment in methicillin-resistant *Staphylococcus aureus* acquisition: The case for hospital cleaning. *Lancet Infect Dis* 8:101–113, Feb. 2008.
8. Robicsek A., et al.: Universal surveillance for methicillin-resistant *Staphylococcus aureus* in 3 affiliated hospitals. *Ann Intern Med* 148:409–418, Mar. 18, 2008.
9. McDonald L.C., Owings M., Jernigan D.B.: *Clostridium difficile* infection in patients discharged from US short-stay hospitals, 1996–2003. *Emerg Infect Dis* 12:409–415, Mar. 2006.
10. Jarvis W.R., et al.: National prevalence of methicillin-resistant *Staphylococcus aureus* in inpatients at US health care facilities, 2006. *Am J Infect Control* 35:631–637, Dec. 2007.
11. Cosgrove S.E., et al.: Comparison of mortality associated with methicillin-resistant and methicillin-susceptible *Staphylococcus aureus* bacteremia: A meta-analysis. *Clin Infect Dis* 36:53–59, Jan. 1, 2003.
12. DiazGranados C.A., et al.: Comparison of mortality associated with vancomycin-resistant and vancomycin-susceptible enterococcal bloodstream infections: A meta-analysis. *Clin Infect Dis* 41:327–333, Aug. 1, 2005.
13. Kwon K.T., et al.: Impact of imipenem resistance on mortality in patients with *Acinetobacter* bacteraemia. *J Antimicrob Chemother* 59:525–530, Mar. 2007.
14. Engemann J.J., et al.: Adverse clinical and economic outcomes attributable to methicillin resistance among patients with *Staphylococcus aureus* surgical site infection. *Clin Infect Dis* 36:592–598, Mar. 1, 2003.
15. Webb M., Riley L.W., Roberts R.B.: Cost of hospitalization for and risk factors associated with vancomycin-resistant *Enterococcus faecium* infection and colonization. *Clin Infect Dis* 33:445–452, Aug. 15, 2001.
16. Perencevich E.N., et al.: Society for Healthcare Epidemiology of America. Raising standards while watching the bottom line: Making a business case for infection control. *Infect Control Hosp Epidemiol* 28:1121–1133, Oct. 2007.
17. Centers for Medicare & Medicaid Services: *Medicare Program; Proposed Changes to the Hospital Inpatient Prospective Payment Systems and Fiscal Year 2008 Rates.* Apr. 2007. http://www.cms.hhs.gov/AcuteInpatientPPS/downloads/CMS-1533-P.pdf (accessed Sep. 6, 2008).
18. Muto C.A., et al.: SHEA guideline for preventing nosocomial transmission of multidrug-resistant strains of *Staphylococcus aureus* and *Enterococcus. Infect Control Hosp Epidemiol* 24:362–386, May 2003.
19. Stelfox H.T., Bates D.W., Redelmeier D.A.: Safety of patients isolated for infection control. *JAMA* 290:1899–1905, Oct. 8, 2003.

On the CD

MDRO Risk Assessment Primer
Which patients in which care areas are most vulnerable to which MDRO at your hospital? The MDRO Risk Assessment Primer offers an introduction to the complex process of understanding how MDROs affect patients and staff at your organization. The primer provides guidance on all aspects of risk assessment, from planning to execution using a linear, systematic methodology. The document encourages a multidisciplinary approach to this process for best results and leadership engagement in recognizing and confronting the greatest threats.

Considerations for Enhanced Risk Assessment
For organizations already adept at the basics of MDRO risk assessment, more sophisticated analysis can frequently reveal ongoing risk to specific populations in the hospital. The catalog of considerations for advanced risk assessment offers ideas to enrich and customize your existing risk-assessment program. Identify vulnerable patients and apply the other tools in this toolkit to ensure that your MDRO control plan is truly comprehensive.

Sample Risk Assessment Matrix
A custom-made organizational MDRO risk matrix is an important tool for risk assessment at many hospitals. The examples provided here offer a semiquantitative method to assess risk related to MDROs at your organization. Select specific topics pertinent to your organization and to proven strategies to populate the potential risk column. Then, using data, information, and experience, determine the score for each item in each column. By totaling the numbers across the row, you will calculate a numerical value for each potential risk event. When all risks have been evaluated, select those with the highest ranking to tackle first.

Dashboard for MDRO Reporting
Preventing MDROs must be a priority and commitment across the organization, from the frontline clinical staff to the Board of Trustees. The dashboard provides a comprehensive overview at a glance of not only the frequency and distribution of MDROs at your hospital but also adherence to core transmission control and antibiotic stewardship practices and the impact of new initiatives.

Competency Questions
Incorporating content about MDROs into ongoing staff educational programs for quality, safety, and infection prevention helps the learner integrate information into practice. The sample questions about the basic epidemiology and global scope of MDROs included in this tool can be administered to clinical and (for some questions) nonclinical staff in written or electronic format to help get your entire team on board with preventing MDROs.

CEO Talking Points
Stay “on message” about MDROs with this slide presentation that summarizes the overview of MDROs described in Chapter 1. The slides are designed to be equally suitable for presentation to the hospital governing board or to frontline clinical and nonclinical staff. The slides can be combined with those from the other chapters to create a customized and comprehensive presentation about MDROs at your organization. If a formal presentation is not planned, just try dropping these key points into your comments and feedback during leadership rounds on the wards.

CHAPTER 2

The Clinical Consequences of Antibiotic Resistance

Thomas R. Talbot, M.D., M.P.H.

How many patients at your institution died last year as a result of infection with multidrug-resistant organisms?

Ms. Jones and Ms. Smith, both 56-year-old women with a history of diabetes mellitus, undergo elective total knee replacements at your facility on the same day. Both procedures are reportedly uneventful and there are no intraoperative complications. Postoperatively, both patients have a central venous catheter (CVC) placed to deliver fluids and pain medication. On hospital day 4, the planned discharge date for both patients, they both develop a high fever and elevated white blood cell count. Later that day, although Ms. Jones remains clinically stable, Ms. Smith's blood pressure drops, requiring transfer to the surgical intensive care unit (ICU). Blood cultures drawn at the time of the initial fever return positive for each patient. Cultures from Ms. Jones grow methicillin-susceptible Staphylococcus aureus *(MSSA), a strain that is susceptible to most of the antibiotics to which it is tested. Blood cultures from Ms. Smith, however, grow methicillin-resistant* Staphylococcus aureus *(MRSA).*

Following a course of intravenous (IV) antibiotics and removal of her CVC, Ms. Jones is discharged home 7 days post-procedure, where she has a complete recovery. Ms. Smith, despite IV antibiotics and removal of her CVC, requires continued support for low blood pressure and is placed on a ventilator for respiratory distress. Blood cultures from Ms. Smith continue to grow MRSA. After 6 days in the ICU, Ms. Smith's condition worsens, as she develops renal failure requiring hemodialysis and progressive ventilatory support. On hospital day 12, she sustains cardiac arrest and dies.

Background

This realistic example illustrates some of the serious consequences experienced by patients infected with multidrug-resistant organisms (MDROs) such as MRSA, vancomycin-resistant *Enterococcus* (VRE), and multidrug-resistant (MDR) gram-negative bacteria such as *Acinetobacter* and *Pseudomonas*. MDRO infections can have serious and lasting consequences for both the infected patient and the health care facility where the patient is receiving care. This chapter will highlight the clinical consequences associated with MDRO infection to provide executives and other organizational leaders with the essential information needed to understand the clinical impact of MDROs, prioritize strategies for prevention, and understand their roles in MDRO control.

To determine the clinical impact of MDRO infections at a specific institution, health care executives must examine two principal factors related to the epidemiology, microbiology, and physiology of the organism in question. First, how frequent are MDRO infections among patients at the institution? Pathogens that cause great morbidity and mortality but occur rarely (such as avian influenza) may not have a huge impact to the population or a health care facility in the absence of an outbreak. In contrast, an organism associated with only a slightly increased risk for complication or death could be a major problem for patients and hospitals if infections with this organism occur frequently (such as catheter-associated urinary tract infections).

Second, if a person is infected with an MDRO, is the risk of a poor clinical outcome for that patient increased, particularly when compared to a patient who develops a similar infection with an organism that is more susceptible to antibiotics? Some MDROs are more virulent and aggressive than antibiotic-susceptible pathogens. This may be the result of the production of specific toxins or factors that cause tissue damage or impede the normal immune response. Alternatively, the MDRO infection could manifest with atypical or unexpected symptoms that may cause a delay in recognition, diagnosis, and institution of appropriate treatment. A delay in the timely administration of appropriate antibiotics has been associated with an increased risk of complication and death for many infections.[1–3]

Determining the Burden of MDRO Infection

Determining the overall frequency of antibiotic resistance as well as the risk of morbidity and mortality with each MDRO infection is challenging, but it is a necessary first step for health care executives who seek to develop and support an effective control program. To complete this crucial risk assessment, input will be required from experts in infectious diseases, microbiology, infection prevention, and epidemiology. An overview of this process is discussed in the paragraphs that follow.

Frequency of MDROs

Quantify the burden of MDRO infection at your organization by determining the overall frequency of antibiotic resistance as well as the risk of morbidity and mortality with each infection.

Although a precise estimate of the frequency of MDRO infections at an institution may be somewhat easier to quantify than the specific risks associated with individual infections, methodological considerations render even this step a challenge. In general, there are two methods to assess the frequency of a particular MDRO at an institution.[4] The first method describes the *proportion* of all bacterial specimens or isolates of the pathogen of interest that were antibiotic-resistant which were collected from patients during a specific time period. For example, to quantify the burden of MRSA one would examine the proportion of all isolates of *Staphylococcus aureus* detected that were methicillin-resistant (i.e., number of MRSA isolates/total number of *Staphylococcus aureus* isolates). To prevent overestimation of the proportion of resistant isolates, only the first bacterial isolate per patient is included in these calculations. At larger hospitals, this approach is often part of the routine analysis performed by the infection prevention/ epidemiology team to assess trends in institutional antibiotic resistance. This method is typically also used to compile periodic antibiotic susceptibility reports (antibiograms). This approach is valuable to clinicians treating infected patients, as it allows for the selection of empiric treatment that will most likely be effective in treating the predominant pathogens.

A second method to assess the frequency of MDROs in a hospital population is the determination of a true *incidence rate* (i.e., the absolute number of new MDRO isolates or infections in a population per unit of time), such as the rate of serious infection with VRE in a three-month period. The denominator measurement may simply be a period of time (e.g., per month) or may be modified to more accurately capture the at-risk population (e.g., per 100 hospital admissions, or per 100 occupied beds per month). For additional precision, the incidence of MDROs causing specific types of infections could also be quantified (e.g., the incidence of MRSA pneumonia in patients on mechanical ventilation expressed as the number of infections per 1,000 ventilator days).

Compared to the proportions method, the use of incidence rates is more accurate and informative for examining the true burden of disease and understanding MDRO trends over time. The incidence method is also independent of the population of antibiotic-susceptible organisms. With the proportion method, a change in the population of susceptible organisms will affect the proportion of MDROs even if the number of cases of MDRO infection is unchanged. The two methods present different pictures of the status of MDROs in the facility, and it is important for health care executives and others who receive the data to understand these differences (see Figure 2-1 on page 16). Ultimately, the incidence rate is a better determinant of the true burden of MDRO infections at a facility because such data may be

Compared to the proportions method, the use of incidence rates is more accurate and informative for examining the true burden of disease and understanding MDRO trends over time.

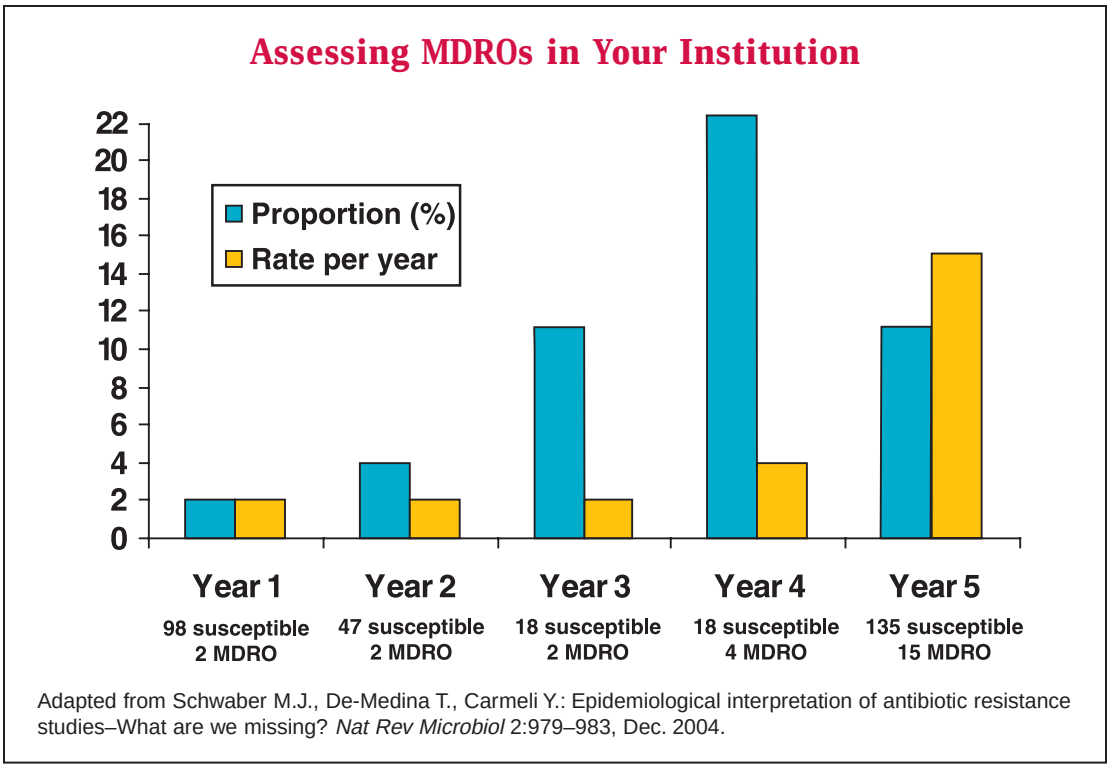


Figure 2-1. This figure shows differences in two assessments of the epidemiology of MDROs at a health care facility. *Proportion* refers to the proportion of all isolates (antibiotic-susceptible and MDRO) detected at the facility that are multidrug-resistant. *Rate*, in this example, refers to number of isolates of MDROs identified at the facility per year. Note the different interpretations of MDRO trends based on measurement used. If one examines proportions, then the assessment of MDRO burden would be a several-year increase and then a decline. Examining rates, however, reveals a stable burden of MDROs followed by a steep rise in year 5. MDRO, multidrug-resistant organism.

examined at a unit- or care-center level to allow for direct assessments of variations in the burden of MDROs within the facility, gauge performance of clinical leadership on MDRO control, and target interventions intended for MDRO prevention to areas of higher burden. A recent paper from the Society for Healthcare Epidemiology of America (SHEA) and the Healthcare Infection Control Practices Advisory Committee (HICPAC) of the Centers for Disease Control and Prevention (CDC) describes in detail various metrics for multidrug-resistant organisms in health care settings.*

Impact of MDRO Infection on Individual Patient Outcomes

An important question is whether infection with an MDRO leads to worsened patient outcomes, such as mortality. This is a question that can be difficult to answer. One basic but key impact of MDRO infections rests on the limitation such organisms place on treatment options for infected patients. For organisms that are antibiotic-susceptible, there are

* See Cohen A.L. et al.: Recommendations for metrics for multidrug-resistant organisms in healthcare settings: SHEA/HICPAC position paper. *Infect Control Hosp Epidemiol* 29:10:901–913, Oct. 2008.

generally a number of available antibiotics that target different pathogen defenses, thus providing greater opportunity for helping the patient defeat the infection. MDROs, by definition, are resistant to many individual and classes of antibiotics, thus limiting the available treatment options. In other words, clinicians have fewer available "weapons" to treat and, hopefully, cure MDRO infections.

For some highly resistant pathogens (such as multidrug-resistant *Acinetobacter baumannii*), the number of available antibiotics to treat infected patients may be reduced to only one or two options, which often have more toxic side effects than commonly used agents. Adding to this concern for some MDROs is the limited development of novel classes of antibiotics targeting these bacteria, leaving no options for the treatment of these organisms for the foreseeable future. This can be an extremely important issue for empirical treatment for hospitalized patients (i.e., before the identification of the infecting pathogen and the availability of data on its specific antibiotic sensitivities) because for many infections, successful early empiric coverage of the infecting pathogen leads to improved patient outcomes.[1–3] The chance that an empiric treatment regimen will not adequately treat the underlying organism is greater with an MDRO infection, and this can contribute substantially to patient morbidity and mortality. For the health care executive, understanding and communicating this important issue with regard to MDRO infections will help all stakeholders understand one of the major challenges of dealing with MDRO infections.

For some highly resistant pathogens, the number of available antibiotics to treat infected patients may be reduced to only one or two options, which often have more toxic side effects than commonly used agents.

Further complicating matters, patients who develop MDRO infections, particularly those due to strains acquired during hospitalization, often have multiple medical conditions (e.g., immunosuppression, cardiac disease, respiratory disease) that increase their risk for developing an MDRO infection and may also themselves lead to an increased risk of complications and death. In these cases, the major question is whether an increase in mortality associated with antibiotic resistance is due to (1) virulence factors specific to the resistant pathogen, (2) delays in delivery of adequate antibiotic therapy or incorrect empiric treatments that fail to cover the more resistant organism, (3) underlying patient conditions, or (4) a combination of all of these factors.

Hence, when seeking to determine whether patients at your organization infected with MDROs have an increased risk of dying, it is important to carefully select the group for comparison. Specifically, comparing the mortality of MDRO–infected patients with that of noninfected patients can really only provide information about the mortality risk from the infection itself, not specifically the fact that the infection was due to an MDRO. To truly assess the impact of MDRO infections compared to non–MDRO infections, one must compare the risk of mortality (and other outcomes) in those persons infected with an MDRO (e.g., MRSA) to persons with a similar infection type due to a more susceptible strain of the organism (e.g., MSSA).

Types of MDRO Infections

Below is a discussion of several types of MDROs with information that should aid health care executives and their teams in assessing the effect of a given MDRO in their facilities. The information is intended to inform health care executives about the severity of three major types of MDRO infections: MRSA, VRE, and MDR gram-negative bacteria (see Table 2-1 on page 18). Although administrative leaders are not solely responsible for evaluating and integrating this information into an institutional MDRO control plan, it is essential that executives understand the complexity involved and ensure that those who are developing the plan are doing so based on valid assessments. This should also serve as important information to disseminate to senior leadership, clinical directors and managers, and frontline health care workers to emphasize the serious impact MDRO infections have on the patients cared for in their facilities and how the presence of such infections can result in lower quality and unsafe patient care.

Table 2-1

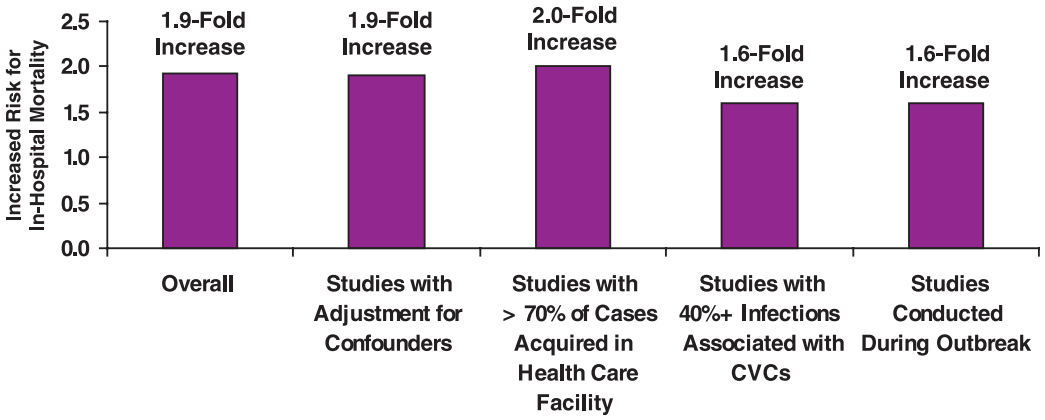
Summary of Morbidity and Mortality Data

Type of MDRO	Risk of Morbidity	Risk of Mortality
MRSA	Prolonged length of stay and increased cost of care, even when compared to patients infected with susceptible strains of *Staphylococcus aureus*	Increased risk of death for patients with bloodstream infection, pneumonia, and surgical site infections.
VRE	Increased length of ICU stay and overall duration of hospitalization for patients infected with VRE	Risk of death is at least two-fold higher for patients infected with VRE in the blood
MDR gram-negative bacteria	Associated with significantly increased length of stay in the hospital and the ICU in particular	Nearly a four-fold risk of death from sepsis among patients infected with certain strains

ICU, intensive care unit; VRE, vancomycin-resistant *Enterococcus*.

MRSA

Risk of Mortality. Mortality differences between MRSA and MSSA infections have been examined in a variety of populations and infection types, which are reviewed in some detail in the following paragraphs. Bloodstream infections (BSI) occur frequently in hospitalized patients, and strains of *Staphylococcus aureus* (both MRSA and MSSA) account for a large proportion of these infections. One group of researchers conducted a meta-analysis of published studies and noted nearly a doubled risk of in-hospital mortality in patients with



Adapted from Cosgrove S.E., et al.: Comparison of mortality associated with methicillin-resistant and methicillin-susceptible *Staphylococcus aureus* bacteremia: A meta-analysis. *Clin Infect Dis* 36:53–59, Jan. 1, 2003.

Figure 2-2. A meta-analysis of published studies revealed nearly a doubled risk of in-hospital mortality in patients with MRSA BSIs. BSI, bloodstream infection; MRSA, methicillin-resistant *Staphylococcus aureus*; MSSA, methicillin-susceptible *Staphylococcus aureus*; CVC, central venous catheter.

MRSA BSIs.[5] This increase remained when restricting their analysis to studies in which the majority of BSIs were acquired in a health care facility, to those where a majority of infections were associated with central venous catheters, and to those conducted during an institutional outbreak of the pathogen (see Figure 2-2, above). Subsequent studies examining the risk of mortality in patients with BSI due to MRSA have noted similar disquieting increases in mortality among persons age 65 years or older with hospital-acquired MRSA BSI[6] and among hemodialysis patients with MRSA BSI.[7]

Staphylococcus aureus—MRSA in particular—is also one of the most common causative pathogens for ventilator-associated pneumonia (VAP), making examination of MRSA's impact on mortality in patients with VAP quite important. A recent analysis of eight published studies on the impact of VAP due to MRSA (versus disease due to MSSA) noted a two-fold increase in both crude hospital and ICU mortality in those patients with an MRSA VAP.[8]

Studies examining the impact of VAP due to MRSA (vs. disease due to MSSA) showed a two-fold increase in crude hospital and ICU mortality in patients with an MRSA VAP.

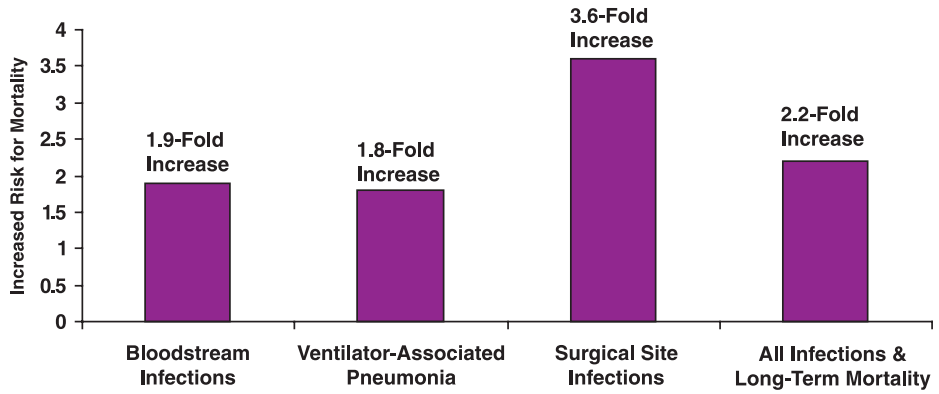
Surgical site infections (SSIs) due to MRSA have also been shown to result in higher mortality than their MSSA counterparts. Researchers from Duke University examined the attributable impact of methicillin resistance on SSI outcomes, comparing outcomes in patients following cardiothoracic, orthopedic, vascular, gynecological, and general surgical procedures with MRSA SSI, MSSA SSI, and uninfected control patients.[9] Mortality in the 90-day postoperative period was significantly higher in patients who had MRSA SSI when compared to those with MSSA SSI and those without SSI. In all, 20.7 percent of those with MRSA SSI

A recent study found that 20.7% of patients with MRSA SSI died after surgical procedures, as opposed to 6.7% of patients with MSSA SSI and 2.1% of uninfected patients.

died during this period, as opposed to 6.7 percent of those with MSSA SSI and 2.1 percent of the uninfected patients.

Finally, infection with MRSA appears to have an impact on long-term patient mortality—even after discharge from the hospital. Haessler, et al. examined the long-term outcomes of patients with either MRSA or MSAA infections who survived the initial hospitalization.[10] In their analysis, in the 12 months after the initial infection diagnosis, only 49 percent of patients infected with MRSA were alive compared with 68 percent of patients infected with MSSA (see Figure 2-3, below).

Increased Risk of Mortality for Infections Due to MRSA Compared to Those Due to MSSA, by Infection Type



Adapted from Cosgrove S.E., et al.: Comparison of mortality associated with methicillin-resistant and methicillin-susceptible *Staphylococcus aureus* bacteremia: A meta-analysis. *Clin Infect Dis* 36:53–59, Jan. 1, 2003; Athanassa Z., Siempos, I.I., Falagas M.E.: Impact of methicillin resistance on mortality in *Staphylococcus aureus* VAP: A systematic review. *Eur Respir J* 31:625–632, Mar. 2008; Engemann J.J., et al.: Adverse clinical and economic outcomes attributable to methicillin resistance among patients with *Staphylococcus aureus* surgical site infection. *Clin Infect Dis* 36:592–598, Mar. 2003; Haessler S., Mackenzie T., Kirkland K.B.: Long-term outcomes following infection with methicillin-resistant or methicillin-susceptible *Staphylococcus aureus*. *J Hosp Infect* 69:39–45, May 2008.

Figure 2-3. The specific mortality outcome for each infection type is as follows: bloodstream infections and ventilator-associated pneumonia = in-hospital mortality; surgical site infection = 90-day postoperative mortality; all infections = 12-month mortality in those surviving the hospital discharge. MRSA, methicillin-resistant *Staphylococcus aureus*; MSSA, methicillin-susceptible *Staphylococcus aureus.*

Risk of Morbidity. Along with the mortality effects noted above, infection with MRSA is also associated with other poor but nonlethal outcomes in affected patients. Compared to patients infected with susceptible organisms causing bloodstream infections (e.g., MSSA BSI), MRSA–infected patients have been shown to have an increased length of stay—often two extra hospital days.[11] Hospital charges are also higher in patients with MRSA BSI and MRSA SSI compared with patients infected with MSSA. The significance of this observation is discussed in greater detail in Chapter 3, "The Financial Impact of Antibiotic Resistance."

VRE Infections

Risk of Mortality. Compared with MRSA, the evidence for worsened clinical outcomes is not as clear for other pathogens, including VRE. Several earlier studies failed to detect a clear difference in mortality due to VRE infection (compared to persons with vancomycin-susceptible *Enterococcus* [VSE] infections) or found an association but failed to adjust for underlying severity of illness. However, other studies have noted a significant mortality difference between the two groups.[12,13]

Thankfully, several recent large meta-analyses have shed light on the role of acquisition of vancomycin resistance and mortality while accounting for underlying illness severity. In a meta-analysis of 9 studies that provided an assessment of the mortality risk for VRE BSI versus VSE BSI that adjusted for underlying severity of illness, DiazGranados, et al. noted the risk of death among those with VRE BSI was more than double that of persons with VSE BSI.[14] Further highlighting the risk of death with VRE, a similar analysis of 13 studies comparing patients with VRE BSI to those with VSE BSI found that the risk of mortality after adjusting for severity of illness in VRE–infected persons was 2.5 times that in VSE–infected persons.[15] Studies have also noted that VRE colonization (having the pathogen as a part of a person's normal bacterial flora) in the absence of actual infection is associated with increased risk of death among liver transplant patients.[16] So despite the challenges in ascertaining a *definitive* estimate of the increase in mortality risk due to VRE infection, VRE does appear to impact patient mortality.

Risk of Morbidity. One study that examined patients with any type of VRE infection was a matched cohort study of more than 230 VRE–infected patients compared to nearly 650 non-VRE–infected controls. The study found that the risk of ICU admission increased significantly after a diagnosis of a VRE infection (3.5 times that of controls), as did the risk of surgery following infection diagnosis (more than 2.5 times that of controls).[17] It is unclear if the increase in these outcomes was due to the presence of the infection itself, the acquisition of a vancomycin-resistant pathogen, or both. However, in several studies examining BSI outcomes, infection with VRE has also been associated with a significant excess in ICU days compared to similar illnesses due to VSE, a finding attributed to the acquisition of the MDRO.[15] Patients with VRE infection have also been found to have prolonged postinfection lengths of hospitalization and increased hospital costs compared to VSE–infected counterparts.[15] See Chapter 3, "The Financial Impact of Antibiotic Resistance" for more information.

Patients with VRE infection have been found to have prolonged post-infection lengths of hospitalization and increased hospital costs when compared to VSE-infected counterparts.

Infections Due to MDR Gram-Negative Bacteria

Risk of Mortality. The story appears disturbingly similar for persons infected with another type of MDRO known as MDR gram-negative bacteria. In general, MDR gram-negative bacteria

are bacteria that are resistant to several classes of antibiotics, which limits the available treatment options for the patient. One specific type of MDR gram-negative bacteria that is of increasing concern consists of bacteria that produce enzymes called extended-spectrum beta-lactamases (ESBL). Stated simply, ESBL can break down several types of antibiotics, rendering them ineffective. For infections due to ESBL-producing *Enterobacteriaceae* (a specific group of bacteria that often live in a person's intestinal flora), significant increases in mortality (nearly two-fold) have been detected in patients with BSI due to these organisms.[18] Such an increased risk in mortality should cause grave concern among health care executives. ESBL–producing organisms are often resistant to the antibiotic drugs commonly used by clinicians to treat infection while awaiting definitive diagnostic results. As a result, patients infected with ESBL–producers have a five-fold increased risk of delay of effective antibiotic therapy when compared to persons with non-ESBL infecting strains This may help explain the observed mortality differences.[18] Whether the mortality association is directly attributable to the presence of the ESBL producer or if it is impacted by underlying patient comorbidities is not yet known.

Studies also have shown that infections due to antibiotic-resistant strains of *Acinetobacter baumannii* are associated with increased mortality. For example, in a recent study of patients with *A. baumannii* BSI, 30-day mortality in patients infected with strains resistant to the powerful carbapenem antibiotics was markedly higher than in those infected with a susceptible strain (58% vs. 28%).[19] A similar study also noted a nearly four-fold increased risk in sepsis-related mortality in patients infected with strains of *Acinetobacter* resistant to one of several classes of antibiotics when compared to counterparts with less-resistant *Acinetobacter* BSI.[20]

Risk of Morbidity. Finally, as with their MDRO counterparts discussed earlier, MDR gram-negative organisms have been also associated with adverse patient morbidity. Prolonged hospital and ICU lengths of stay have been noted in patients with MDR *Acinetobacter* infections when compared to patients infected with susceptible strains.[21] Increased lengths of stay and hospital costs have also been described in patients infected with ESBL–producing *Enterobacteriaceae*.[22]

Clinical and Operational Impact of MDRO Infections

Although patient mortality and morbidity are the most serious consequences of MDRO infection, the impact of such infections can also have financial and operational consequences for a health care organization. Standard precautions from the CDC are used as the basic transmission prevention strategy for all patients, regardless of diagnosis. These precautions include hand hygiene, gloves, and gowns as needed for potential contact with body substances and face wear for protection from potential splashing of body fluids to the face and eyes. The diagnosis of MDRO colonization or infection in a patient necessitates the implementation of additional transmission-based contact precautions to reduce the

subsequent spread to patients and staff. Contact precautions (also known as contact isolation) include placing patients into private rooms, continued emphasis on hand hygiene practices, use of personal protective equipment (e.g., gowns and gloves) for persons who have contact with the patient and his or her environment, and limitation of patient transport out of his or her room. At some facilities, patients on isolation precautions are scheduled for testing and procedures at the end of the day to allow for more comprehensive environmental cleaning. Such precautions have been effective in reducing the transmission of MDROs as a part of a comprehensive program (see Chapter 4, "Transmission Control to Prevent the Spread of MDROs in Health Care Facilities," for more information). It must be noted that these added precautions may put additional strain on health care providers, add costs to providing care, and affect staffing ratios required to maintain a safe environment.

Although absolutely essential for control of MDROs, the use of contact precautions can have unintended consequences for the infected patient as well as the health care facility, as isolated patients have twice the rate of adverse events during hospitalization than non-isolated patients.[23] In addition, instituting contact precautions has been associated with reduced recording of patient vital signs, reduced health care worker contact, higher levels of patient depression and anxiety, and greater patient dissatisfaction.[24–27] Concerns also exist regarding the ability to discharge patients with MDRO infections who are on isolation to another facility (see Sidebar 2-1, below).

Sidebar 2-1

Frequently Encountered Question Regarding MDRO Infections

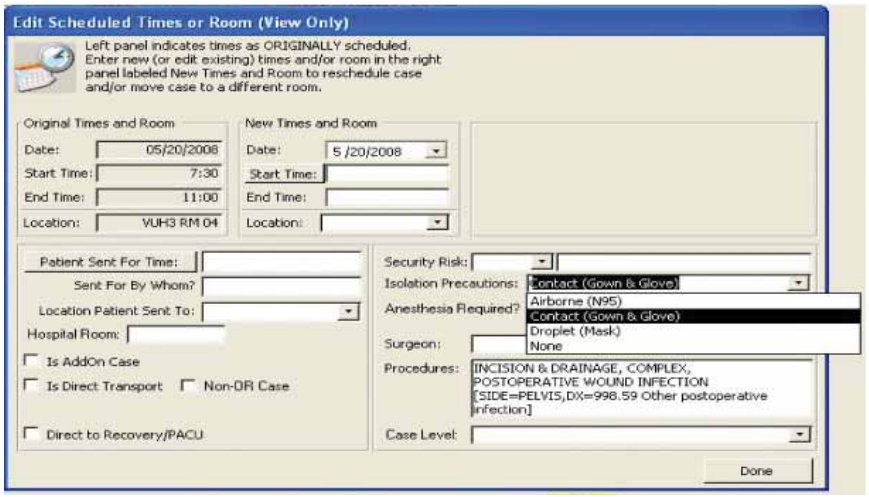
Q *Will we have a difficult time discharging a patient with an MDRO infection to another facility (e.g., rehabilitation or long term care facility)?*

A This is a question that often arises from frontline clinicians and is usually based on prior experiences or anecdotes; however, estimates in the literature on the prevalence of delays in patient placement due to MDRO infection and placement in isolation precautions used to prevent spread of the MDRO are scarce. A 2002 survey of 331 long term care facilities in Iowa noted that only 7.3% of these facilities acknowledged refusing to accept patients with known MRSA infection, and 16.9% refused to accept patients infected with VRE.* Even with this uncertainty, the practice of "blocking" these patients is specifically prohibited in some jurisdictions. Further study is needed to ascertain the true impact of MDRO infection on patient transfer.

* Kreman T., et al.: Survey of long-term-care facilities in Iowa for policies and practices regarding residents with methicillin-resistant *Staphylococcus aureus* or vancomycin-resistant enterococci. *Infect Control Hosp Epidemiol* 26:811–815, 2005.

MDRO, multidrug-resistant organism; VRE, vancomycin-resistant *Enterococcus*.

Example of Scheduling Prompt to Query Patient Isolation Status



Source: Vanderbilt Medical Center. Used with permission.

Figure 2-4. Prompt on patient isolation status is noted in the lower right section of the on-screen prompt.

Implementation of contact precautions can also limit room availability, patient flow, and the efficient delivery of patient care. For example, if a patient on contact precautions for an MDRO infection has to wait until the end of the day for a diagnostic procedure (as has been suggested), one could anticipate a potential prolonged length of stay. Logistically, full communication of a patient's isolation status prior to transfer off the unit (e.g., to the operating room for a surgical procedure) is required to ensure implementation of appropriate isolation precautions at the accepting unit. Some institutions have incorporated standard processes to ensure full communication of a patient's isolation status. At Vanderbilt Medical Center, for example, as patients are scheduled for surgery, a computerized prompt queries the scheduler on the need for isolation precautions. This allows for appropriate setup of the room, communication of the patient's isolation status to all members of the team, and efficient patient flow (see Figure 2-4, above). Placement of patients infected or colonized with MDROs into contact precautions is a core infection control intervention to prevent further morbidity, but the unintended consequences of such precautions further emphasize the potential impact of MDRO infection on a health care system and the need to control and hopefully reduce the burden of MDROs.

The MDRO Burden Calculator included on the CD can assist with assessments of the burden of specific MDROs institution-wide, as well as to determine unit-specific rates of MDRO infection to facilitate risk assessment and resource allocation.

In summary, the clinical and operational consequences of MDRO infection with an MDRO can be quite marked for both the individual patient and the health care facility (see Sidebar 2-2 on page 25).

Sidebar 2-2

Summary for the Health Care Executive: Patient Impact of MDRO Infections

In general, a patient at your facility with an MDRO infection will have the following:

- **Two-fold** or more increased risk of **death**
- Multiple days of **excess length of stay** in the hospital and ICU
- Up to a three-fold **increased risk** of **ICU transfer**
- As much as **$100,000** in **excess hospital costs**
- **Reduced contact** with health care providers
- **Less-safe care** because of decreased frequency in assessments and monitoring
- Higher risk of **adverse events**
- Increased patient **dissatisfaction**

Such undesirable outcomes should raise concern among all health care executives, facility clinical and administrative managers, and frontline caregivers and illustrate the urgent and crucial need to reduce the burden of MDRO infection in all health care facilities.

MDRO, multidrug-resistant organism; ICU, intensive care unit.

The Role of the CEO

As has been discussed, the clinical consequences of MDRO infections are substantial. Data examining the effect of several different types of MDROs have noted significant increases in patient morbidity and mortality, lengths of hospitalization, and hospital costs, as well as decreased patient and family satisfaction with care and damaged reputation for the organization. MDRO infections require implementation of important precautions to prevent further spread of pathogens, some of which, unfortunately, may also have adverse consequences. MDRO infections also require increased logistic planning to address issues related to potential secondary transmission that may also impact the delivery of care. The CEO and facility leadership have several essential roles to play in helping to determine the impact of MDROs at an institution as well as to emphasize the clinical consequences of these infections.

First and foremost, the CEO should demand that the determination of the burden and clinical consequence of MDRO infections be made at his or her institution. To that end, CEOs should ensure that infection control and informatics professionals have adequate resources to assess the impact of MDROs in the institution overall and in specific units and select patient populations. While allowing for an initial review of MDRO burden at the facility, these measurements also serve as baseline metrics to assess the impact of the MDRO control program.

The CEO Talking Points slide presentation can be used to provide content for discussions with senior oversight (e.g., Board of Trustees), clinical managers, and frontline staff.

Use the Competency Questions on the CD as a model to formally assess staff's understanding of MDROs and stressing the importance of MDRO control.

Sidebar 2-3

Key Roles and Functions for Executive Leadership: Clinical Consequences of MDRO Infections

- Charge facility leaders with determining MDRO burden.
- Communicate—and require senior leaders and managers to communicate—the consequences of MDRO infections.
- Ensure adequate data resources to accurately ascertain institutional impact of MDRO infections.
- Prioritize MDRO assessment and control within the facility through visible leadership support and resource commitment.
- Emphasize the impact of MDRO infection to facility leadership, clinical managers, physicians, and frontline staff.
- Empower the facility's infection prevention and control/epidemiology staff in their development of the facility's MDRO assessment and prevention program.

MDRO, multidrug-resistant organism.

When the burden of MDRO infection has been determined, the CEO must emphasize to key stakeholders, such as clinical leaders and the institutional board, the consequences of these infections in patients. The CEO should discuss the clinical consequences of MDRO infections with performance improvement teams and clinical leadership as well as at staff meetings. MDRO assessment and control must be prioritized within the facility through visible leadership support and resource commitment. The CEO should empower and support leaders to emphasize the impact of these infections, and, more importantly, the institution's plans to control such infections. Frontline physicians and staff should also understand the impact of MDRO infections in their patients. The CEO and other health care executives play a vital role in any MDRO program (see Sidebar 2-3, above). Understanding the clinical consequences of MDRO infection and emphasizing the importance of such consequences with all tiers of the institution are crucial for any facility that hopes to reduce the burden, costs, and impact of MDROs among their patients.

References

1. Kollef M.H., et al.: Inadequate treatment of infections: A risk factor for hospital mortality among critically ill patients. *Chest* 115:462–474, Feb. 1999.
2. Depuydt P., et al.: Outcome in bacteremia associated with nosocomial pneumonia and the impact of pathogen prediction by tracheal surveillance cultures. *Intensive Care Med* 32:1773–1781, Nov. 2006.
3. Krobot K., et al.: Effect of inappropriate initial empiric antibiotic therapy on outcome of patients with community-acquired intra-abdominal infections requiring surgery. *Eur J Clin Microbiol Infect Dis* 23:682−687, Sep. 2004
4. Schwaber M.J., De-Medina T., Carmeli Y.: Epidemiological interpretation of antibiotic resistance studies–What are we missing? *Nat Rev Microbiol* 2:979–983, Dec. 2004.
5. Cosgrove S.E., et al.: Comparison of mortality associated with methicillin-resistant and methicillin-susceptible *Staphylococcus aureus* bacteremia: A meta-analysis. *Clin Infect Dis* 36:53–59, Jan. 1, 2003.
6. Tacconelli E., Pop-Vicas A.E., D'Agata E.M.: Increased mortality among elderly patients with methicillin-resistant *Staphylococcus aureus* bacteraemia. *J Hosp Infect* 64:251–256, Nov. 2006.
7. Reed S.D., et al. Costs and outcomes among hemodialysis-dependent patients with methicillin-resistant or methicillin-susceptible *Staphylococcus aureus* bacteremia. *Infect Control Hosp Epidemiol* 26:175–183, Feb. 2005.
8. Athanassa Z., Siempos, I.I., Falagas M.E.: Impact of methicillin resistance on mortality in *Staphylococcus aureus* VAP: A systematic review. *Eur Respir J* 31:625–632, Mar. 2008.
9. Engemann J.J., et al.: Adverse clinical and economic outcomes attributable to methicillin resistance among patients with *Staphylococcus aureus* surgical site infection. *Clin Infect Dis* 1;36:592–598, Mar. 2003.
10. Haessler S., Mackenzie T., Kirkland K.B.: Long-term outcomes following infection with methicillin-resistant or methicillin-susceptible *Staphylococcus aureus*. *J Hosp Infect* 69:39–45, May 2008.
11. Cosgrove S.E., et al.: The impact of methicillin resistance in *Staphylococcus aureus* bacteremia on patient outcomes: Mortality, length of stay, and hospital charges. *Infect Control Hosp Epidemiol* 26:166–174, Feb. 2005.
12. Pelz R.K., et al.: Vancomycin-sensitive and vancomycin-resistant enterococcal infections in the ICU: Attributable costs and outcomes. *Intensive Care Med* 28:692–697, Jun. 2002.
13. Lucas G.M., et al.: Vancomycin-resistant and vancomycin-susceptible enterococcal bacteremia: Comparison of clinical features and outcomes. *Clin Infect Dis* 26:1127–1133, May 1998.
14. DiazGranados C.A., et al.: Comparison of mortality associated with vancomycin-resistant and vancomycin-susceptible enterococcal bloodstream infections: A meta-analysis. *Clin Infect Dis* 41:327–333, Aug. 1, 2005.
15. Salgado C.D., Farr B.M.: Outcomes associated with vancomycin-resistant enterococci: A meta-analysis. *Infect Control Hosp Epidemiol* 24:690–698, Sep. 2003.
16. Russell DL., et al.: Outcomes of colonization with MRSA and VRE among liver transplant candidates and recipients. *Am J Transplant* 8:1737–1743, Aug. 2008.
17. Carmeli Y., et al.: Health and economic outcomes of vancomycin-resistant enterococci. *Arch Intern Med* 162:2223–2228, Oct. 28, 2002.
18. Schwaber M.J., Carmeli Y.: Mortality and delay in effective therapy associated with extended-spectrum beta-lactamase production in *Enterobacteriaceae* bacteraemia: A systematic review and meta-analysis. *J Antimicrob Chemother* 60:913–920, Nov. 2007.
19. Kwon K.T., et al.: Impact of imipenem resistance on mortality in patients with *Acinetobacter* bacteraemia. *J Antimicrob Chemother* 59:525-530, Mar. 2007.
20. Lee N.Y., et al.: Clinical and economic impact of multidrug resistance in nosocomial *Acinetobacter baumannii* bacteremia. *Infect Control Hosp Epidemiol* 28:713–719, Jun. 2007.
21. Sunenshine R.H., et al.: Multidrug-resistant *Acinetobacter* infection mortality rate and length of hospitalization. *Emerg Infect Dis* 13:97–103, Jan. 2007.
22. Giske C.G., et al.: Clinical and economic impact of common multidrug-resistant gram-negative bacilli. *Antimicrob Agents Chemother* 52:813–821, Mar. 2008.
23. Stelfox H.T., Bates D.W., Redelmeier D.A.: Safety of patients isolated for infection control. *JAMA* 290:1899–1905, Oct. 8, 2003.
24. Tarzi S., et al.: Methicillin-resistant *Staphylococcus aureus*: Psychological impact of hospitalization and isolation in an older adult population. *J Hosp Infect* 49:250–254, Dec. 2001.
25. Saint S., et al.: Do physicians examine patients in contact isolation less frequently? A brief report. *Am J Infect Control* 31:354–366, Oct. 2003.
26. Kirkland K.B., Weinstein J.M.: Adverse effects of contact isolation. *Lancet* 2;354:1177–1178, Oct. 1999.
27. Evans H.L., et al.: Contact isolation in surgical patients: A barrier to care? *Surgery* 134:180–188, Aug. 2003.

On the CD

MDRO Burden Calculator
This adaptable spreadsheet will permit key institutional stakeholders to quantitatively determine the impact of MDRO infections on hospital operations. With basic information from the medical literature, microbiology lab, and administrative data, specific assumptions about the epidemiology of MDROs can be adjusted to determine the effect of these pathogens on patient outcomes, length of stay, and hospital cost. The calculator is a must for organizational MDRO risk assessment and dashboard reporting.

Competency Questions
Even experienced frontline staff members are often unaware of the danger posed by MDROs to hospital patients. The sample questions about the clinical impact of MDROs on patients included in this tool can be integrated with those from other chapters to build a comprehensive awareness and knowledge assessment tool for use across the organization. Consider incorporating these questions into existing educational programs at your institution to highlight for clinical staff the importance of MDRO control. They can be applied to online resources, written examinations or even incorporated into scripting for executive leadership rounds. While each of these questions may not be suitable for every staff member, consider incorporating elements of this knowledge assessment in training across the organization.

CEO Talking Points
Too often, frontline staff and senior clinical and administrative leaders are surprised to learn about the points covered in this slide presentation. These slides can be customized to provide detailed information about the impact of MDROs on patients at your organization.

CHAPTER 3

The Financial Impact of Antibiotic Resistance

Keith Kaye, M.D., M.S.

How much did it cost your hospital last year to prevent and manage infections caused by multidrug-resistant organisms?

Mr. Johnson, a 65-year-old man, was admitted to your institution from a rehabilitation facility with chest pain. He had been at the rehabilitation facility for two weeks after suffering an acute stroke. He underwent cardiac catheterization followed by a coronary artery bypass graft on hospital day 7. On hospital day 9, he became septic and required blood pressure support. Multidrug-resistant (MDR) Klebsiella pneumoniae *were found in his blood and from the tip of his central venous catheter, and he was started on three antibiotics—the only three active against the pathogen.*

On the same day, Mr. Andrews, a patient in the medical intensive care unit, developed a catheter-related bloodstream infection, and the following day Mr. McDonald, a patient in the telemetry unit, developed hospital-acquired pneumonia. The pathogens isolated from the cultures of Mr. Andrews and Mr. McDonald were also MDR Klebsiella pneumoniae.

Mr. Johnson—the index patient—died three weeks after his bloodstream infection of acute respiratory distress syndrome. Mr. Andrews and Mr. McDonald were discharged to a rehabilitation facility three and four weeks, respectively, after infection with MDR Klebsiella pneumoniae. *At the facility, both patients experienced acute renal failure as a result of their antibiotic therapy. The cost of hospital care for the three patients at the institution exceeded $1 million.*

Mr. McDonald's family learned about the outbreak of MDR Klebsiella pneumonia *and sued the hospital, charging that poor hygiene led to the spread of the identical pathogen from other patients to their family member. The local newspaper published a three-part series on your hospital, describing how an "untreatable resistant killer bug" had spread uncontrollably throughout the institution. Government and regulatory bodies began intensive investigations. The hospital suffered huge losses in patient referrals and millions of dollars in legal fees.*

Background

The economic consequences of antibiotic resistance represent the complex confluence of multiple forces, including the clinical status of the infected patient, other patients in the hospital who might be affected by antibiotic resistance due to the spread of multidrug-resistant organisms (MDROs) from the originally infected patient, resources expended by the hospital to prevent and control antibiotic resistance, and reimbursement of expenses to the hospital by third-party carriers (see Figure 3-1, left). As a result, precise quantification of the economic toll of resistance remains a challenge. In general, available estimates of the costs attributable to antibiotic resistance are conservative and tend to underestimate the overall financial impact of MDROs. Nevertheless, the available data can still be applied rationally to a critical examination of costs in general and even specifically at individual institutions. As long as studies examining the cost of resistance clearly describe how the financial impact was determined, then data regarding the financial impact of antibiotic resistance can be appropriately interpreted, and results from different groups can be compared and contrasted.

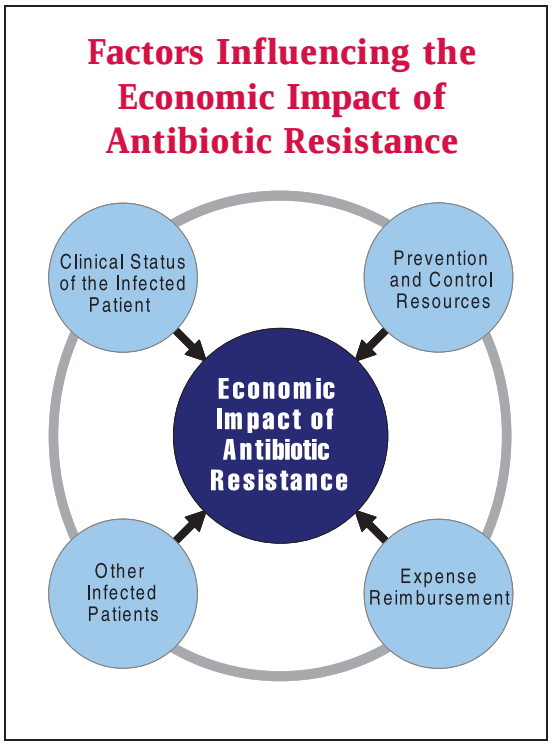


Figure 3-1. The economic consequences of antibiotic resistance represent the multifaceted combination of multiple elements.

The following section discusses specific issues regarding the financial impact of MDROs, including different measures of the impact of antibiotic resistance; the mechanisms through which antibiotic resistance leads to increased costs; costs associated with specific MDROs; costs associated with controlling antibiotic resistance in hospitals; limitations in measuring and reporting costs associated with antibiotic resistance; and key concepts and take-home messages for hospital leadership, administrators, and executives.

Measuring the Impact of Antibiotic Resistance

Every chief executive officer (CEO) must be concerned about the impact of MDROs on the costs associated with hospital operations (e.g., supplies, personnel). However, the most important manner in which MDROs increase organizational costs is through their independent association with increased morbidity and mortality. Antibiotic resistance has been clearly shown to be associated with increased risk of death and clinical complications among infected patients. Mortality is usually reported as in-hospital mortality, although increased mortality during the 90-day and one-year post-infection period has also been described. Morbidity is conventionally expressed as the total number of added hospital days following an MDRO infection, a measure that simultaneously captures not only the seriousness of the infection but the difficulty in optimizing treatment for these patients. In some reports, the summation

of hospital days includes only the initial hospitalization during which an infection is acquired. Less often, more rigorous accounting is performed that includes all hospital days including readmissions during the 30-to-90-day period after infection. For certain types of infection, such as ventilator-associated pneumonia (VAP), morbidity may also be reported as days in the intensive care unit (ICU) or days requiring mechanical ventilation. Unfortunately, more sophisticated models for determining the full extent of the effect of antibiotic resistance on patient outcomes have very rarely been applied. For example, the impact of antibiotic resistance on one of the most important outcomes—functional status, an assessment of the patient's ability to carry on with normal activities of daily living—has not been well studied or reported in the literature. For a more complete discussion of the impact of antibiotic resistance on patient morbidity and mortality and other clinical outcomes, see Chapter 2, "Clinical Consequences of Antibiotic Resistance."

The most important manner in which MDROs increase organizational costs is through their independent association with increased morbidity and mortality.

The financial impact of antibiotic resistance on hospitals and health care systems can be expressed either as hospital costs or hospital charges. Most health care executives prefer to study costs rather than charges, as costs more closely reflect the direct financial impact on a hospital than do charges (although it is worth noting that in many cases hospital charges are more generalizable across organizations in different geographic regions than are costs). Regardless, charges and costs are ultimately directly associated with one another. In general, hospital costs are approximately 60 to 70 percent of hospital charges.[1,2] To standardize results of studies discussed in this chapter and to make this discussion most relevant to health care executives in all settings, only hospital costs will be discussed in the sections that follow. In cases where hospital charges were reported in the original literature being discussed, these charges were converted to costs by multiplying charges by 0.7.

How Antibiotic Resistance Leads to Increased Financial Costs

The primary driver of increased costs is an increase in length of hospitalization.

The mechanisms by which antibiotic resistance leads to increased hospital costs are numerous and complex. However, as has already been noted, the primary driver of increased cost is an increase in duration of hospitalization, particularly when patients are cared for in the ICU. Other important contributors to increased costs associated with the care of patients with MDRO infections are the increased expenses of radiographic and other diagnostic testing and pharmacy costs. Of course, this association may not be surprising in that antibiotic-resistant infections often affect patients who have had significant prior health care exposure and/or have severe or numerous underlying comorbid conditions (see Sidebar 3-1 on page 32).

The association between antibiotic resistance and increased pharmacy costs is partly explained by the increased severity of acute and chronic illness among patients infected by

Sidebar 3-1

Impact of Risk Factor Profiles

-resistant infections often affect patients who have had significant prior health care exposure and/or have severe or numerous underlying comorbid conditions. As an example, consider two patients admitted to the hospital for the same primary diagnosis—chest pain—but have very different risk factor profiles for acquisition of a resistant pathogen in the hospital and for increased hospital costs. The first is a 76-year-old nursing home resident who has diabetes, dementia, obesity, and an indwelling Foley catheter and has been treated on multiple occasions for recurrent urinary tract infections. The second is a 45-year-old without significant past medical history. Although both patients are admitted for the same primary diagnosis, a common set of risk factors (nursing home residence, underlying diabetes, the presence of an indwelling device, and recent antibiotic exposures) predisposes the first patient to infection and for increased hospital costs.

MDROs. Another critical component of the expense is the cost of the antibiotic agents used to treat MDRO infections. Pharmaceutical agents used to treat MDROs are generally much more expensive than agents that can be used to treat susceptible pathogens. The procurement prices of newer, novel agents that maintain activity against MDROs can be 4 to 20 times more expensive than older agents that can be used to treat more susceptible pathogens. In addition, some of the agents required to treat MDROs are significantly more toxic and/or require more clinical monitoring and laboratory work than other antibiotic agents (usually aimed at maintaining safe and effective blood levels of the drug or detect the earliest signs of drug toxicity). The financial costs associated with the increased toxicity and monitoring also add to the hospital expenses attributable to antibiotic resistance.

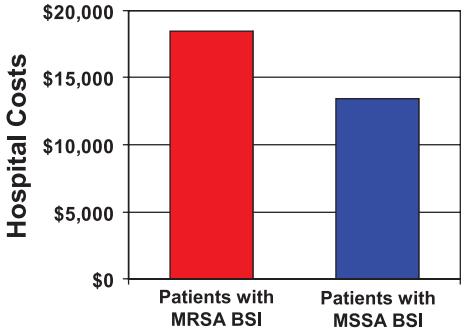
Costs Associated with Specific MDROs

Methicillin-Resistant Staphylococcus aureus

Methicillin-resistant *Staphylococcus aureus* (MRSA) is the single most frequently encountered MDRO causing health care-associated infections. Included among these are invasive infections, such as bloodstream infection (BSI), deep and organ/space surgical site infection (SSI), and VAP.[3,4] MRSA has commonly been implicated in outbreaks of infection in hospitals and other clinical settings. In addition, the emergence of community-associated MRSA as the single most common cause of purulent skin and soft-tissue infections outside of hospitals has increased the burden of MRSA managed in emergency rooms and urgent care clinics and is being observed more frequently in patients entering the hospital for acute care. The confluence of the increased incidence of MRSA, the virulence associated with this pathogen, and its propensity to spread from patient to patient in hospitals has created a serious and previously unanticipated crisis in health care.

The financial impact of MRSA on hospitals is important to understand so that health care administrators, infection prevention personnel, and public health professionals can calculate the cost-effectiveness of various strategies to control the spread of MRSA. The adverse financial impact of MRSA is most well-documented in cases of BSI and SSI. A study conducted at a large teaching hospital in Boston reported the costs of patients with BSI due to *Staphylococcus aureus* from 1997 to 2000 (see Figure 3-2, right).[5] Patients with infection due to MRSA had significantly higher costs after infection than did patients with methicillin-susceptible *Staphylococcus aureus* (MSSA) ($18,497 and $13,448, respectively—a 1.38-fold increase, p=0.008). In multivariate analysis, after controlling for other factors influencing hospital costs, infection with MRSA was independently associated with a 1.36-fold increase in cost compared to patients with MSSA bloodstream infection (p=0.017).

Costs of Treating Patients with BSI Due to *Staphylococcus aureus*, 1997–2000



Source: Adapted from Cosgrove S.E., et al.: The impact of methicillin resistance in *Staphylococcus aureus* bacteremia on patient outcomes: Mortality, length of stay, and hospital charges. *Infect Control Hosp Epidemiol* 26:166–174, Feb. 2005.

Figure 3-2. Patients with infection due to MRSA had significantly higher costs after infection than did patients with MSSA (p=0.008). BSI, bloodstream infection; MRSA, methicillin-resistant *Staphylococcus aureus*; MSSA, methicillin-susceptible *Staphylococcus aureus*.

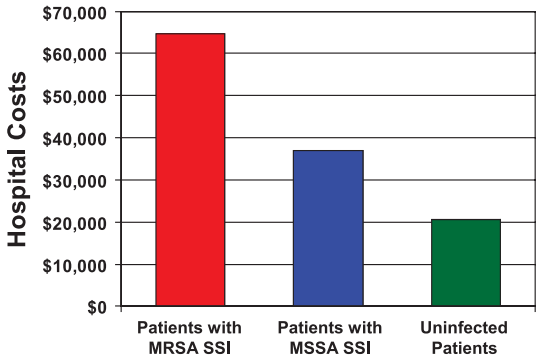
A study of deep and organ/space SSIs due to *Staphylococcus aureus* was conducted between 1994 and 2000 at two sites: a tertiary care teaching hospital and a community hospital in Durham, North Carolina.[6,7] Hospital costs after surgery, including re-admissions during the 90-day post-operative period, were calculated for three groups of patients: those with deep or organ/space SSI due to MRSA, patients with SSI due to MSSA, and operative patients without infection (see Figure 3-3 on page 34). The mean costs of care for patients with SSI due to MRSA ($64,654) was three times higher compared to uninfected controls ($20,619, p<0.001) and significantly higher costs than patients with SSI due to MSSA ($36,954, p<0.001). In multivariable analyses, MRSA was associated with a 2.2-fold increase in hospital costs compared to operative patients without SSI (mean adjusted attributable cost of $28,892 per MRSA SSI, p<0.001) and a 1.2-fold increase in hospital costs compared to patients with SSI due to MSSA (mean adjusted attributable cost of $9,731 per MRSA SSI, p=0.03).

Vancomycin-Resistant *Enterococcus*

As recently as the 1990s, infection with vancomycin-resistant *Enterococcus* (VRE) was perceived by many experts as essentially untreatable. Fortunately, the development of several new antibiotic agents over the past 15 years has dramatically increased available treatment options. However, several of the agents now commonly used to treat VRE are expensive, toxic, or

In one example, the mean costs of care for patients with SSI due to MRSA ($64,654) was three times higher than uninfected controls ($20,619, p<0.001) and significantly higher costs than patients with SSI due to MSSA ($36,954, p<0.001).

Costs of Treating Patients with SSI Due to *Staphylococcus aureus*, 1997–2000



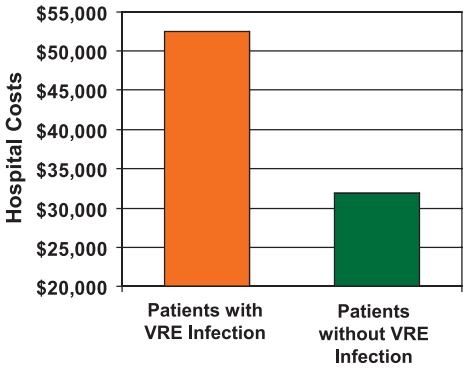
Source: Adapted from Engemann J.J., et al.: Adverse clinical and economic outcomes attributable to methicillin resistance among patients with *Staphylococcus aureus* surgical site infection. *Clin Infect Dis* 36:592–598, Mar. 1, 2003; Kaye K.S., et al.: Reference group choice and antibiotic resistance outcomes. *Emerg Infect Dis* 10:1125–1128, Jun. 2004.

Figure 3-3. Hospital costs after surgery were calculated for three groups of patients: those with deep or organ/space SSI due to MRSA (Group 1), patients with SSI due to MSSA (Group 2), and operative patients without infection (Group 3). Patients with SSI due to MRSA accrued significantly higher mean costs ($64,654) compared to uninfected controls ($20,619, $p<0.0010$) and also accrued significantly higher costs than patients with SSI due to MSSA ($36,954, $p<0.001$). SSI, surgical site infection; MRSA, methicillin-resistant *Staphylococcus aureus*; MSSA, methicillin-susceptible *Staphylococcus aureus*.

both. To further complicate matters, colonization with VRE can leave affected patients at risk for repeated infection for extended periods of time. After a patient becomes colonized or infected with VRE, he or she can remain colonized with this organism for years. The clinical and economic impacts of VRE are magnified by the fact that the bacterium appears to be particularly common among some of the most vulnerable hospital patients, including recipients of bone marrow and organ transplants. Given these considerations, control of the spread of VRE within hospitals remains an important mission for infection prevention and control programs. Understanding the costs of infections caused by VRE is important in developing and implementing programs to prevent VRE spread, particularly among immunocompromised patients.

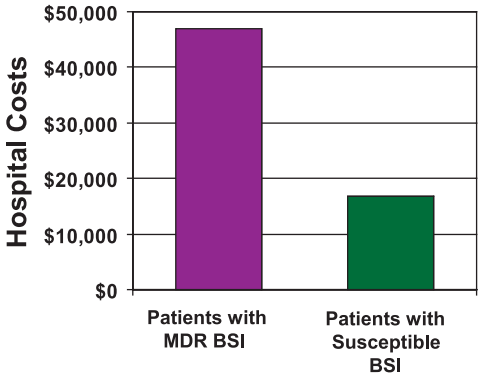
In a study conducted at a Boston teaching hospital between 1993 and 1997, 233 patients with VRE infections were compared to 647 matched "control" patients without VRE infection (see Figure 3-4 on page 35).[8] Patients with VRE had significantly higher total hospital costs compared to patients without infection ($52,449 and $31,915, respectively, $p<0.001$). In multivariate analysis, VRE infection was associated with a 1.4-fold increase in total hospital costs. The mean adjusted attributable cost of a VRE infection, compared to patients without infection, was $12,766.

Two published studies compared hospital costs among patients with infection due to VRE and patients with infection due to vancomycin-susceptible *Enterococcus* (VSE). In the first study conducted at a tertiary care hospital in New York from 1995 to 1996, 262 patients with VRE isolated from various anatomic sites, including urine, wounds, and blood, were compared to patients with VSE isolated from similar anatomic sites.[9] The difference in mean cost per person-day of hospitalization for patients with VRE compared to patients with VSE was $252 ($p<0.05$). Another study included patients admitted to a tertiary care hospital in Chicago from 1992 to 1995 who had BSI due to either VRE ($n=21$) or VSE ($n=32$).[10] The mean cost of hospitalization for patients with BSI due to VRE was significantly higher than the mean cost of hospitalization for patients with bacteremia due to VSE ($83,897 and $56,707, $p=.04$), a cost difference of 32.4%, or $27,190.



Source: Adapted from Carmeli Y., et al.: Health and economic outcomes of vancomycin-resistant enterococci. *Arch Intern Med* 162:2223–2228, Oct. 2002.

Figure 3-4. In a study conducted between 1993 and 1997, 233 patients with VRE infections were compared to 647 matched "control" patients without VRE infection. Patients with VRE had significantly higher total hospital costs compared to patients without infection ($52,449 and $31,915, respectively, $p<0.001$). VRE, vancomycin-resistant *Enterococcus*.



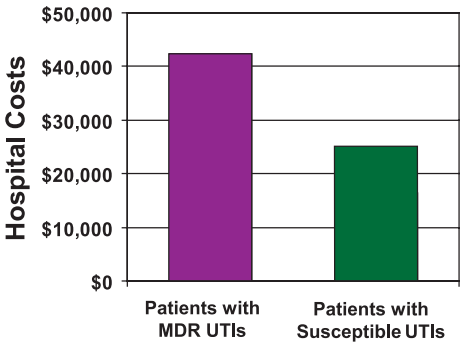
Source: Adapted from Schwaber M.J., et al.: Clinical and economic impact of bacteremia with extended-spectrum-beta-lactamase-producing *Enterobacteriaceae*. *Antimicrob Agents Chemother* 50:1257–1262, Apr. 2006.

Figure 3-5. Patients with MDR BSI accrued significantly higher hospitalization costs compared to controls with susceptible infection ($46,970 and $16,877, respectively, $p<0.001$). MDR, multidrug-resistant; BSI, bloodstream infection.

MDR Gram-Negative Bacteria

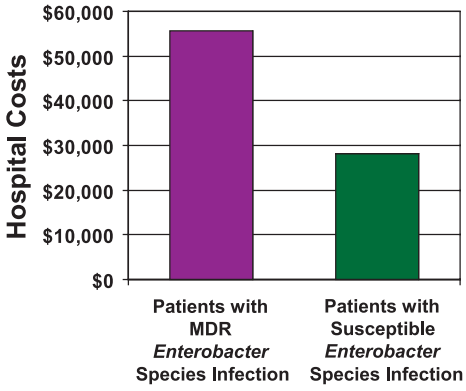
Although much of the resistance spotlight has been dominated by gram-positive pathogens such as MRSA and VRE, the resistance issues with gram-negative bacilli are equally concerning. The progressive and sometimes rapid emergence and spread of MDR gram-negative pathogens in the hospital, combined with a shortage of new antibiotic agents in the pipeline to treat these pathogens, has created a crisis for hospitals and long term care facilities. Limiting the emergence and spread of these organisms through infection control and antibiotic stewardship programs is critical for survival of hospitals and patients alike. (See Chapter 5, "Antibiotic Stewardship.")

The *Enterobacteriaceae* family of bacteria includes *Escherichia coli*, *Klebsiella* species, and *Enterobacter* species. The development of MDR in this family of bacteria has been occurring for decades, and the financial impact of resistance has been fairly well studied. A study from Israel analyzed the impact of MDR in hospital bloodstream isolates of *E. coli* and *K. pneumoniae* from 2000 to 2003.[11] Ninety-nine patients with MDR *E. coli* or *K. pneumoniae* were compared to an identical number with antibiotic-susceptible isolates (see Figure 3-5, above). Patients with MDR BSI accrued significantly higher hospitalization costs compared to controls with susceptible infection ($46,970 and $16,877, respectively, $p<0.001$). In multivariate analysis, MDR BSI was independently associated with a 1.57-fold increase in hospital cost (mean increase in cost of hospitalization of $9,620 per MDR *E. coli* or *K. pneumoniae* BSI).



Source: Adapted from Lee S.Y., et al.: Impact of extended-spectrum beta-lactamase-producing *Escherichia coli* and *Klebsiella* species on clinical outcomes and hospital costs: A matched cohort study. *Infect Control Hosp Epidemiol* 27:1226–1232, Nov. 2006.

Figure 3-6. The total costs of hospitalization during the period of infection was significantly higher in patients with UTIs due to MDR *E. coli* or *K. pneumoniae* than in patients with susceptible strains of infection ($42,353 and $24,902, respectively, p=0.04). MDR, multidrug-resistant; UTI, urinary tract infections.



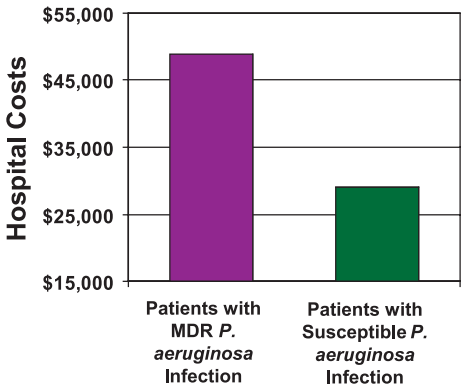
Source: Adapted from Cosgrove S.E., et al.: Health and economic outcomes of the emergence of third-generation cephalosporin resistance in *Enterobacter* species. *Arch Intern Med* 162:185–190, Jan. 28, 2002.

Figure 3-7. Patients with MDR infection accrued significantly higher costs of hospitalization than did patients with susceptible *Enterobacter* species infections ($55,526 and $28,284, respectively, p<0.001). MDR, multidrug-resistant.

Another study performed at a tertiary care hospital in Connecticut analyzed the cost of MDR infections in urinary tract infections (UTIs) due to *E. coli* or *K. pneumoniae* from 2001 to 2004 (see Figure 3-6, above).[12] The cost of hospitalization among patients with UTIs due to MDR *E. coli* or *K. pneumonia* was compared to patients with UTIs due to susceptible strains of *E. coli* or *K. pneumonia*. The total costs of hospitalization during the period of infection was nearly double in patients with UTIs due to MDR *E. coli* or *K. pneumonia* than in patients with susceptible strains of infection ($42,353 and $24,902, respectively, p=0.04; mean additional cost attributable to infection with an MDRO of $16,451 per patient).

Another study pertaining to costs of MDR in *Enterobacteriaceae* was performed in Boston at a tertiary care hospital from 1994 to 1997 (see Figure 3-7, above).[13] Forty-six patients who developed infection with MDR *Enterobacter* species during hospitalization were compared to 133 control patients who had infection with susceptible strains of *Enterobacter* species. Common sites of infection included the respiratory tract, wounds, and bloodstream. Patients with MDR infection accrued significantly higher costs of hospitalization than did patients with susceptible *Enterobacter* species infections ($55,526 and $28,284, respectively, p<0.001). In multivariate analysis, infection with MDR *Enterobacter* species was independently associated with a 1.51-fold increase in hospital costs compared to infection with susceptible *Enterobacter* species (p<0.001). The mean attributable cost of each MDR infection was $20,565.

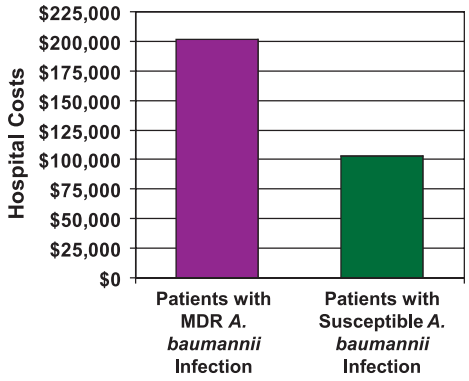
Impact of MDR *P. aeruginosa* on Hospital Costs



Source: Adapted from Lautenbach E., et al.: Imipenem resistance among *pseudomonas aeruginosa* isolates: Risk factors for infection and impact of resistance on clinical and economic outcomes. *Infect Control Hosp Epidemiol* 27:893–900, Sep. 2006.

Figure 3-8. Mean hospital costs were significantly higher among patients with infection due to MDR *P. aeruginosa* compared to patients with infection due to more susceptible strains of *P. aeruginosa* ($48,798 and $29,029, respectively, $p<0.001$). MDR, multidrug-resistant.

Comparison of Burn Unit Patients With and Without *A. baumannii*, 2000–2001



Source: Adapted from Wilson S.J., et al.: Direct costs of multidrug-resistant *Acinetobacter baumannii* in the burn unit of a public teaching hospital. *Am J Infect Control* 32:342–344, Oct. 2004.

Figure 3-9. Mean costs of hospitalization were significantly higher for patients with MDR *A. baumannii* than for controls ($201,558 and $102,983, respectively, $p<0.01$; mean excess of hospital costs of $98,575). MDR, multidrug-resistant.

Pseudomonas aeruginosa is an organism of serious concern often discussed in the context of MDROs. It accounts for a substantial number of infections and deaths among the most vulnerable hospital patients. Studies reporting the impact of MDR *P. aeruginosa* on hospital costs have yielded compelling findings. One study from a tertiary care hospital in Philadelphia compared more than 125 patients with infection due to MDR *P. aeruginosa* to patients with infection due to more susceptible strains of *P. aeruginosa* (see Figure 3-8, above).[14] Sites of infection included the urine, wounds, and bloodstream. Mean hospital costs were significantly higher among patients with infection due to MDR *P. aeruginosa* compared to patients with infection due to more susceptible strains of *P. aeruginosa* ($48,798 and $29,029, respectively; $p<0.001$).

Acinetobacter baumannii is an MDRO that infects patients in ICUs and burn units and has also been detected frequently among U.S. soldiers with wound infections inflicted in Iraq. Most of the antibiotics that are effective against *A. baumanii* are associated with considerable toxicity. A study from a large teaching hospital in Taiwan compared hospital costs of patients with BSI due to MDR *A. baumannii* to patients with BSI due to more susceptible strains of *A. baumannii* between 1996 and 2001.[15] Infection with MDR *A. baumannii* was associated with excess hospital costs of $4,483. In a study from a tertiary care hospital in Indiana, burn unit patients with infection due to MDR *A. baumannii* between 2000 and 2001 were compared to controls who had similar burn severity but did not have infection due to MDR *A. baumannii* (see Figure 3-9, above). Mean costs of these expensive hospital stays for patients with

MDR *A. baumannii* were almost double the costs for controls ($201,558 and $102,983, respectively, $p<0.01$; mean excess of hospital costs of $98,575).[16]

Limitations of Studies Analyzing Financial Impact of MDR Infections

As illustrated in the preceding section, the medical literature clearly indicates that antibiotic resistance is independently associated with increased hospital costs. However, even the most rigorous of analyses can result in an over- or underestimation of the effect of resistance on costs, depending on the methods used. Because increased severity of acute and chronic illness and increased duration of hospitalization are risk factors for MDR, it is often difficult to separate the effects of MDR from those of underlying illness and prolonged hospitalization in cost analyses. While the effect of this bias is to overestimate the costs associated with resistance, the available literature is more likely to *underestimate* the financial impact of MDROs.

- In nearly all of the published analyses that examine the costs of MDROs to health care facilities, only the direct impact on the cost of the infected individual is accounted for. Unfortunately, the effects of that one patient's MDRO on other patients and the hospital in general is not captured and quantified by even the most rigorous of published analyses. When an individual pathogen spreads from a single patient to others in the hospital, in some cases causing an outbreak, the collateral damage and excess total costs resulting from transmission will dramatically magnify costs. This bias leads to a gross underestimation of the association between MDR and hospital costs.

- Most available studies do not calculate the costs of hospital readmissions that are related to an infection acquired during a prior hospitalization. Many invasive infections, notably SSI, are typically present at the time of readmission. Thus, failure to include costs of re-admissions in some cases grossly underestimates the costs of MDR infections.

- Many investigators compare patients with infections due to MDROs to patients with infections due to more susceptible pathogens. It is important to realize that the cost difference between resistant and susceptible pathogens represents costs related to resistance, not the cost of entire MDR infection. Therefore, patients with infections due MDROs must be compared to similar uninfected patients, to determine the complete cost of the MDR infection.

- Finally, there is a lack of literature pertaining to costs of MDR in community hospitals. This is unfortunate because the majority of health care is delivered in community hospitals. It is likely that financial costs of MDR are similar in community and tertiary care hospitals, but this remains largely unknown.

In summary, precise quantification of the increased financial costs that accompany antibiotic resistance remains a challenge. With this in mind, health care executives should be cautioned against linking a specific financial expectation to the reduction (or elimination) of resistance. However, given the consensus that resistance is generally but definitively associated with increased costs, control of MDROs can be embraced as not only a clinical priority for the organization but a financial one as well.

Control of MDROs can be embraced as not only a clinical priority for the organization but a financial one as well.

Cost of Controlling MDROs

The major costs for controlling MDROs in the hospital pertain to the staffing and operational costs of infection prevention and control programs. Specific costs also include the following:

- Operational expenses of antibiotic stewardship initiatives
- Supplies for hand hygiene, isolation, and other core transmission control activities
- Cultures and rapid detection methods applied as part of active surveillance
- Database maintenance and programming expenses

Although these costs can be intimidating in an era in which executives are challenged by market forces and boards of governance to exert strict fiscal responsibility, it is worthwhile to take a closer look at the relative impact of these expenses

A recent publication examined infection control budgets in 28 community hospitals in the Southeastern United States.[17] Hospitals budgeted a median of $129,000 for infection control and employed a median of one infection control professional (ICP) (interquartile range [IQR], 1–1.5). The median amount budgeted at each hospital for payment of ICPs was $65,750 (IQR, $53,999–$89,365). The median amount budgeted for the infection prevention program at smaller hospitals (median of <220 beds) was $100,000, and the median amount budgeted for the program at larger hospitals (>220 beds) was $212,000. At large (>500 beds) tertiary care teaching hospitals, the amount budgeted for infection control was usually higher than at community hospitals, with an approximate range of $350,00–$500,000.

The authors specifically studied the cost of infection control budgets relative to the cost of hospital-acquired infections. The median annual institutional cost of hospital-acquired infections was 4.6 times greater than the amount budgeted for infection prevention and control programs.[17] These analyses did not account for the incremental increase in cost of infections due to MDROs, so costs associated with hospital-acquired infections were underestimated.

The Role of the CEO

As this chapter has illustrated, understanding the economic impact of antibiotic resistance and applying these principles to a specific determination of costs to *your* organization are

Sidebar 3-2

Take-Home Points

1. MDROs are causing a crisis in health care.
2. The problem of MDROs is increasing and shows no signs of improving.
3. MDROs can rapidly spread in hospitals.
4. New antibiotics cannot effectively fight many rapidly spreading MDROs.
5. MDR is clearly associated with significantly increased hospital costs.
6. The average annual cost of hospital-acquired infections at most institutions is more than four times greater than the amount budgeted for infection control programs.
7. Investing in state-of-the-art, aggressive infection control and antibiotic stewardship programs will usually result in cost savings.
8. The only way to track costs of MDROs, trends in associated costs, and impact and success of interventions is to continuously perform standardized infection surveillance, routinely review the data, and use published costs of hospital-acquired pathogens to measure the financial impact of these pathogens.

MDRO, multidrug-resistant organism.

challenging. However, there are some basic concepts that are critical for clinical and executive leaders to appreciate and apply when developing and deploying a comprehensive MDRO prevention and control plan (see Sidebar 3-2, left).

First, antibiotic resistance is a growing problem, despite the best efforts of institutional and public health experts. Even if the infection control program at your organization is well-resourced and effective, the proliferation of MDROs in hospitals and now in the community will continue to challenge your team to respond. The economic stakes of MDRO control will only get higher.

Second, antibiotic resistance is definitively associated with increased hospital costs. However, the direct costs of managing patients with MDROs represents only a fraction of the full economic impact of resistance. The indirect costs of antibiotic resistance include the financial impact of the spread of resistant pathogens to other patients; the cost of controlling spread; and the cost of poor press, lawsuits, and regulatory investigations. Despite this complexity, efforts to quantify and communicate the institutional costs associated with MDROs can yield important benefits in engaging both leadership and frontline personnel in effecting change.

Next, cost-efficient strategies must be deployed to limit the spread of resistant pathogens in your institution and to optimally manage patients infected with MDROs. The leadership team's role in prioritizing, promoting, and sustaining these efforts is essential. Neither the infection control team nor expert clinical leaders have the authority or the platform from which to demand the engagement and participation of all those needed to effectively combat resistance. Backing from hospital leadership is critical in gaining cooperation from various groups, including the medical and nursing staff, microbiology, information services, risk management, and pharmacy. Understanding and, when possible, quantifying the economic impact of resistance on the institution reveals that this investment of time, effort, and credibility is worthwhile.

The infection prevention and control program and projects must be adequately staffed and supported to address the unique challenges of antibiotic resistance within the organization.

The quality and timeliness of data regarding the prevalence, severity, and clinical and economic consequences of resistance must be assured. Moreover, the economic impact of all prevention activities—both in terms of programmatic costs and the return on investment—must be monitored and shared within the organization. See Chapter 4, "Transmission Control to Prevent the Spread of MDROs in Health Care Facilities," for more information.

References

1. Haley R.: Measuring the costs of nosocomial infections: Methods for estimating economic burden on the hospital. *Am J Med* 16;91(3B):32S–38S, Sep. 1991.
2. Howard D., et al.: Measuring the economic costs of antimicrobial resistance in hospital settings: Summary of the Centers for Disease Control and Prevention-Emory Workshop. *Clin Infect Dis* 33:1573–1578, Nov. 1, 2001.
3. Anderson D.J., et al.: Severe surgical site infection in community hospitals: Epidemiology, key procedures, and the changing prevalence of methicillin-resistant *Staphylococcus aureus. Infect Control Hosp Epidemiol* 28:1047–1053, Sep. 2007.
4. National Nosocomial Infections Surveillance System: National Nosocomial Infections Surveillance (NNIS) System Report, data summary from January 1992 through June 2004, issued October 2004. *Am J Infect Control* 32:470–485, Dec. 2004.
5. Cosgrove S.E., et al.: The impact of methicillin resistance in *Staphylococcus aureus* bacteremia on patient outcomes: Mortality, length of stay, and hospital charges. *Infect Control Hosp Epidemiol* 26:166–174, Feb. 2005.
6. Engemann J.J., et al.: Adverse clinical and economic outcomes attributable to methicillin resistance among patients with *Staphylococcus aureus* surgical site infection. *Clin Infect Dis* 36:592–598, Mar. 1, 2003.
7. Kaye K.S., et al.: Reference group choice and antibiotic resistance outcomes. *Emerg Infect Dis* 10:1125–1128, Jun. 2004.
8. Carmeli Y., et al.: Health and economic outcomes of vancomycin-resistant enterococci. *Arch Intern Med* 162:2223–2228, Oct. 28, 2002.
9. Webb M., Riley L.W., Roberts R.B.: Cost of hospitalization for and risk factors associated with vancomycin-resistant *Enterococcus faecium* infection and colonization. *Clin Infect Dis* 33:445–452, Aug. 15, 2001.
10. Stosor V., et al.: *Enterococcus faecium* bacteremia: Does vancomycin resistance make a difference? *Arch Intern Med* 158:522–527, Mar. 9, 1998.
11. Schwaber M.J., et al.: Clinical and economic impact of bacteremia with extended-spectrum-beta-lactamase-producing *Enterobacteriaceae. Antimicrob Agents Chemother* 50:1257–1262, Apr. 2006.
12. Lee S.Y., et al.: Impact of extended-spectrum beta-lactamase-producing *Escherichia coli* and *Klebsiella* species on clinical outcomes and hospital costs: A matched cohort study. *Infect Control Hosp Epidemiol* 27:1226–1232, Nov. 2006.
13. Cosgrove S.E., et al.: Health and economic outcomes of the emergence of third-generation cephalosporin resistance in *Enterobacter* species. *Arch Intern Med* 162:185–190, Jan 28, 2002.
14. Lautenbach E., et al.: Imipenem resistance among *pseudomonas aeruginosa* isolates: Risk factors for infection and impact of resistance on clinical and economic outcomes. *Infect Control Hosp Epidemiol* 27:893–900, Sep. 2006.
15. Lee N.Y., et al.: Clinical and economic impact of multidrug resistance in nosocomial *Acinetobacter baumannii* bacteremia. *Infect Control Hosp Epidemiol* 28:713–719, Jun. 2007.
16. Wilson S.J., et al.: Direct costs of multidrug-resistant *Acinetobacter baumannii* in the burn unit of a public teaching hospital. *Am J Infect Control* 32:342–344, Oct. 2004.
17. Anderson D., et al.: Underresourced hospital infection control and prevention programs: Penny wise, pound foolish? *Infect Control Hosp Epidemiol* 28:767–773, Jul. 2007.

On the CD

MDRO Burden Calculator
The MDRO calculator, first introduced in Chapter 2, uses information specific to the organization to provide estimates about the clinical and economic impact of MDROs at the organization. Sharing the calculator or your findings with your chief financial officer may lead to some surprising but valuable results.

Competency Questions
The economic impact of MDROs touches all levels and units of the hospital. Frontline managers particularly will benefit from the awareness raised with these questions. Use these questions to spur discussions at staff meetings or leadership retreats or combine them with those from other chapters to build a comprehensive MDRO knowledge assessment tool.

CEO Talking Points
Communicating the financial impact of MDROs across the organization is a challenging undertaking. These slides bring clarity to the issue and should help to give all clinical and nonclinical staff a stake in efforts to prevent the spread of MDROs.

CHAPTER 4

Transmission Control to Prevent the Spread of MDROs in Health Care Facilities

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How frequently do clinicians at your organization clean their hands before and after seeing a patient?

Ms. Wilson was admitted in transfer to your long term acute care hospital (LTACH) for skilled wound care to treat a slowly healing abdominal wound. She had a negative nasal screening culture for methicillin-resistant Staphylococcus aureus *(MRSA) on admission, appeared to be progressing well, and was scheduled for discharge the following week. However, 24 hours later she developed fever, tachycardia, and hypotension and was transferred back to her original acute care facility where she was found to have an MRSA bloodstream infection.*

Subsequent molecular analysis of her MRSA isolate confirmed that the strain of MRSA that had caused her infection had been isolated from several other inpatients at the LTACH. Subsequent surveillance cultures revealed unacceptably high rates of MRSA cross-transmission among LTACH inpatients, and direct observation of LTACH care staff revealed suboptimal adherence to recommended hand hygiene and contact isolation procedures. Intensive education of staff, coupled with an ongoing system for monitoring adherence with recommended hand hygiene and isolation practices, was followed by a sustained reduction in rates of MRSA cross-transmission.

Introduction

Multidrug-resistant organisms (MDROs) such as MRSA, vancomycin-resistant *Enterococcus* (VRE), *Clostridium difficile*, and resistant gram-negative bacteria such as *Pseudomonas aeruginosa* are increasingly common causes of health care–acquired infections. Although some patients enter the hospital already colonized with MDROs, the majority of patients who acquire MDROs are believed to do so as a direct result of contact with the health care system. Acquisition of an MDRO generally occurs without the knowledge of the patient or clinicians, but a sizeable proportion of colonized patients do go on to develop overt infection[1,2] that can be associated with an array of poor outcomes and can even result in death.[3,4] Not surprisingly, interrupting the transmission of MDROs between patients in the hospital can contribute to dramatic reductions in facility rates of health care–acquired infection, certainly a goal of all health care executives.[5–7]

In general, nearly all MDROs can be spread within the hospital via cross-transmission from colonized or infected patients. However, the specific routes by which MDROs may spread and the factors governing transmission in the hospital can be quite complex. The spread of MDROs in health care facilities can be conceptually simplified to three major routes:

1. Spread via the animate environment
2. Spread via the inanimate environment
3. Spread involving both the animate and inanimate environment

In the first scenario, a health care worker's hands that become transiently contaminated with an MDRO after having contact with a colonized or infected patient may then transfer the pathogen to another patient (see Figure 4-1, below). In the second scenario, items such as

Animate Transmission:
Patient A → Health Care Worker → Patient B

Source: Adapted from Pittet D, et al.: Evidence-based model for hand transmission during patient care and the role of improved practices. *Lancet Infect Dis* 6:641–652, Oct. 2006.

Figure 4-1. In this scenario, a health care worker's hands become transiently contaminated with an MDRO after having contact with an infected patient, and the pathogen is then transferred to another patient. MDRO, multidrug-resistant organism.

stethoscopes could theoretically become contaminated with an MDRO after contact with a colonized patient and then transfer the pathogen when used on another patient (see Figure 4-2, below). In the third scenario, MDROs are spread first to surfaces and items in a colonized or infected patient's hospital room (e.g., an infusion pump) and are subsequently transferred to the hands of health care workers who, in turn, transmit the pathogen to previously noncolonized patients (see Figure 4-3, below). The spread of MDROs by this route is greatly facilitated by the high level of environmental contamination that occurs in critical,

Inanimate Transmission:
Patient A → Health Care Worker's Stethoscope → Patient B

Source: Adapted from Pittet D, et al.: Evidence-based model for hand transmission during patient care and the role of improved practices. *Lancet Infect Dis* 6:641–652, Oct. 2006.

Figure 4-2. In this scenario, a health care worker's stethoscope becomes contaminated with an MDRO after contact with an infected patient and then transfers the pathogen when used on another patient. MDRO, multidrug-resistant organism.

Interaction Between the Animate and Inanimate:
Patient A → Infusion Pump → Health Care Worker → Patient B

Source: Adapted from Pittet D, et al.: Evidence-based model for hand transmission during patient care and the role of improved practices. *Lancet Infect Dis* 6:641–652, Oct. 2006.

Figure 4-3. In this scenario, an MDRO is spread first to an infusion pump in an infected patient's room and is subsequently transferred to the hands of a health care worker who, in turn, transmits the pathogen to a previously noncolonized patient. MDRO, multidrug-resistant organism.

high-touch areas of colonized patient rooms. Studies have shown that nearly a quarter to a third of all surfaces in the rooms of patients colonized or infected with an MDRO can be contaminated by these pathogens (see Table 4-1, below, and Figure 4-4, page 47).[8–10] Moreover, studies suggest that the level of environmental contamination is equivalent in the rooms of patients who have an active infection caused by an MDRO versus those who are only colonized with these pathogens.[11]

Although the spread of MDROs in hospitals may appear inevitable, a number of core and investigational infection prevention practices have been shown to reduce the spread of these pathogens. Hand hygiene, contact isolation, environmental hygiene, active surveillance to detect asymptomatic MDRO colonization, and decolonization of patients who are colonized with MDRO have each been shown to reduce the transmission of MDROs in hospitals. In the sections that follow, the literature supporting the effectiveness of these control methods is discussed with an emphasis on how to implement them in your hospital and how to monitor your facility's compliance with these practices.

At many hospitals, these methods have been successfully deployed in conjunction with established performance improvement methodologies and techniques (see Sidebar 4-1, page 47). Although launching an effective MDRO transmission control plan does not require proficiency with Six Sigma or other quality control strategies, it is important to recognize that most such approaches are well suited to this effort.

Table 4-1

Rates of Surface Contamination with MRSA, VRE, and *C. difficile*

Surface	MRSA*	VRE†	*C. difficile*‡
Floors	55%	—	48%
Commode/Toilet	—	—	41%
Windowsill	—	—	33%
Bedsheets	53%	40%	21%
Patient Gown	51%	—	—
Overbed Table	40%	20%	—
Bedrail	29%	28%	19%
Blood Pressure Cuff	—	14%	—
Totals	29%	23%	27%

* Boyce J.M., et al.: Environmental contamination due to methicillin-resistant *Staphylococcus aureus*: Possible infection control implications. *Infect Control Hosp Epidemiol* 18:622–627, Sep. 1997.
† Slaughter S., et al.: A comparison of the effect of universal use of gloves and gowns with that of glove use alone on acquisition of vancomycin-resistant enterococci in a medical intensive care unit. *Ann Intern Med* 125:448–456, Sep. 15, 1996.
‡ Samore M.H., et al.: Clinical and molecular epidemiology of sporadic and clustered cases of nosocomial *Clostridium difficile* diarrhea. *Am J Med* 100:32–40, Jan. 1996.

MRSA, methicillin-resistant *Staphylococcus aureus*; VRE, vancomycin-resistant *Enterococcus*; *C. difficile, Clostridium difficile.*

Sidebar 4-1

Applying Performance Improvement Methodologies

Many hospital leaders across the country are applying more rigorous and systematic performance improvement methodologies to reduce the transmission of MDROs within their organizations. Six Sigma, Toyota Production System (TPS), "Lean" methodology, and other systems-engineering approaches have been shown to be extremely useful tools in the control of MRSA and other pathogens

One of the most well-documented experiences was reported by Muder, et al., at the Pittsburgh Veterans Administration Hospital. There, the TPS was employed in conjunction with a robust active surveillance system to ensure consistent and reliable adherence to infection prevention standards. The results were impressive. A 60% reduction in the MRSA infection rate was observed in a surgical unit and in the ICU, the rate of infection fell by 75%.*

* As reported in Muder R.R., et al.: Implementation of an industrial systems-engineering approach to reduce the incidence of methicillin-resistant Staphylococcus aureus infection. *Infect Control Hosp Epidemiol* 29:702–708, Jul. 2008.

Strategies to Prevent the Spread of MDROs

Hand Hygiene

Background. Because of the risk for spreading MDROs between patients or into the environment through the unwashed or uncleaned hands of frontline clinicians, hand hygiene is the single most important tool to prevent transmission of MDROs in hospitals and other health care facilities. Evidence-based guidelines describing the methods and indications for hand hygiene in health care have been widely disseminated.[12] Hand hygiene is a simple procedure that can be mastered by even schoolchildren.[13] However, even well-resourced organizations with engaged clinical and executive leadership routinely fail to maximize compliance with hand hygiene standards. Published interventions touting the success of a variety of initiatives to improve compliance rarely achieve hand hygiene rates greater than 70%.[14] Multiple barriers to full adherence to hand hygiene standards on the part of frontline clinicians (see Table 4-2 on page 48) suggests that maximizing performance of this relatively straightforward behavior will require a more vibrant systems-based approach than has previously been applied.

Potential Contamination Sites

Figure 4-4. Studies have shown that nearly a quarter to a third of all surfaces in the rooms of patients colonized or infected with an MDRO can be contaminated by these pathogens.

Source: Mary Hayden, M.D., Rush University Medical Center, Chicago, IL. Used with permission.

A number of strategies for improving hand hygiene adherence have been studied. Educational interventions, when used alone, have a modest but transient effect on adherence to hand hygiene

Table 4-2

Barriers to Hand Hygiene in Hospitals

Barrier	Description	Intervention
Lack of knowledge	Most health care workers understand that hand hygiene is important, but many do not appreciate the specific indications for hand hygiene or what appropriate hand hygiene entails.	Education
Lack of outcome beliefs	Most health care workers believe that hand hygiene is important but often fail to appreciate how dramatic an effect it can have on institutional rates of infection.	Education
Overestimation of adherence	Many health care workers report high perceived rates of adherence to hand hygiene, which is in stark contrast to that recorded when directly observed.	Surveillance and feedback of hand hygiene adherence rates
Lack of time	Studies show that most health care workers report a desire to perform hand hygiene but often report that their rates of adherence are suboptimal because of lack of time.	Use of waterless hand hygiene products
Hand irritation	Some health care workers report that frequent hand hygiene leads to dryness and cracking of the skin.	Use of trial hand hygiene products to ensure use of the least irritating agents and promote use of hand moisturizers
Lack of role models	Studies have consistently shown that health care workers model the behaviors of those around them.	Identify champions among staff to vocalize the virtues and model hand hygiene for other staff.
Lack of safety culture	Studies have shown that facilities with organizational cultures of safety are able to achieve and maintain high hand hygiene adherence rates.	Administrative support and vocalization of the importance of hand hygiene
Lack of supplies	Without ready access to functioning sinks, soap, and alcohol-based hand rub dispensers, providers are less likely to be fully adherent to standards.	Ensure that sinks as well as soap and alcohol-based hand rub dispensers are adequately distributed to meet the workflow of staff.

To help operationalize an infection control program, a hand hygiene data collection and analysis tool is included on the CD and may be shared with managers and other project leaders tasked with improving compliance.

recommendations.[15] Alcohol-based waterless hand hygiene products are more bactericidal than soap and water, effectively reduce the need for sinks, and greatly reduce the amount of time required to effectively disinfect hands.[14] Studies have shown that widespread adoption of these products can greatly improve health care worker adherence to hand hygiene[16,17] and reduce institutional rates of infection caused by a variety of MDROs.[14] Other opportunities include the engagement of patients in hand hygiene programs by specifically empowering them to confront clinicians about the failure to perform hand hygiene.[18]

Sidebar 4-2

Key Steps CEOs Can Take to Reduce Cross-Transmission of MDROs in Their Facilities

1. Make adherence to each core cross-transmission preventive activity—hand hygiene, isolation precautions, and environmental hygiene—an institutional performance goal.
2. Ensure that the facility has adopted clearly written policies for each of these core activities and that these policies are reviewed on a regular basis.
3. Create a process improvement team for each core activity and do the following:
    a. Recruit appropriate representation from clinical and administrative personnel (e.g., failing to include nursing representation on a team seeking to improve adherence with hand hygiene will likely result in project failure).
    b. Identify a process owner whose responsibility it is to ensure that the process improvement remains on target and is sustainable.
    c. Ensure appropriate level of resources.
    d. Ensure that the program incorporates an ongoing performance assessment evaluation system to monitor project success.
4. Set concrete objectives that raise expectations (think about President Kennedy's promise to put a man on the moon before the end of the 1960s).
5. Reinforce adherence with core activities:
    a. Encourage staff to reinforce desirable behaviors among themselves in a nonconfrontational manner.
    b. Respond quickly to staff suggestions when barriers to the desired behavior are identified.
    c. Reward staff and units that achieve or exceed performance measures.
    d. Aggressively recruit and retain staff who exemplify a commitment to safety and quality.
    e. Rapidly identify and address problem staff who willingly ignore remediation efforts.

CEO, chief executive officer; MDRO, multidrug-resistant organism.

Role of the CEO. Organizational theory states that a culture of safety and quality is built from the top down.[19] The involvement of the hospital chief executive officer (CEO) is one of the most important factors in determining whether an organization pursues a path toward continuous quality improvement or slides toward mediocrity. Nowhere is this more apparent than in the institutional pursuit of maximizing hand hygiene compliance by health care workers. The CEO can facilitate the implementation of a comprehensive hand hygiene program (and other core transmission control activities) through a number of key steps (see Sidebar 4-2, above). While many of these steps influence hand hygiene indirectly, the CEO can directly support this core activity by being a vocal and authoritative champion of the importance of hand hygiene to the overall climate of safety and quality at the institution.

Leadership rounds are a powerful tool that can be used to achieve this latter objective. For example, the CEO and other leaders can directly cultivate a culture of safety and quality during leadership rounds by

The Executive Rounding Checklist included on the CD encourages the administrative or clinical leader to collect a small sample of data regarding compliance with hand hygiene and other core transmission control activities while visiting a unit or care area.

washing their hands when coming onto the unit or before entering any patient room. Even if they are not expecting direct patient contact, the staff observation of a CEO washing his or her hands as the first action in a clinical area sends a powerful message. In addition, the leadership team should discuss hand hygiene compliance data with the management and staff of a unit, asking about compliance rates and what obstacles exist for timely and appropriate hand hygiene. As staff express concerns or make suggestions, these should be considered and a response generated after the visit to indicate that leadership is serious about making hand hygiene a priority.

Isolation Precautions

Background. Colonized or infected patients are the primary source for the spread of MDROs in hospitals. Studies have shown that patients colonized with an MDRO who are placed in contact precautions (also sometimes called contact isolation) are much less likely to transmit these pathogens to other hospitalized patients in the setting of an outbreak.[20] For this reason, it is considered a standard of care to place all hospitalized patients found to be colonized or infected with MRSA, VRE, *C. difficile*, or highly-resistant gram-negative bacteria in contact precautions.[21] At some facilities, droplet precautions may also be applied if the patient has an MDRO that is causing infection in the respiratory tract (see Sidebar 4-3 on pages 51–52). For example, patients with MRSA pneumonia may be placed in droplet and contact precautions.[21] Contact and droplet precautions represent just two of a variety of special precautions that have been recommended to prevent the spread of MDROs and other contagious diseases in hospitals and health care facilities.

Colonized or infected patients are the primary source for the spread of MDROs in hospitals.

Although the standards and expectations regarding the use of isolation precautions for MDROs may be clear, the implementation of this basic measure remains a challenge at many institutions. Similar to poor compliance with hand hygiene standards, much has been written about the failure of health care workers to make use of appropriate protective equipment to prevent the transmission of MDROs.[22,23]

Less well-recognized are the larger system failures that can undermine an effective isolation program. For example, if patients who are colonized or infected with MDROs are not identified in a timely fashion, precautions may never be undertaken, increasing the opportunity for transmission of organisms. Meticulous tracking of colonized patients, which may be facilitated by placement of an "electronic flag" on the patient's medical record (see Sidebar 4-4, page 53), should help to ensure the success of such efforts.

Finally, institutions must be prepared to deal with the negative consequences that can sometimes accompany the implementation of a successful isolation program. A number of studies have raised concerns about the safety and satisfaction of patients when isolated,

citing increased adverse outcomes and less well-documented care.[24] Providing patients and families with educational material that explains the rationale for isolation, assigning fewer patients to staff who are caring for patients in isolation, and reinforcing the importance of providing the same level of care to patients in isolation as those not in isolation are considered essential components of any high-functioning MDRO precautions program.

Role of the CEO. As with hand hygiene, the CEO can help increase facility adherence rates to isolation precautions through a number of key steps (Sidebar 4-2). Establishing adherence to isolation precautions as a key institutional performance goal and vocally supporting efforts to improve adherence with this behavior are obligatory duties of CEOs committed to creating a culture of safety and quality in their institutions. The CEO can facilitate the success of the performance improvement team by asking several simple questions (see Sidebar 4-5, page 53).

Sidebar 4-3

Transmission-Based Precautions

Spread of infectious diseases in the hospital requires three elements:
1. A **source** of the infecting organism
2. A **susceptible host**
3. A **mode of transmission**

A brief description of the isolation precautions used to prevent the spread of infectious diseases by each of the major routes of transmission is presented below. The majority of MDROs are spread by contact transmission.

Airborne Transmission Precautions

Airborne precautions are used (in addition to standard precautions*) for patients with infections that are transmitted by small droplet nuclei of 5 µm or smaller. Such droplets are generated when talking, coughing, or sneezing and during procedures involving the respiratory tract such as suction, intubation, or bronchoscopy. They can be widely dispersed by air currents. Infections spread by the airborne route are relatively uncommon in hospitals but include tuberculosis, chickenpox, measles, and *Aspergillus* infections.

Patient placement—Place the patient in an individual room with adequate ventilation (this includes, where possible, negative pressure, door closed, at least six air exchanges per hour, exhaust to outside away from intake ducts).

Respiratory protection—Wear respiratory protection, (e.g., high-efficiency filter mask) when entering the room. Susceptible people (e.g., pregnant women) should not enter the room of a patient infected with chickenpox or measles.

Patient transport—Limit transport of the patient to essential purposes only. If movement is necessary, minimize the risk of infection for others by placing a mask on the patient.

Environmental control—Ensure appropriate environmental and equipment cleaning, disinfection, and sterilization.

(continued on next page)

Sidebar 4-3

Transmission-Based Precautions *(continued)*

Droplet Transmission Precautions

Droplet precautions are used (in addition to standard precautions*) for patients with infections that are transmitted by large particle droplets (greater than 5 µm). Large droplet nuclei do not remain suspended in the air for long and travel only short distances. Transmission from large droplets requires close contact (i.e. within 3–5 feet) between the infected source and the recipient. Examples of infections transmitted by large droplets are meningococcal meningitis, influenza, mumps, rubella, diphtheria, pneumonic plague, and infections caused by multidrug-resistant *Streptococcus pneumoniae.* Other infections where respiratory precautions, such as using particulate filter masks, need to be taken are severe acute respiratory syndrome (SARS) and avian flu.

Patient placement—Place the patient in an individual room, if available. Special air handling and ventilation are not necessary, and the door may remain open.

Respiratory protection—Wear a mask when working within three to five feet of the patient.

Patient transport—Limit transport of the patient to essential purposes only. If movement is necessary, minimize the risk of infection to others by placing a mask on the patient.

Environmental control—Ensure appropriate environmental and equipment cleaning, disinfection, and sterilization.

Contact Transmission Precautions

Contact precautions (as well as standard precautions*) should be used for patients known or suspected to be infected or colonized with micro-organisms transmitted by direct or indirect contact. Examples of infectious diseases requiring contact precautions are gastrointestinal infections (including diarrhea of unknown origin), wound and skin infections (e.g. impetigo), and colonization with multidrug-resistant bacteria (e.g., MRSA).

Patient placement—A single room is advisable for infectious patients who are likely to contaminate the environment. Patients with the same active infection can be nursed together (cohorted) in one room, rather than in individual rooms.

Protective clothing and handwashing—Wear a disposable gown and gloves when entering the patient's room. Remove gown and gloves before leaving the patient's room. Wash hands before and after patient contact and when leaving the room.

Patient transport—Limit the movement and transport of the patient to essential purposes only. If the patient is moved out of the room, ensure that precautions are maintained.

Patient care equipment—When possible, dedicate the use of noncritical patient-care equipment, and items such as stethoscopes and thermometers, to a single patient (or to cohorted patients). If sharing equipment is unavoidable, ensure appropriate decontamination before use on another patient.

Environmental control—Ensure appropriate environmental and equipment cleaning, disinfection, and sterilization.

* Standard precautions are the practices adopted by all health care workers when potentially coming into contact with any patient's blood or body fluids. They are a set of principles designed to minimize exposure to and transmission of a wide variety of microorganisms. Because every patient is a potential infection risk, it is essential that you apply standard precautions to all patients at all times. Standard precautions include appropriate hand hygiene, use of personal protective equipment when exposure to blood and body fluids is anticipated, safe disposal of sharps, and appropriate management when exposure to blood and body fluids occurs.

MDRO, multidrug-resistant organism; MRSA, methicillin-resistant *Staphylococcus aureus*.

Source: Siegel J.D., et al.: 2007 Guideline for isolation precautions: Preventing transmission of infectious agents in health care settings. *Am J Infect Control* 35(suppl. 2):S65–S164, Dec. 2007.

Sidebar 4-4

Necessary Components of an Effective MDRO Tracking System

1. Rapid isolation and identification of MDROs
    a. Microbiology laboratory staff should employ rapid identification tests to identify MDROs and VRE as quickly as possible.
    b. For example, laboratory technology exists that would allow for identifying whether a patient is colonized with MRSA in as little as three hours of sample collection.
2. Rapid and effective communication with nursing staff or a member of the infection control department
    a. Procedures should be in place that require microbiology technologists to contact a member of the nursing staff or infection control department as soon as a patient is found to harbor an MDRO.
    b. Clinicians should not find out that a patient has a culture positive for MRSA after the fact.
3. Method for flagging medical records
    a. The microbiology laboratory and infection control department should work with the hospital computer system to make sure that patients found to be colonized or infected with an MDRO are flagged for future reference.
    b. These individuals should be placed in contact transmission precautions the moment they are readmitted or seen in the outpatient setting. For these patients, the decision to implement precautions may be made automatically at the time a hospital bed is assigned, whether or not an order has been placed by the admitting clinician.
    c. Procedures should be in place to monitor adherence to the flagging system (e.g., a patient known to be MRSA–positive but not placed in contact transmission precautions).
    d. Procedures to remove the medical record flag should be clearly defined and disseminated to care staff (e.g., three sequentially negative surveillance cultures for MRSA would allow removal of the MRSA flag from a patient's record).

MDRO, multidrug-resistant organism; MRSA, methicillin-resistant *Staphylococcus aureus*, VRE, vancomycin-resistant *Enterococcus.*

Sidebar 4-5

Enhancing Institutional Compliance with Isolation Precautions

A number of key questions should be considered when embarking on an institutionwide program to enhance the success of isolation precautions:

1. What is the compliance rate of our health care workers with isolation standards?
2. How easily and efficiently are patients who require precautions being identified?
3. Are precautions having an impact on patient safety and satisfaction?

Environmental Hygiene

Background. The role of inanimate surfaces (fomites) in the transmission of health care–associated infections has been a topic of debate for decades. Prior to the 1970s, infection control personnel routinely sampled hospital surfaces despite the lack of evidence to support this practice.[25] However, interest in the inanimate environment has seen a resurgence in light of recent studies demonstrating heavy contamination of hospital surfaces—such as bed linens, bed rails, and tabletops—with MDROs such as MRSA, VRE, and *C. difficile*, to name a few.[8–10] More recently, microbial surveillance of common-use objects—for example, computer terminals and sinks—and personal-use devices—such as stethoscopes, pagers, and uniforms—has revealed previously unappreciated foci of MDRO contamination in the hospital environment.[26]

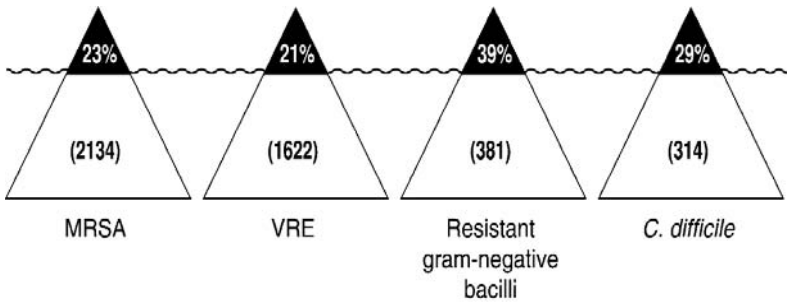
Many MDROs are able to live on inanimate surfaces for prolonged periods of time, and studies have shown that the hands of health care workers are just as likely to become contaminated with MDROs by touching surfaces in the rooms of colonized patients as they are by touching the skin of those patients.

Many MDROs are able to live on inanimate surfaces for prolonged periods of time, and studies have shown that the hands of health care workers are just as likely to become contaminated with MDROs by touching surfaces in the rooms of colonized patients as they are touching the skin of those patients.[27,28] Therefore, the first step in reducing the effects of environmental contamination on the transmission of MDROs is to educate health care workers that touching surfaces in the rooms of patients colonized with an MDRO is the same as touching the skin of the patient. The next step in mitigating the impact of the inanimate environment in the transmission of MDROs is to make sure that "high-touch" surfaces, such as doorknobs, bedrails, light switches, and wall areas around the toilet in the patient room, are cleaned on a regular basis.[29]

The rounding checklist, talking points, and data collection and analysis tools provided on the CD should prove invaluable in not only assessing compliance with the appropriate use of isolation precautions at your institution but also as an important starting point to improved performance.

An increasing number of studies have shown that patients who are admitted to rooms previously occupied by a patient colonized with an MDRO have a higher risk of acquiring an MDRO during their hospitalization,[30,31] so it is important that hospitals strive to rigorously clean and disinfect the surfaces in patient rooms after patients colonized with MDRO are discharged. Enhancing terminal disinfection in rooms previously occupied by a patient colonized with an MDRO has been shown to significantly reduce rates of environmental contamination with MRSA and VRE[32] and has been shown to reduce rates of infections caused by these MDROs during outbreaks.[26,33]

Role of the CEO. As with the other core activities for preventing MDRO transmission (hand hygiene and isolation precautions), the CEO can support the reduction in the risk of environmental contamination and transmission through a number of key steps as delineated in Sidebar 4-1. It is important that the CEO and his or her administrators identify key



Source: Crnich C.J., Safdar N., Maki D.G.: The role of the intensive care unit environment in the pathogenesis and prevention of ventilator-associated pneumonia. *Respir Care* 50:813–838, Jun. 2005. Used with permission.

Figure 4-5. The proportion of patients shown to be colonized with MDROs serendipitously detected by clinical cultures, contrasted with the total number of colonized patients detected through prospective surveillance, is shown here, based on studies using prospective surveillance cultures to detect asymptomatic colonization by multiresistant organisms. Note: Numbers in parentheses refer to the total number of colonized patients found by prospective surveillance cultures. MRSA, methicillin-resistant *Staphylococcus aureus*; VRE, vancomycin-resistant *Enterococcus*; *C. difficile, Clostridium difficile.*

leadership in the environmental services department to ensure the appropriate training, reinforcement, and competency of environmental staff on routine and enhanced cleaning and disinfection procedures. In addition, it is important that managers on patient units continually reinforce with care staff the importance of and proper techniques for cleaning and disinfecting nondedicated equipment that is used for patient care (e.g., Hoyer lift, glucose monitor).

Active Surveillance for MDROs

Background. Patients can be carriers of MDROs even in the absence of signs and symptoms of infection. Such individuals appear to play a critical role in the spread of MDROs in hospitals and other clinical settings. For every one patient known to be colonized or infected with MRSA, VRE, or *C. difficile* there are three to five patients on the same unit with undetected colonization by the resistant species (see Figure 4-5, above).[26] It is important to note that these asymptomatically colonized patients may be just as capable of transmitting MDROs as those with active infection. As a result, most horizontal transmission of MDROs in hospitals could arise from patients who are unknowingly colonized but not infected with these pathogens. The rationale for active surveillance is to identify this population of patients so precautions can be implemented, reducing the risk that they may transmit their pathogen to other patients or the environment.

The competency questions included on the CD can be incorporated into orientation and periodic education programs to ensure that the risk of infection transmission due to inadequate environmental cleaning is appropriately framed for frontline staff.

Operationally, active surveillance involves collecting specimens from patients regardless of whether they have signs or symptoms of infection. This typically involves swabbing different body sites depending on the organism of interest. For example, active surveillance for MRSA typically involves obtaining a swab of the nares and, occasionally, other body sites such as the rectum or open wounds, while active surveillance for VRE involves a swab culture of the rectum or perirectal skin. Swab specimens are then submitted to the microbiology laboratory and undergo one or more culture- or molecular-based tests to detect the presence of relevant organisms.[34,35] Patients found to be colonized with an MDRO are then placed in contact isolation and may also be treated with systemic or topical antibiotic agents in an attempt to decolonize them.

Active surveillance has been primarily applied to the control of MRSA and VRE.[36] The use of active surveillance has been championed in Northern Europe where it has been credited as part of a more comprehensive "search and destroy" method for maintaining hospital rates of MRSA infection below 1% in the Netherlands.[37] The evidence supporting the use of active surveillance in the United States is arguably more limited. Targeted use of active surveillance in the intensive care unit (ICU) of a single academic medical center has been temporally associated with a reduction in rates of invasive MRSA infections in both the ICU and non–ICU setting.[5] Likewise, implementation of a universal active surveillance for all newly admitted patients led to an 80% reduction in MRSA bloodstream infections across three Midwestern hospitals within the same health care organization.[6] Finally, implementation of an active surveillance program was temporally associated with a reduction in the numbers of infections caused by VRE in a large geographic region in the upper Midwest.[38] Overall, these studies suggest that active surveillance can reduce rates of infection caused by MRSA and VRE in the hospital setting[39] despite occasional reports to the contrary.[40]

The infection control risk assessment tools included on the CD are critical to gathering information on the needs and expected yields of an active surveillance program. For example, it would be counterproductive to devote resources to an active surveillance program to combat MRSA if highly resistant gram-negative bacteria are in fact the singular greatest MDRO threat to patients at the institution. After institutional risks are quantified, the CEO should demand a reliable accounting of the current performance of core infection control and prevention activities (hand hygiene, isolation precautions, and environmental hygiene).

Nevertheless, the routine use of active surveillance in hospitals remains a controversial topic. The Society for Healthcare Epidemiology of America has advocated for the use of active surveillance in specific health care settings,[36] while the most recent Healthcare Infection Control Practices Advisory Committee (HICPAC) guideline recommends that active surveillance should be used selectively and only after other infection control practices have failed.[41] In spite of the ongoing uncertainty over the scientific merit of active surveillance, a number of states have taken the unusual step of legislatively mandating that hospitals implement active surveillance programs.[42] Moreover, the Veterans Health Administration (VHA) has recently mandated the implementation of active surveillance programs in all of its facilities.[43] In light of these developments, it seems prudent that all hospitals begin to carefully

assess the cost and benefits of implementing an active surveillance program.

Role of the CEO. Before deploying an active surveillance program, it is important for the CEO to confirm that his or her facility has implemented programs to improve adherence to the core transmission prevention activities—hand hygiene, isolation precautions, and environmental hygiene. If institutional rates of infection caused by MDRO remain high after maximizing these core activities, it may be reasonable to consider implementing an active surveillance program. When considering whether to implement an active surveillance program, it is important for organizational leadership to consider the cost to the institution, the expected benefit, the burden it will place on care staff and laboratory staff, the stress it will place on bed availability, and the impact that an active surveillance program will have on the patient's care, both real and perceived. [44]

If after these preliminary steps the deployment of an active surveillance program continues to appear appropriate, the Active Surveillance Checklist (a 12-step program) included on the CD will allow the managers and leaders tasked to implement the program to ensure that the approach taken is both rigorous and rational.

Implementing an active surveillance program requires the creation of a multidisciplinary team with representation from infection control, nursing, physician groups, information technology, laboratory medicine, finance, and hospital leadership.[45] The considerable costs and logistical issues associated with starting an active surveillance program require strong involve- ment and commitment from the hospital CEO. The Evanston Northwestern Health (ENH) care system's experience offers a unique and detailed account of how they arrived at the decision to implement an active surveillance program, the planning that went into making the program a reality, the steps they took to monitor adherence to the various processes required, and the methods they used to evaluate programmatic outcomes,[45] and members of the ENH program have made a point of stating that hospital leadership was critical in each step of this process.[46]

Studies also suggest that active surveillance programs can lead to considerable cost savings for hospitals;[6] however, implementing an active surveillance program, regardless of its scope, can involve considerable up-front and continuing costs.[45] Moreover, the effects of the program will not be immediate, and it may take a year or more before benefits are seen.[6] As a result, it is important that hospital leadership view the active surveillance program as a long-term investment in patient safety and quality with a minimum of a two-year results horizon to see clinical and financial returns.

In the toolkit, a number of resources to facilitate the deployment of an active surveillance program are discussed. Before an active surveillance program is contemplated, it is essential that organizational leaders have access to timely and accurate information regarding the needs and expected yields of this strategy.

Decolonization of Patients with MDRO

Background. Patients who are colonized with an MDRO are at considerable risk of developing infections caused by these pathogens, and despite appropriate placement in contact precautions, can remain a reservoir for the transmission of MDROs throughout the facility. Logically, interventions that could eliminate MDROs would have direct benefits to the patient and would reduce the risk of MDRO transmission in the hospital. Decolonization strategies are based on the application of antibiotics either topically or systemically to eradicate MDROs from treated patients. Almost all of the studies focused on decolonization have addressed the management of MRSA, most commonly using topical antibiotic agents such as mupirocin. Initially, these studies focused on decolonization of patients undergoing surgical procedures[47] and those receiving hemodialysis.[48] However, more recent studies have begun to focus on the utility of decolonization in all hospitalized patients found to be colonized with MRSA.[6,49]

Decolonization strategies are based on the application of antibiotics either topically or systemically to eradicate MDROs from treated patients.

Current guidelines do not adopt a strong position on the issue of decolonization for MDROs, and a recent survey suggests that most infectious diseases specialists discourage the routine use of decolonization using topical and/or systemic antibiotics as a hospitalwide strategy for controlling their spread.[50] This reluctance stems in part from somewhat conflicting evidence from large, multicenter randomized trials but, even more importantly, from concerns that widespread use of antibiotics to eradicate MDRO colonization will only serve to fuel the emergence of increasingly resistant bacterial pathogens. Indeed, this situation has been described in nursing homes[51] as well as in hospitals outside the United States[52] where widespread use of intranasal mupirocin was followed by the rapid emergence of strains of MRSA that displayed high-level resistance to this agent.

While most infectious diseases and infection control specialists are concerned about the overuse of antibiotics in decolonization programs, several recent studies have begun to examine the use of cutaneous antiseptics,[53,54] not as a means of eradicating MDRO colonization, but as a way to reduce environmental shedding in the hope that this will reduce institutional rates of cross-transmission of these pathogens. This is a potentially more attractive approach to the control of MDRO transmission as it avoids the use of antibiotics entirely. However, it must be stressed that the promising results seen in controlling the spread of MRSA[54] and VRE[53] should be validated in multicenter trials before this control approach can be routinely recommended.

Role of the CEO. The decision to introduce an MDRO decolonization program into the hospital or select units must be considered carefully and with direct input from institutional experts in infection prevention and health care epidemiology. The CEO can play an integral part in this process by establishing an environment that fosters interactions between individuals from different disciplines and by setting an agenda that seeks to maximize adherence to the core transmission prevention activities—hand hygiene, isolation

precautions, and environmental hygiene. When these core transmission prevention activities have been maximized, it may be reasonable to consider whether quality can be improved further through an antibiotic or antiseptic decolonization program. At that point the increased costs of such a program can be discussed, and potential unintended consequences can be examined. In this situation, the CEO or his or her designated representative can provide critical leadership by doing the following:

- Insisting that the program go through a risk-assessment process
- Establishing a clearly defined set of procedures
- Implementing a system for monitoring appropriate use of decolonization agents and adverse events (e.g., the emergence of high-level mupirocin resistance)
- Ensuring that the program is meeting its stated objectives to reduce the numbers of infections caused by MDROs

Conclusion: Putting It All Together

The CD includes a hand hygiene monitoring tool that can be used to assess the success of transmission prevention.

The approach described in this chapter features many procedures and activities to prevent the transmission of MDROs in hospitals and other health care facilities. This approach can be used not only in large, highly resourced university-affiliated medical centers but also in considerably smaller facilities—especially those in which infection control and prevention programs are still modest in experience, scope, and budget. As has already been emphasized, organizational risk and performance assessments are essential preliminary steps in this process and must be embraced and supported by the CEO and other executive leaders. With the results of these assessments in hand, the challenge then is to apply the data in a manner that maximizes performance of the basic core activities (hand hygiene, isolation precautions, and environmental hygiene) to ensure that more intensive and resource-demanding strategies (e.g., active surveillance, decolonization) are deployed only when most appropriate.

The end product of this approach is not a uniform program to prevent the spread of MDROs. Rather, with a consistent approach it is likely that each organization will develop and support an MDRO control plan that is unique but specific to the needs of the patients who are cared for and the clinicians who provide care at that institution.

Role of the CEO

Look for an Active Surveillance Checklist on the CD.

It is not enough for CEOs to articulate facility goals; CEOs must begin the work through the following steps:

1. Establish performance improvement groups for each of the three core transmission prevention activities—hand hygiene, isolation precautions, and environmental hygiene.

a. Select the right people: Teams should consist of representatives from appropriate clinical and administrative areas.
b. Set up accountability: A single individual should be tasked with leading the performance improvement team and ensuring that it stays on target and sustains its activities.
c. Set specific goals: Each team should set specific goals in each of its activity areas (e.g., increasing facility hand hygiene adherence rates to 90%).
d. Monitor performance: Each team should have methods for monitoring its transmission prevention activities.
e. Develop and implement a plan: Each team should develop a specific plan to achieve its aims.
    i. Test performance improvement interventions at a small level to identify problems.
    ii. Perfect intervention through an iterative process.
    iii. Disseminate intervention through the rest of the organization.

2. Make sure each team has the necessary resources to achieve its stated objectives.
3. Meet with leaders of each team to assess progress toward stated goals and the need for additional resources.
4. Meet with care staff to reinforce the importance of core transmission prevention activities.
5. Assess progress toward the overall programmatic objective at least annually.
    a. If the objective is met, set an even more aggressive objective for next year.
    b. If the objective is not met, assess whether core transmission prevention activities need to be reinforced or whether it is time to examine if more aggressive measures such as active surveillance and decolonization programs should be entertained.
6. Maintain transmission prevention teams to ensure the sustainability of these objectives when they have been met.

References

1. Huang S.S., Platt R.: Risk of methicillin-resistant *Staphylococcus aureus* infection after previous infection or colonization. *Clin Infect Dis* 36:281–285, Feb. 2003.
2. Yeh K.M., et al.: Vancomycin-resistant *Enterococcus* (VRE) carriage and infection in intensive care units. *Microb Drug Resist* 10:177–183, Summer 2004.
3. Carmeli Y., et al.: Health and economic outcomes of vancomycin-resistant enterococci. *Arch Intern Med* 162:2223–2228, Oct. 28, 2002.
4. Cosgrove S.E., et al.: Comparison of mortality associated with methicillin-resistant and methicillin-susceptible *Staphylococcus aureus* bacteremia: A meta-analysis. *Clin Infect Dis* 36:53–59, Jan. 1, 2003.
5. Huang S.S., et al.: Impact of routine intensive care unit surveillance cultures and resultant barrier precautions on hospital-wide methicillin-resistant *Staphylococcus aureus* bacteremia. *Clin Infect Dis* 43:971–978, Oct. 2006.
6. Robicsek A., et al.: Universal surveillance for methicillin-resistant *Staphylococcus aureus* in 3 affiliated hospitals. *Ann Intern Med* 148:409–418, Mar. 18, 2008.
7. Harrington G., et al.: Reduction in hospitalwide incidence of infection or colonization with methicillin-resistant *Staphylococcus aureus* with use of antimicrobial hand-hygiene gel and statistical process control charts. *Infect Control Hosp Epidemiol* 28:837–844, Jul. 2007.

8. Samore M.H., et al.: Clinical and molecular epidemiology of sporadic and clustered cases of nosocomial *Clostridium difficile* diarrhea. *Am J Med* 100:32–40, Jan. 1996.
9. Slaughter S., et al.: A comparison of the effect of universal use of gloves and gowns with that of glove use alone on acquisition of vancomycin-resistant enterococci in a medical intensive care unit. *Ann Intern Med* 125:448–456, Sep. 15, 1996.
10. Boyce J.M., et al.: Environmental contamination due to methicillin-resistant *Staphylococcus aureus*: Possible infection control implications. *Infect Control Hosp Epidemiol* 18:622–627, Sep. 1997.
11. Riggs M.M., et al.: Asymptomatic carriers are a potential source for transmission of epidemic and nonepidemic *Clostridium difficile* strains among long-term care facility residents. *Clin Infect Dis* 45:992–998, Oct. 15, 2007.
12. Boyce J.M., et al.: Guideline for Hand Hygiene in Health-Care Settings: Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. *Infect Control Hosp Epidemiol* 23(suppl.):S3–S40, Dec. 2002.
13. Hammond B., et al.: Effect of hand sanitizer use on elementary school absenteeism. *Am J Infect Control* 28:340–346, Oct. 2000.
14. Pittet D., et al.: Effectiveness of a hospital-wide programme to improve compliance with hand hygiene. *Lancet* 356:1307–1312, Oct. 2000.
15. Pittet D.: The Lowbury lecture: Behaviour in infection control. *J Hosp Infect* 58:1–13, Sep. 2004.
16. Bischoff W.E., et al.: Handwashing compliance by health care workers: The impact of introducing an accessible, alcohol-based hand antiseptic. *Arch Intern Med* 160:1017–1021, Apr. 10, 2000.
17. Rupp M.E., et al.: Prospective, controlled, cross-over trial of alcohol-based hand gel in critical care units. *Infect Control Hosp Epidemiol* 29:8–15, Jan. 2008.
18. Swoboda S.M., et al.: Isolation status and voice prompts improve hand hygiene. *Am J Infect Control* 35:470–476, Sep. 2007.
19. Larson E.L., et al.: An organizational climate intervention associated with increased handwashing and decreased nosocomial infections. *Behav Med* 26:14–22, Spring 2000.
20. Jernigan J.A., et al.: Effectiveness of contact isolation during a hospital outbreak of methicillin-resistant *Staphylococcus aureus. Am J Epidemiol* 143:496–504, Mar. 1, 1996.
21. Siegel J.D., et al.: 2007 Guideline for isolation precautions: Preventing transmission of infectious agents in health care settings. *Am J Infect Control* 35(suppl. 2):S65–S164, Dec. 2007.
22. Afif W., et al.: Compliance with methicillin-resistant *Staphylococcus aureus* precautions in a teaching hospital. *Am J Infect Control* 30:430–433, Nov. 2002.
23. Weber D.J., et al.: Compliance with isolation precautions at a university hospital. *Infect Control Hosp Epidemiol* 28:358–361, Mar. 2007.
24. Stelfox H.T., Bates D.W., Redelmeier D.A.: Safety of patients isolated for infection control. *JAMA* 290:1899–1905, Oct. 8, 2003.
25. Maki D.G., et al.: Relation of the inanimate hospital environment to endemic nosocomial infection. *N Engl J Med* 307:1562–1566, Dec. 16, 1982.
26. Crnich C.J., Safdar N., Maki D.G.: The role of the intensive care unit environment in the pathogenesis and prevention of ventilator-associated pneumonia. *Respir Care* 50:813–836; discussion 836–838, Jun. 2005.
27. Bhalla A., et al.: Acquisition of nosocomial pathogens on hands after contact with environmental surfaces near hospitalized patients. *Infect Control Hosp Epidemiol* 25:164–167, Feb. 2004.
28. Hayden M.K., et al.: Risk of hand or glove contamination after contact with patients colonized with vancomycin-resistant *Enterococcus* or the colonized patients' environment. *Infect Control Hosp Epidemiol* 29:149–154, Feb. 2008.
29. Sehulster L.M., et al.: *Guidelines for Environmental Infection Control in Health-Care Facilities. Recommendations from the CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC).* Chicago: American Society for Healthcare Engineering/American Hospital Association, 2004.
30. Drees M., et al.: Prior environmental contamination increases the risk of acquisition of vancomycin-resistant enterococci. *Clin Infect Dis* 46:678–685, Mar. 1, 2008.
31. Huang S.S., Datta R., Platt R.: Risk of acquiring antibiotic-resistant bacteria from prior room occupants. *Arch Intern Med* 166:1945–1951, Oct. 9, 2006.
32. Goodman E.R., et al.: Impact of an environmental cleaning intervention on the presence of methicillin-resistant *Staphylococcus aureus* and vancomycin-resistant *Enterococci* on surfaces in intensive care unit rooms. *Infect Control Hosp Epidemiol* 29:593–599, Jul. 2008.

33. Dancer S.J.: Importance of the environment in methicillin-resistant *Staphylococcus aureus* acquisition: The case for hospital cleaning. *Lancet Infect Dis* 8: 101–113, Feb. 2008.
34. Brown D.F., et al.: Guidelines for the laboratory diagnosis and susceptibility testing of methicillin-resistant *Staphylococcus aureus* (MRSA). *J Antimicrob Chemother* 56:1000–1018, Dec. 2005.
35. Carroll KC. Rapid diagnostics for methicillin-resistant *Staphylococcus aureus*: Current status. *Mol Diagn Ther* 12(1):15–24, 2008.
36. Muto C.A., et al.: SHEA guideline for preventing nosocomial transmission of multidrug-resistant strains of *Staphylococcus aureus* and *Enterococcus. Infect Control Hosp Epidemiol* 24:362–386, May 2003.
37. Wertheim H.F., et al.: Low prevalence of methicillin-resistant *Staphylococcus aureus* (MRSA) at hospital admission in the Netherlands: The value of search and destroy and restrictive antibiotic use. *J Hosp Infect* 56:321–325, Apr. 2004.
38. Ostrowsky B.E., et al.: Control of vancomycin-resistant *Enterococcus* in health care facilities in a region. *N Engl J Med* 344:1427–1433, May 10, 2001.
39. McGinigle K.L., Gourlay M.L., Buchanan I.B.: The use of active surveillance cultures in adult intensive care units to reduce methicillin-resistant *Staphylococcus aureus*–related morbidity, mortality, and costs: A systematic review. *Clin Infect Dis* 46:1717–1725, Jun. 1, 2008.
40. Harbarth S., et al.: Universal screening for methicillin-resistant *Staphylococcus aureus* at hospital admission and nosocomial infection in surgical patients. *JAMA* 299:1149–1157, Mar. 12, 2008.
41. Siegel J.D., et al.: Management of multidrug-resistant organisms in health care settings, 2006. *Am J Infect Control* 35(suppl. 2):S165–S193, Dec. 2007.
42. Weber S.G., et al.: Legislative mandates for use of active surveillance cultures to screen for methicillin-resistant *Staphylococcus aureus* and vancomycin-resistant enterococci: Position statement from the Joint SHEA and APIC Task Force. *Infect Control Hosp Epidemiol* 28:249–260, Mar. 2007.
43. Veterans Health Administration: *Methicillin-Resistant* Staphylococcus aureus *(MRSA) Initiative, 2007.* Jan. 22, 2007. http://www1.va.gov/vhapublications/ViewPublication.asp?pub_ID=1525 (accessed Feb. 15, 2008).
44. Diekema D.J., Edmond M.B.: Look before you leap: Active surveillance for multidrug-resistant organisms. *Clin Infect Dis* 44:1101–1107, Apr. 15, 2007.
45. Peterson L.R., Hacek D.M., Robicsek A.: 5 Million Lives Campaign. Case study: An MRSA intervention at Evanston Northwestern Healthcare. *Jt Comm J Qual Patient Saf* 33:732–738, Dec. 2007.
46. Robicsek A., et al.: Impact of universal inpatient surveillance and decolonization (USD) on rates of healthcare associated methicillin-resistant *Staphylococcus aureus* (MRSA) bloodstream infection (BSI) [Abstract]. In *Program and Abstracts of the 44th Annual Meeting of the Infectious Disease Society of America 12–15 October 2006; Toronto, Ontario, Canada:* Infectious Disease Society of America. Alexandria, VA.
47. van Rijen M.M., et al.: Intranasal mupirocin for reduction of *Staphylococcus aureus* infections in surgical patients with nasal carriage: A systematic review. *J Antimicrob Chemother* 61:254–261, Feb. 2008.
48. Tacconelli E., et al.: Mupirocin prophylaxis to prevent *Staphylococcus aureus* infection in patients undergoing dialysis: A meta-analysis. *Clin Infect Dis* 37:1629–1638, Dec. 15, 2003.
49. Ridenour G., et al.: Selective use of intranasal mupirocin and chlorhexidine bathing and the incidence of methicillin-resistant *Staphylococcus aureus* colonization and infection among intensive care unit patients. *Infect Control Hosp Epidemiol* 28:1155–1161, Oct. 2007.
50. Sunenshine R.H., et al.: Management of inpatients colonized or infected with antimicrobial-resistant bacteria in hospitals in the United States. *Infect Control Hosp Epidemiol* 6:138–143, Feb. 2005.
51. Kauffman C.A., et al.: Attempts to eradicate methicillin-resistant *Staphylococcus aureus* from a long-term-care facility with the use of mupirocin ointment. *Am J Med* 94:371–378, Apr. 1993.
52. Vivoni A.M., et al.: Mupirocin for controlling methicillin-resistant *Staphylococcus aureus*: Lessons from a decade of use at a university hospital. *Infect Control Hosp Epidemiol* 26:662–667, Jul. 2005.
53. Vernon M.O., et al.: Chlorhexidine gluconate to cleanse patients in a medical intensive care unit: The effectiveness of source control to reduce the bioburden of vancomycin-resistant enterococci. *Arch Intern Med* 166:306–312, Feb. 13, 2006.
54. Wendt C., et al.: Value of whole-body washing with chlorhexidine for the eradication of methicillin-resistant *Staphylococcus aureus*: A randomized, placebo-controlled, double-blind clinical trial. *Infect Control Hosp Epidemiol* 28:1036–1043, Sep. 2007.

On the CD

Active Surveillance Checklist
When it comes to active surveillance, look before you leap! This checklist is designed for leaders and managers who have been designated to develop and implement an active surveillance program for MDROs. The checklist takes the reader through details of the pre-planning stage (including performance assessment and goal setting), active surveillance logistics (the "who, what, where, and when"), and program rollout (including potential pitfalls).

Marketing and Promotional Ideas
Are the walls of care areas and public spaces in your hospital covered with three layers of forgotten posters touting past improvement initiatives? Take the promotion of hand hygiene and other MDRO transmission control activities to the next level with this comprehensive annotated list of low-cost awareness and educational pieces that your staff will love.

Executive Rounding Checklist
Roll up your sleeves and get your hands dirty (so to speak!) in assessing and preventing the spread of MDROs at your organization. When you make rounds on the clinical units you deliver a powerful message when you talk to staff about key infection prevention principles and their application in the clinical settings. This simple checklist will assist leaders in looking at adherence to hand hygiene and isolation precautions as a means by which to break the ice and engage bedside providers to raise awareness about MDRO prevention.

Hand Hygiene Monitoring Tool
Because of the risk for spreading MDROs between patients or into the environment through the unwashed hands of frontline clinicians, hand hygiene is the single most important tool to prevent transmission of MDROs. If your organization is not consistently meeting the desired compliance rate for hand hygiene, consider simply observing staff behavior to identify opportunities where your organization can improve. Use this tool (or design your own) to document your findings and encourage other leaders to do the same. Then discuss your findings together (and with staff) to identify trends. Some programs use only nurses or other experienced clinical staff to perform monitoring. However, at many hospitals, personnel who lack specific clinical experience but who are provided with a comprehensive monitoring tool, strict instructions, and supervision can be effectively deployed.

Competency Questions
All frontline providers should want to know what they can do to prevent their patients from becoming infected with MDROs, and these questions will help you assess what they actually do know. These questions ask about basic practices that will protect even the most vulnerable of patients. Administered alone or combined with those from the other chapters, online or on paper, these competency questions may provide surprising results.

CEO Talking Points
The basics of transmission control need to be incorporated into the daily activities of everyone who works at the hospital—including the CEO. The key principles described in these slides can be shared up and down the organizational hierarchy—everywhere from the boardroom to the bedside.

CHAPTER 5

Antibiotic Stewardship

Paul Cook, M.D.

Is antibiotic misuse promoting the spread of MDROs and unnecessarily increasing costs at your institution?

Dr. Anderson admitted an elderly nursing home patient to your hospital with pneumonia. He ordered blood cultures and an antibiotic (moxifloxacin), which the patient began three hours after admission. In spite of the antibiotic, the patient's condition worsened. The microbiology reports were returned the next day and showed that the blood cultures were growing Pseudomonas aeruginosa *resistant to moxifloxacin but susceptible to imipenem.*

Dr. Anderson changed the antibiotic to imipenem as soon as the test results became available. The patient was transferred to the intensive care unit (ICU) where she worsened and required mechanical ventilation. She spent two weeks in the ICU before being transferred to the internal medicine service.

The patient was finally transferred back to her nursing home after a 24-day hospital stay. The total cost of her admission was more than $100,000. During a subsequent morbidity and mortality conference, Dr. Anderson learned that nearly all of the patients admitted from that particular nursing home with infection ended up requiring treatment with broad-spectrum antibiotics (such as imipenem) because of a high frequency of multidrug-resistant organisms (MDROs). Dr. Anderson wondered whether his patient's course might have been less complicated had he been aware of this problem and used the more powerful antibiotic from the start.

Background

The old saying "There's no such thing as a free lunch" aptly applies to antibiotic use. The use of antibiotics, even when well-intentioned and clinically appropriate, promotes the selection of MDROs. In the hospital setting, it has been estimated that as much as 50 percent of antibiotic use is unnecessary.[1] Given the association of antibiotic use with antibiotic resistance, it would seem to follow that the rational regulation and reduction of antibiotic use at a hospital could contribute to reducing, or at least stemming, the rise of antibiotic resistance. Moreover, an effective program to promote appropriate antibiotic use can ensure that the choice of treatment for infected patients is made rationally and with as much information as possible (*unlike* Dr. Anderson's situation in the introductory example).

The creation of antibiotic stewardship programs (ASPs), also known as antibiotic management programs, is one powerful method of dealing with MDROs directly. Antibiotic stewardship is a multisystem team approach that involves limiting inappropriate use of antibiotic agents while optimizing the selection, dose, duration, and route of therapy with the most appropriate drug for the patient's condition. Institutions that implement antibiotic stewardship programs commonly reduce antibiotic use between 22 percent and 36 percent.[2,3] There are numerous studies that demonstrate the benefits of an ASP,[3,4] but it is important to note that a good antibiotic management program complements an infection prevention and control program and vice versa.

Regardless of size, organizations that implement ASPs will save money and improve patient care. The sections that follow will examine the structure and functions of an ASP and will consider in detail the strategies and challenges of implementing an ASP and the opportunities for both clinical and financial benefit. Each case will emphasize the quantitative evaluation of program effectiveness. The final part of this chapter examines the role of the chief executive officer (CEO) and other senior executives in supporting antibiotic stewardship.

Regardless of size, organizations that implement ASPs will save money and improve patient care.

Structure of an Effective Stewardship Program

The Infectious Diseases Society of America (IDSA) and the Society for Healthcare Epidemiology of America (SHEA) have both published guidelines for antibiotic stewardship.[4] According to these guidelines, one of the critical elements for reducing antibiotic resistance is an ASP. Whenever possible, this program should include an infectious diseases clinician and an infectious diseases–trained pharmacist. The composition of the group ideally should also include medical staff from all of the representative services of the hospital (internal medicine, pediatrics, family medicine, surgery, hospitalists, obstetrics and gynecology, critical care). There should also be a microbiologist or other representative from the microbiology laboratory, one or more pharmacists, an information systems expert, and a representative from infection prevention and control such as a hospital epidemiologist.

The ASP generally operates under the auspices of the Pharmacy and Therapeutics Committee of the hospital (or comparable administrative structure). As such, the program seeks input from members of the Pharmacy and Therapeutics Committee as well as from the hospital administration and medical staff. The group should meet regularly (e.g., bimonthly or quarterly). At meetings of the full group, this committee should review the trends from the microbiology laboratory to monitor the institution's ongoing antibiotic-resistance challenges. In addition, the committee should review the antibiotic-use patterns of the hospital. At these sessions, policy initiatives should be considered and plans for disseminating new interventions to frontline clinicians should be discussed. In general, the ASP should report to the Pharmacy and Therapeutics Committee, which should review and approve the recommendations of the program. A more comprehensive discussion of the specific activities of the ASP is presented in the next section.

Functions of the Antibiotic Stewardship Program

In essence, the responsibility of the ASP can be distilled to several key elements. The first is to compile and integrate quantitative evidence regarding the use of antibiotic agents and the frequency of antibiotic resistance (among other outcomes related to the management of infection). Based on these findings, the ASP next develops comprehensive strategies to govern antibiotic use in the institution based on the most up-to-date data. Finally, the program plays a central role in disseminating not only the findings of the data analysis but also the policies and practices that are required across the institution to optimize antibiotic use by frontline clinicians. Each of these functions is explored in greater detail in the sections that follow.

Review of Pharmacy Data

Every hospital pharmacy should have available data regarding antibiotic consumption. Pharmacy purchase data is easy to obtain but can be misleading depending on when the data are collected. For example, many hospital pharmacies will make major purchases at the end of a fiscal year or may trade drugs with other hospitals to balance a surplus or shortage. These policies can lead to misinformation about the true use of certain drugs. A much more accurate means of assessing antibiotic use is to measure the amount of drugs dispensed to individual patients. These data are slightly more difficult to obtain but are ultimately more reliable and useful to a rational and effective ASP.

Drug use (in grams) can be easily converted to a unit known as the defined daily dose (DDD), a universally accepted unit of measurement of drug use such that use of Drug A (e.g., ciprofloxacin) can be compared with use of Drug B (e.g., cefazolin). Each antibiotic has a DDD determined by the World Health Organization (WHO) (see http://www.whocc.no/atcddd). For example, the DDD of cefazolin is three grams because the usual dose of the drug is one gram every eight hours. Grams of drug are converted into DDDs and then adjusted for hospital

Table 5-1

Antibiotic Usage by Quarter in DDD/1,000 Patient Days

Name	1st Qrt 07	2nd Qrt 07	3rd Qrt 07	4th Qrt 07
AMPICILLIN-SULBACTAM	45.7	60.0	23.0	17.3
CEFAZOLIN	78.0	75.1	33.8	51.6
CEFEPIME	41.0	50.0	56.1	71.4

DDD, defined daily dose.

census by dividing by the total number of hospital days and multiplying this number by 1,000—i.e., DDD per 1,000 patient days (DDD/1,000 patient days).

The standardization of the DDD method allows for comparison of antibiotic use between institutions and against a variety of benchmarks. Perhaps more importantly, this measurement allows the hospital to compare its use over time, such as after a specific intervention or even as hospital census changes. These data can be generated and reported periodically (at many institutions in the form of quarterly reports). Table 5-1, above, shows a hypothetical sample of data for commonly used antibiotics at one institution, demonstrating that the use of ampicillin/sulbactam and cefazolin decreased in the third and fourth quarters of the year, whereas cefepime use increased over this same period of time. One must be careful in the interpretation of the information contained in these reports. For example, the use of many antibiotics tend to increase in the first and fourth quarters of the calendar year, when there are more admissions for pneumonia. Therefore, it may be more appropriate to compare the same quarter of each year on an ongoing basis.

Review of Clinical Microbiology Data

Antibiotic use data provide information about one of the *causes* of resistance in hospitals, but the *effect* of the antibiotic use can be measured only by examining the actual frequency of resistance within an institution. This can be accomplished through review of data from the clinical microbiology laboratory. Many hospitals will be able to generate this information in the form of an antibiogram, a periodic report describing the proportion of various common bacteria that are resistant to specific antibiotics. Most large hospitals publish an antibiogram at least annually. Some do so more frequently or provide specific data for individual nursing units, care centers, or service lines (e.g., cardiac or transplantation) However, smaller hospitals, or those that outsource clinical microbiology work to reference laboratories, should also be able to compile the data to publish their own antibiogram. This information is critical to determining the antibiotic-resistance issues of the individual institutions as well as to monitor the effects of various interventions.

Sidebar 5-1

Does Your Hospital Have a Problem with MRSA?

Does your hospital have a problem with MRSA? This information is readily obtained from the hospital antibiogram provided by the microbiology laboratory. Although most clinicians think of MRSA as an infection control issue, there is increasing evidence that broad-spectrum antibiotic use, particularly with third-generation cephalosporins and fluoroquinolones, can promote acquisition of MRSA.* Because there is some evidence that reducing the use of these drugs may reduce the burden of MRSA,† the ASP may work to reduce the use of fluoroquinolones and/or third-generation cephalosporins, either by promoting alternative agents or by restricting the use of these drugs.

* Weber S.G., et al.: Fluoroquinolones and the risk for methicillin-resistant *Staphylococcus aureus* in hospitalized patients. *Emerg Infect Dis* 9:1415–1422, Nov. 2003.
† Cook P.P., et al.: Effect of reduction in ciprofloxacin use on prevalence of methicillin-resistant *Staphylococcus aureus* rates within individual units of a tertiary care hospital. *J Hosp Infect* 64:348–351, Dec. 2006.

MRSA, methicillin-resistant *Staphylococcus aureus;* ASP, antibiotic stewardship program.

For common organisms of particular concern at an institution, such as *Staphylococcus aureus*, *E. coli*, and *Pseudomonas aeruginosa*, quarterly reports can be generated that summarize the proportion of organisms that are resistant to commonly used antibiotics. For smaller, community-based hospitals, annual reports should be adequate. An increase in the percentage of a particular organism resistant to a specific antibiotic (e.g., ciprofloxacin-resistant *Pseudomonas aeruginosa*) may be secondary to a breakdown in infection prevention practices or could be a result of overuse of particular antibiotic agents (see Sidebar 5-1, above).

Often, interventions will need to address issues of both antibiotic misuse and infection control. For example, every hospital will have patients who develop *Clostridium difficile*–associated diarrhea (CDAD). A recent study in Pittsburgh showed that an infection control program by itself was ineffective in reducing an outbreak of CDAD. However, when the infection control measures were coupled with an antibiotic policy that restricted the use of fluoroquinolones and third-generation cephalosporins, the rate of CDAD dropped dramatically.[5] This so-called "bundled approach" is likely to be a common strategy to combat many MDROs.

It should be the CEO's personal commitment to ensure that the data collection and analysis that is central to an effective antibiotic management program be a high priority and that those data are reviewed and reported regularly and acted upon, as appropriate, by the medical staff. Data that are collected and not used to improve patient care do not contribute to improved patient outcomes.

Reporting Data

While the compilation of data from pharmacy and the clinical microbiology laboratory primarily serves to inform the other activities of the ASP, the availability of these data to prescribers can also be invaluable and may lead to improved antibiotic use. As is noted in Chapter 2, "Clinical Consequences of Antibiotic Resistance," the hospital antibiogram, when compiled and distributed to frontline clinicians, serves as a very useful tool for assisting in the selection of empirical antibiotic therapy for patients with known or suspected infection. The compilation of an annual antibiogram report should be the minimum activity undertaken within the institution to ensure the optimal prescription of antibiotic agents, regardless of whether a major investment is made in an ASP.

More refined approaches to the compilation of susceptibility data can be undertaken. Antibiotic resistance can vary not only from hospital to hospital but also between different hospital units. ICUs typically have much higher antibiotic use than other parts of the hospital (DDDs/1,000 patient days) and, not surprisingly, tend to have higher rates of antibiotic resistance. Because of this phenomenon, many larger hospitals publish unit-specific antibiograms. These data should be made available to all of the practicing physicians on the medical staff so they can provide informed, evidence-based, empiric antibiotics to critically ill patients before culture and susceptibility data are available from the microbiology laboratory. Because most units have total patient days calculated monthly, it should be possible to get DDD data for individual units of the hospital. The microbiology laboratory, for its part, can provide microbiology reports for individual units. As a result, one should be able to monitor both antibiotic use and resistance within individual units of one's hospital.

Integrating Data and Implementing Change

Simply compiling and reporting data should not be the ultimate goal of a well-functioning stewardship program. Rather, in the best programs, data can be used as a starting point upon which comprehensive interventions are based. However, changes must be approached cautiously and with considerable sensitivity to the needs and expectations of the clinical staff. If a major change in the hospital policy is made, the program should be presented to the medical staff for final approval.

Simply compiling and reporting data should not be the ultimate goal of a well-functioning stewardship program. Rather, in the best programs, these data serve as a starting point upon which comprehensive interventions are based.

To ensure acceptance by the medical staff, the ASP will need to promote the positive aspects of the program, including the potential to reduce antibiotic resistance and improve patient care. The program leaders can refer to the IDSA and SHEA guidelines that promote the ASP as a means of combating antibiotic resistance. Undoubtedly, some members of the medical staff will be resistant to any program they perceive as infringing on their autonomy, so the ASP must be careful not to alienate these physicians. One way of dealing with this issue is to have a policy stating that the attending physician can reject the

recommendations of the ASP at any time so long as an appropriate rationale is documented. This clause is important in that it ensures that the attending physician retains the final word with regard to patient care. It is important for the ASP to implement changes that do not adversely affect the workflow of the practicing clinician. Changes that facilitate the best quality of care for patients are much more likely to be accepted by the medical staff. It is this acceptance that will ensure the long-term success of the program. In the subsections that follow, a number of suggested interventions are discussed.

Develop Education and Guidelines

A key function of the ASP is to provide education to the medical staff with regard to antibiotic resistance at the hospital. Some hospitals provide an antibiotic guidelines booklet that is published annually and disseminated to all of the medical staff, including resident house staff, students, and other clinical trainees. The handbook, which can fit in a lab coat, is a summary of the guidelines for empiric treatment of some of the most common conditions that the clinician is likely to encounter—cellulitis, intra-abdominal infection, community-acquired pneumonia (CAP), ventilator-associated pneumonia (VAP). The hospital antibiogram and unit-specific antibiograms, if available, are updated annually in this publication. The cost of printing this publication is miniscule compared to the cost savings of appropriate antibiotic management of hospitalized patients. This same information can be made available in the computerized medical record in the form of best practice guidelines that appear as "pop-ups" in the medical record depending on the diagnosis or ICD-9 code.

Collecting and disseminating aggregate data is important, but the ASP should also ensure that antibiotic use for the individual patient is in line with national guidelines. For example, the IDSA has published guidelines for appropriate management of patients with CAP,[5] hospital-acquired pneumonia (HAP), health care–associated pneumonia (HCAP), and VAP.[6] Given that each of these diagnoses carries a specific ICD-9 code, it is possible for the infectious diseases–trained pharmacist to ensure that patients are receiving antibiotics that are consistent with national guidelines. For hospitals that have computerized order entry, these guidelines can be incorporated into the admission orders such that the nursing home patient with pneumonia will be identified as having HCAP rather than CAP. As such, the treatment algorithm will be appropriate for the correct diagnosis.

Implementing guidelines for the duration of antibiotic therapy is an underused but highly effective means of reducing antibiotic use.[7] Recent national guidelines have determined that most cases of VAP need only eight days of therapy,[6] and cases of CAP can be treated with as little as five to seven days of therapy. Along the same lines, the duration of antibiotic prophylaxis for surgical procedures needs to be no more than 24 hours following surgery (48 hours for cardiac surgery).[8] By implementing these guidelines that limit the duration of antibiotics for specific conditions, the ASP can greatly reduce hospital antibiotic use while sustaining excellence in patient care.

Another method to reduce antibiotic use is to promote innovative methods of dosing of certain antibiotic classes. This complicated intervention can best be undertaken through multidisciplinary collaboration such as that provided by the ASP. For example, numerous studies have shown that cell wall–active antibiotic drugs (such as penicillin and the cephalosporins) are more likely to maintain an effective level in the bloodstream if the drug is given by a prolonged infusion (i.e., over four hours), as compared with the standard infusion of 30 minutes. For example, for a patient receiving one particular broad-spectrum antibiotic commonly used to treat serious infections in many hospitals, this strategy can reduce the amount of drug administered by 25 percent (and therefore reduce drug costs in the pharmacy by the same amount). These dosing strategies can be integrated into the computerized order entry such that the prolonged infusion method is the default for the patients. If there is a contraindication to having the prolonged infusion, the nurse or physician can call the pharmacy to request that the drug be administered by the standard 30-minute infusion.

Formulary Decisions, Including Antibiotic Restrictions

Antibiotic restriction is an important, albeit unpopular, means of correcting a specific antibiotic-related problem at an institution. It is considered one of the core strategies of an ASP according to the IDSA and SHEA guidelines. With this method, clinicians are limited as to the specific set of antibiotics that can be prescribed. More expensive or more broad-spectrum agents require prior approval or may be subject to post-prescription review. A good example of the utility of restriction is in the control of infection with *Clostridium difficile*. CDAD, like other infections with MDROs, is closely linked to prior administration of antibacterial drugs. Although infection control is the mainstay of preventing person-to-person spread of this infection, there is clear evidence that supports the role of judicious antibiotic use as a means of controlling the rate of infection.[9]

As is true for most other MDROs, it is not only the *amount* of antibiotic received but also the specific *class* of antibiotic used that increases the risk of CDAD for an individual patient. For example, there is a particularly high association of CDAD with the use of third-generation cephalosporins (e.g., ceftriaxone, ceftazidime, cefepime), clindamycin, and fluoroquinolones.[10] To navigate this complicated relationship between exposure to specific antibiotics and infection or resistance, the ASP may promote the use of certain classes of antibiotics or may restrict the use of other classes of antibiotics. This technique has proven to be quite successful in decreasing resistance in some cases.[5]

Antibiotic restriction can have unintended consequences. For example, if a specific antibiotic is restricted, prescribers are likely to overuse *other* antibiotics, thereby increasing the chances that resistance to these other drugs will increase. This phenomenon, often called "squeezing the balloon," supports the notion that antibiotic restrictions should be viewed as a last resort, when other, less drastic methods have failed.

Review of Hospital Antibiotic Use and Individual Prescriber Feedback.

Individual antibiotic use can also be monitored through the hospital pharmacy. The ASP should be able to review (in real time) the hospital charts of patients receiving antibiotics to determine whether the use of the particular antibiotics is appropriate. An infectious diseases–trained pharmacist (with backup from an infectious diseases clinician) is qualified to make these decisions. When the antibiotic regimen is deemed to be not appropriate, the pharmacist can be empowered to take steps to optimize coverage. For example, if the antibiotic prescribed is unnecessarily broad given the available results from the microbiology lab, the pharmacist may recommend a change to a more narrow (and often safer and less expensive) antibiotic regimen (see Sidebar 5-2 on page 74.)

Timely review of patient medical records also allows for transitioning patients from intravenous to oral antibiotics, a strategy that has been shown to be both safe and cost effective. In this approach, the pharmacist uses well-described criteria to determine when it is safe to switch from intravenous to oral medications. By setting up an intravenous-to-oral antibiotic algorithm, the ASP allows the pharmacist to operate using standard guidelines that will save the hospital money, which would otherwise be associated with the preparation, dispensing, and administration of IV antibiotics. Even for small hospitals, an intravenous-to-oral switch program can be set up by the pharmacy department using accepted guidelines.

Every hospital has its problem prescribers—clinicians who use three antibiotics when one will do the trick or who keep patients on "prophylactic" antibiotics for three to five days following surgery. So how does an ASP deal with these individuals? One method is by inviting these physicians to become *members* of the ASP. However, extending the proverbial "olive branch" may actually put some of these physicians on the defensive, and many will refuse to become members. Those who accept the invitation, however, are likely to become educated on the true need of antibiotic stewardship at the institution and may even become "converts." Another means of addressing this minority group is by referring to national guidelines, whenever possible. These guidelines, which are updated as needed, set the gold standard for the therapy of patients with the given condition. For hospitals with computerized prescriber order entry (CPOE), this issue can be handled preemptively by pairing appropriate antibiotic choices with ICD-9 diagnoses. For hospitals without CPOE, the pharmacist can leave recommendations based on a variety of IDSA guidelines (see Table 5-2 on page 75). The ASP must avoid a confrontation with these "problem" physicians. It should be made clear to these physicians that the same guidelines are applied to *all* patients in the hospital. CEO leadership may be critical to support the ASP in its efforts and encouraging physicians to comply with best practices. Ultimately, however, it may be necessary to engage existing mechanisms of peer review and accountability with the elected officers of the medical staff to bring problem prescribers into line.

Sidebar 5-2

Why Change?

Example 1

A 69-year-old male patient is admitted to the intensive care unit with a diagnosis of sepsis syndrome. He is treated with ciprofloxacin and vancomycin. Two days later, the patient's blood cultures are positive for E. coli susceptible to ampicillin, cefazolin, gentamicin, and ciprofloxacin. The pharmacist recommends that the patient receive ampicillin and that both vancomycin and ciprofloxacin be discontinued.

Why not continue the ciprofloxacin in this patient? Broad-spectrum antibiotics such as ciprofloxacin, third-generation cephalosporins, carbapenems, and piperacillin-tazobactam should be reserved for empiric therapy and for situations when narrow-spectrum drugs are not an option. Continuing broad-spectrum antibiotics in situations where narrow-spectrum drugs will suffice compromises the long-term efficacy of these agents. This policy of reducing broad-spectrum antibiotics to narrow-spectrum drugs is known as "streamlining" or de-escalation. This practice may be one of the most powerful tools for preventing resistance available to the ASP. However, the manner in which each hospital implements this policy may vary. One of the more effective means of instituting a de-escalation policy is to make the change the default decision, as long as the attending physician does not disagree with the change. For example, a pharmacist may give a recommendation for streamlining antibiotics based on careful review of the chart records, including microbiology culture results. The attending physician is given 24 hours to respond to the recommendation. If the attending physician disagrees with the recommendation, he or she is asked to give a reason for his or her decision. If there is no response, then the recommendation becomes an order that is signed by the infectious diseases head of the ASP. Using this system, more than 90% of the ASP's recommendations are accepted and become orders.

Example 2

A 75-year-old male patient is admitted to the hospital from a nursing home with pneumonia. The patient is admitted to the internal medicine residency service and is treated with ceftriaxone and azithromycin. The pharmacist reviews the chart and recommends that the antibiotics be changed to piperacillin-tazobactam, tobramycin, and linezolid, based on IDSA guidelines for the treatment of HCAP.

This patient was misdiagnosed as having CAP by the internal medicine housestaff, when, in fact, he has HCAP. The pharmacist knows that the common organisms causing HCAP include *Pseudomonas aeruginosa* and MRSA and also knows (from a review of the hospital antibiogram) that a high percentage of the *Pseudomonas aeruginosa* are resistant to ciprofloxacin but are susceptible to piperacillin-tazobactam and tobramycin. This situation is relatively common and is one in which the pharmacist has provided education (in the form of a recommendation) that greatly improves patient care.

ASP, antibiotic stewardship program; ISDA, Infectious Diseases Society of America; HCAP, health care–associated pneumonia; CAP, community-acquired pneumonia.

Every hospital has its problem prescribers—clinicians who use three antibiotics when one will do the trick or who keep patients on "prophylactic" antibiotics for three to five days following surgery.

Computerized Order Entry

CPOE offers many new possibilities to influence the prescription of antibiotic therapy at an institution and is clearly the future of care for hospitalized patients. From the standpoint of an ASP, the computerized medical record greatly facilitates the promotion of judicious antibiotic use. Patient records can be reviewed at any hospital computer. Laboratory data, including microbiology data,

Table 5-2

Recommended Approach to Antibiotic Therapy for Specific Infections from the IDSA

IDSA Guideline	Year Published
CAP	2007
HAP, HCAP, VAP	2005
Skin and soft-tissue infection	2005
Treatment of asymptomatic bacteruria	2005
Treatment of diabetic foot infections	2004
Timing and duration of antibiotic prophylaxis for surgery	1994
Antibiotic stewardship	2007

IDSA, Infectious Diseases Society of America; CAP, community-acquired pneumonia; HAP, hospital-associated pneumonia; HCAP, health care–associated pneumonia; VAP, ventilator-associated pneumonia.

serum creatinine, medication list, allergies, radiology results, and procedure notes, are all available for the pharmacist to review. When a computerized medical record was implemented at Pitt County Memorial Hospital, antibiotic use decreased by 24 percent simply because pharmacists are able to review patient charts more efficiently.

The ASP should be actively involved in creating guidelines for empiric antibiotics for any given condition. These guidelines can then be used to pre-populate standardized order sets for the CPOE system. For example, if a patient is admitted to the hospital with pneumonia, the computerized medical record should be able to give specific recommendations for empiric antibiotic therapy based on simple questions that can be built into the program. These guidelines should be tailored to the likely organisms and susceptibilities from your own hospital; this information should be readily obtainable from the microbiology laboratory. Overall, the electronic medical record can be a powerful tool in supporting all aspects of MDRO control (see Sidebar 5-3 on page 76).

ASP Costs and Cost Savings

Numerous studies have addressed the issue of cost-effectiveness of stewardship programs. Almost all of these studies have shown substantial cost savings in the range of 20 percent to 35 percent based on drug-acquisition costs. At one institution, the cost savings were approximately $70,000 per month ($840,000 per year) in acquisition costs.[11] Larger hospitals with large antibiotic budgets are more likely to benefit from an ASP, but even small hospitals should be able to save money by implementing some of the methods of an antibiotic management program.

One institution saved approximately $70,000 per month ($840,000 per year) in drug-acquisition costs through a stewardship program.

Sidebar 5-3

Using Electronic Medical Records to Help Prevent MDROs

The electronic medical record (EMR) can be an enormous asset in the effort to prevent MDROs in hospitals. At many hospitals, the types of antibiotic stewardship strategies described in this chapter are fully integrated into the EMR. Prescribers receive electronic prompts ("pop-ups") to confirm the appropriateness of antibiotic selections and can easily link to guidelines and recommendations from within the ordering system. Moreover, usage data to audit antibiotic prescription patterns can be retrieved from most EMR systems.

The value of the EMR in MDRO control extends beyond antibiotic stewardship. The EMR can be applied to ensure that patients known to be colonized or infected with MDROs are appropriately placed in precautions (a frequent area of low-performance at many hospitals). In addition, bedside access to the EMR can help to ensure timely and accurate documentation of adherence to best practices to prevent the spread of MDRO, further promoting staff compliance.

MDRO, multidrug-resistant organism.

The cost of the program is driven by the salaries and benefits of a part-time infectious diseases medical director plus the salary of one or more pharmacists. The savings of the program are the acquisition costs of the antibiotics. Indirect savings, as from reductions in antibiotic-associated diarrhea, including CDAD, are not included in the cost-analysis.

Many brand-name antibiotics, particularly newer ones, are extremely expensive. The use of these drugs should be reserved for situations in which other, less expensive drugs are not an option. Here is where an antibiotic management program will pay for itself. By monitoring the microbiology data for the individual patients, the ASP can make streamlining recommendations as well as recommendations to change from the intravenous to the oral route in patients who are clinically improving. For the program to succeed and benefit the organization financially, the CEO must provide the infrastructure to obtain continuous data regarding antibiotic use at the hospital. This includes adequate staff and technological assistance in the form of computerized databases. For smaller hospitals that do not have an infectious diseases physician or an infectious diseases–trained pharmacist, the CEO may consider contracting with a regional infectious diseases physician to help set up an ASP that is tailored to the needs of the institution. The small investment will more than pay for the cost savings of the program.

For the program to succeed and benefit the organization financially, the CEO must provide the infrastructure to obtain continuous data regarding antibiotic use at the hospital.

The small investment of an ASP will more than pay for the cost savings of the program.

These cost savings are more than enough to cover the costs of contracting with an infectious diseases physician (0.5 FTE) and the cost of 1.5 FTE pharmacists. Similar results have been documented in many reports.[4] The cost of printing an antibiotic handbook (approximately $4,000 per year depending on the number of copies issued) and other promotional and education pieces is miniscule. Although the hospital investment in the

Sidebar 5-4

Does Your Hospital Have a Problem with MRSA?

1. What are the antibiotic use patterns at your hospital?
2. How do the use patterns correspond to national guidelines and recommendations?
3. What are the antibiotic resistant organisms at your hospital?
4. What are your hospital's top five most commonly used antibiotics?
5. Who are the "problem prescribers" in your institution?
6. What is the excess use of antibiotics, beyond recommendations, costing the hospital?

MRSA, methicillin-resistant *Staphylococcus aureus.*

computerized medical record is significant, there are no additional software costs in monitoring antibiotic use. Cost reductions and cost savings are a benefit of an effective ASP and should be a strong consideration for health care leaders.

The hospital pharmacy budget is a good place to start when considering the implementation of an ASP. What percentage of the hospital pharmacy budget is devoted to antibiotic agents? Ideally, the antibiotic agent portion of the pharmacy budget should be in the range of 12 percent to 18 percent (for purposes of this calculation, very expensive, rarely used products that are sometimes given to patients with severe infection are excluded, including activated protein C). If your hospital's antibiotic portion is greater than 18 percent, organizational leadership should strongly consider instituting an ASP. Of course, even if your hospital's antibiotic budget is less than 20 percent of the pharmacy total budget, your hospital can still save money by instituting an ASP.

A hospital pharmacy budget is a good place to start when considering the institution of an ASP. Ideally, the antibiotic agent portion of the pharmacy budget should be in the range of 12%–18%. If greater than 18%, you should strongly consider an ASP.

The Role of the CEO

Implementing an effective and comprehensive ASP demands the commitment of leadership from both the medical staff and hospital administration. Whether your hospital is an academic tertiary-care 1,000-bed hospital or a small 100-bed community hospital, an ASP can be effective at ensuring appropriate antibiotic use and preventing resistance. The CEO should consider a number of key questions when embarking on an institution-wide program to enhance the success of an ASP (see Sidebar 5-4, above).

The CEO has a key role to play in concert with the chief medical officer or executive responsible for patient safety in minimizing antibiotic resistance and associated infections caused by MDROs. The frightening reality for patient care is that there are limited antibiotics

Table 5-3

Ways in Which an ASP Can Improve Appropriate Antibiotic Use

Intervention	Effect	Cost Savings
Education	Improves patient care; best when used in combination with other interventions	Variable
Formulary Restriction	Immediate effect on antibiotic use; decreases *Clostridium difficile*–associated diarrhea	20%–30%
Chart Review/Streamlining Antibiotics	Improves patient care; reduction in broad-spectrum and expensive antibiotics	20%
Intravenous to Oral Switch	Decreases catheter-related bloodstream infections; reduces cost	20%
Computerized Order Entry	Improves point-of-care education to providers; facilitates pharmacy chart review	20%–25%
Automatic Stop Orders	Limits duration of antibiotic treatment; improves patient care	20%–30%
Incorporation of Guidelines	Improves patient care; supports limited duration of treatment for many conditions	30%–45%
Extended Infusion of Beta-Lactam Antibiotics	Reduction in daily antibiotic dose	unknown

available to deal with a wide array of organisms in the hospital setting. Antibiotic stewardship is essential to preserving the efficacy of the limited number of effective antibiotics at our disposal. The role of the CEO in promoting an ASP is critical. He or she must be an advocate for the program and should insist on a thorough assessment of antibiotic resistance in the organization, cost of antibiotics, and morbidity and mortality related to MDRO infections.

A strong showing from organization leadership and input from the medical staff will ensure the success of the ASP.

In addition to providing visible leadership, when it is determined that an ASP is the best course of action, the CEO must provide the needed resources, including funding for a pharmacist and contracting for the services of an infectious diseases physician. The savings (in drug-acquisition costs alone) of an ASP will more than pay for these personnel costs. An ASP can improve appropriate antibiotic use in a variety of ways: education, formulary decisions, medical record review with direct feedback to the clinician, and computerized medical record input (see Table 5-3, above). What works will vary from hospital to hospital. One of the critical relationships in this endeavor is a partnership between the CEO or other appropriate health executive and the champions for the medical staff who are the antibiotic prescribers and can support or undermine a program. A strong showing from organization leadership and input from the medical staff will ensure the success of the program, which will benefit the hospital financially while improving patient care.

References

1. John J.F. Jr., Fishman, N.O.: Programmatic role of the infectious diseases physician in controlling antimicrobial costs in the hospital. *Clin Infect Dis* 24:471–485, Mar. 1997.
2. Carling P., et al.: Favorable impact of a multidisciplinary antibiotic management program conducted during 7 years. *Infect Control Hosp Epidemiol* 24:699–706, Sep. 2003.
3. Rüttimann S., et al.: Long-term antibiotic cost savings from a comprehensive intervention program in a medical department of a university-affiliated teaching hospital. *Clin Infect Dis* 38:348–356, Feb. 1, 2004.
4. Dellit T.H., et al.: Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America guidelines for developing an institutional program to enhance antimicrobial stewardship. *Clin Infect Dis* 44:159–177, Jan. 2007.
5. Muto C.A., et al.: Control of an outbreak of infection with the hypervirulent *Clostridium difficile* BI strain in a university hospital using a comprehensive "bundle" approach. *Clin Infect Dis* 45:1266–1273, Nov. 15, 2007.
6. Mandell L.A., et al.: Infectious Diseases Society of America/American Thoracic Society: Consensus guidelines on the management of community-acquired pneumonia in adults. *Clin Infect Dis* 44:(Suppl. 2):S27–S72, Mar. 1, 2007.
7. American Thoracic Society, Infectious Diseases Society of America: Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare-associated pneumonia. *Am J Respir Crit Care Med* 171:388–416, Feb. 15, 2005.
8. Bratzler D.W., et al.: Antimicrobial prophylaxis for surgery: An advisory statement from the National Surgical Infection Prevention Project. *Clin Infect Dis* 38:1706–1715. Jun. 2004.
9. Meyer E., et al.: Modified guidelines impact on antibiotic use and costs: Duration of treatment for pneumonia in a neurosurgical ICU is reduced. *J Antimicrob Chemother* 59:1148–1154, Jun. 2007.
10. Owens R.C. Jr., et al.: Antimicrobial-associated risk factors for *Clostridium difficile* infection. *Clin Infect Dis* 46(Suppl. 1):S19–S31, Jan 15, 2008.
11. Cook P.P., et al.: Reduction in broad-spectrum antimicrobial use associated with no improvement in hospital antibiogram. *J Antimicrob Chemother* 53:853–859, May 2004.

On the CD

Antibiogram Template
Get the information where it's needed—in the hands of clinicians who prescribe antibiotics. The antibiogram template provides a standardized summary of which antibiotics are most effective against specific bacteria in your organization and will help to ensure that antibiotic use is *effective*, but not *excessive*. The template can be customized for nearly any population in an organization depending on the desires and needs of clinicians. Susceptibility data are accompanied by a partial guide to isolation procedures for MDRO and information about the ASP. Whether printed as a tri-fold pocket resource (as designed here) or integrated online, the antibiogram will become an essential tool for clinical practice at your hospital.

Proactive Strategies for ASPs
This document presents the strategies for implementing an ASP using the guideline from IDSA and SHEA. The strategies are divided into those the authors considered "core" and those that support the two primary approaches. Those strategies that lack sufficient data for widespread application are also described. The rating scale follows the IDSA–U.S. Public Health Service Grading System for Ranking Recommendations in Clinical Guidelines.

Antibiotic Audit Form
Data drives change in most health care organizations. This tool in the hands of a sophisticated reviewer forms the basis of building a comprehensive overview of the appropriateness of antibiotic use by clinicians at your institution. Use aggregate data to inform stewardship policy, as the basis for educational programs, or to quantify the impact of interventions by the ASP. Use individual data to identify the "problem prescribers" found on every medical staff. Many institutions find it useful to perform periodic audits regarding the use of a single antibiotic in order to assess variations in practice and usage trends.

Competency Questions
Providers learn a great deal about antibiotic resistance and appropriate prescribing practices during clinical training. Nevertheless, it is difficult for them to keep up with the latest new drug agents and even tougher to keep up with the most recent trends in antibiotic resistance. These competency questions provide them with a valuable opportunity to assess their own readiness for prescribing in the era of resistance.

CEO Talking Points
Everyone—even those who will never write a prescription for an antibiotic or any other drug—has a stake in rational and appropriate antibiotic use. Whether our concern is rooted in a sense of responsibility for patients under our charge, the economic impact of resistance on the institution, or simply our own self-interest as patients, we all want to see this done appropriately. These talking points stress the universal interest we share in rational prescribing.

CHAPTER 6

Challenges on the Path to Higher Performance

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Is your organization ready to implement the changes needed to control MDROs?

The previous chapters have provided specific technical guidance for health care executives to lead the implementation of a comprehensive program to reduce the clinical and financial impact of antibiotic resistance. After the true institutional costs of resistance have been assessed and quantified, organizational leadership will be well-positioned to effectively deploy resources to reduce multidrug-resistant organism (MDRO) risk, generally through the application of the tools of antibiotic stewardship and transmission control.

The success of an MDRO control program is not exclusively dependent on access to particular content expertise or even the availability of implementation aids. Ultimately, the effectiveness of a control plan demands the timely, efficient, and effective execution of strategies tailored to the specific needs of the organization. In this manner, an MDRO control plan is not unlike any other institutional performance improvement initiative. Too often, however, such efforts can be undermined by organizational deficiencies, including improper goal setting, poor communication, inadequate strategic vision, and disengaged clinical and administrative leadership. These challenges are at least as complicated as the biology and epidemiology of MDROs and therefore require the same degree of focus in achieving solutions.

In this chapter, the most common pitfalls (designated "Leadership Challenges") that threaten improvement initiatives are discussed along with possible solutions. The aim is ultimately to ensure that risk- and performance-assessment activities, as well as the efforts directed at antibiotic stewardship and transmission control, are not wasted due to the inability or unwillingness of key stakeholders to commit to the plan. Although the format and content of this chapter are a bit different than the rest of the guide, what remains consistent and essential is the requirement that executives embrace these challenges and apply themselves to the complete and timely deployment of improvement initiatives.

Leadership Challenges

Claim 1: Staff already have too much to do and are overwhelmed by the number of projects.

Staff reporting that they are overwhelmed by projects is a frequently experienced situation in health care organizations today. Although it is true that the need to engage in multiple projects may be influenced by the increased number and scope of external requirements, there are at least two other reasons that an organization may find itself in this situation: (1) *projects* are not well designed and (2) the *process* for selecting and approving projects is either not well defined, not followed, or both.

Poorly designed projects burden staff because the solutions are not often embedded in their work. In fact, the most commonly employed solutions in health care organizations focus on staff education, which usually asks staff to simply *do more* rather than focus on redesign of the work process to remove barriers, improve efficiency, or improve the benefits of the process. Further, the analysis of a problem seldom develops the deep understanding needed to create an embedded and sustainable solution. Perpetual monitoring of adherence to the new process then becomes the primary method for ensuring that the new process continues. When monitoring stops, performance typically drifts back to pre-project levels if not well embedded into daily workflow. For example, if staff are educated about evidence-based practices aimed at preventing central line infections but those practices are not designed into the daily work activities, then the monitoring of staff may be the only reason staff apply the practices. When monitoring stops, staff may not apply the practices if it means searching for equipment and supplies, additional documentation, and duplicate activities. Frontline staff need to be involved in the project to assist with the design and incorporation of new practices into daily workflow.

Another contributor to the problem of "too many projects" is poor selection of projects and lack of an organizational plan for setting priorities related to measurement and improvement. Certainly, there are many requirements established by external entities that demand attention and improvement. Improvement in these cases results in compliance with legal or regulatory standards or increased opportunity for reimbursement. In contrast, many projects, large and small, are launched without a clear purpose or "fit" into the organization's priorities. If the projects all end up in the Quality Office to design, launch, and monitor, then those staff members are likely to be overwhelmed.

If you hear this concern of "too many projects" from your staff, consider the following questions to help determine the underlying causes within your organization:

- Is there a strategic performance improvement plan with specific goals and defined projects prepared annually?
- How are performance improvement projects approved within the organization? Is there a formal process for approval that is used to consider a suggested project? Does the process include defined criteria to assess the importance and urgency of the proposed project?

- Are the affected work units actually carrying out the projects, or do all the projects become the responsibility of the quality and performance improvement department?
- Are solutions embedded into daily workflow at the beginning of the project?

How can senior leaders address this issue?

1. Setting priorities is the first action leaders need to take to ensure that performance improvement projects that are conducted are aligned with organizational priorities and strategies and worthy of the required resources. Engaging the Board can be helpful in ensuring that these standards are met (see Sidebar 6-1, below).
2. Define a process for approving, launching, and monitoring new projects. Approval should consider several points, including the following:
   a. Risk to patients if not addressed
   b. Risk to organization if not addressed (e.g., legal, accreditation, perception)
   c. Alignment with the strategic plan
   d. Cost of the improvement project
   e. Magnitude of the benefit (i.e., is there sufficient return in terms of improved patient outcomes, operations, or costs to warrant the investment in improvement?)
3. Establish a control mechanism by requiring registration of all performance improvement projects with a centralized office (e.g., quality, performance improvement).
4. Determine which proposed projects can be approved by lower level administrative and clinical staff (in lieu of executive level approval).
5. Define a communication strategy between the executive team and a centralized tracking office to ensure that leaders are informed about all projects under way, including those approved at lower levels.
6. After a project is approved, be clear about the resources needed to complete the project. Select individuals to serve as project champions and determine the communication

Sidebar 6-1

Getting the Board on Board

Most experts agree that one of the most important steps to ensuring that the principles of MDRO control are integrated throughout a hospital system is to engage the highest levels of institutional governance. The idea of "getting the Board on board" has been a cornerstone particularly of the efforts of the Joint Commission and the Institute for Healthcare Improvement to promote excellence in HAI prevention. Board members should have timely access to accurate data about both the scope and consequences of MDRO infection at the hospital. In addition, they should receive frequent updates about the effectiveness of control strategies once they are deployed. Board members should be encouraged to participate in leadership rounds with infection preventionists and hospital epidemiologists.

MDRO, multidrug-resistant organism.

strategy to keep the executive team informed and involved as needed (e.g., removal of barriers, provision of resources, approval of significant process redesigns). The scope and complexity of the project will determine how often and how involved the executive sponsor will need to be.

7. Set the expectation that projects be rigorous rather than simply quick, unless they meet the criteria for a quick fix, so that sufficient time is allowed to understand the problem and develop a meaningful solution that is not simply another burden to staff.
8. Project design and implementation should include plans for embedding new/revised solutions into the daily workflow to increase likelihood of staff adherence and sustained, improved performance.

For antibiotic resistance prevention to succeed as a performance improvement effort, it must be recognized as a priority among the numerous projects that staff are urged to undertake. It is the leaders' responsibility to determine if this project is important enough and linked with the organization's strategy to take precedence over other efforts. The magnitude of the benefit and the potential return on investment for controlling antibiotic resistance has been well delineated in the previous chapters, and it is this information that the senior executives can use to justify integrating the reduction of antibiotic resistance and MDROs into the work of the organization.

Claim 2: Leadership does not communicate a clear vision for the project and is not consistent in supporting it.

In a survey of 100 health care consultants attending the Joint Commission Resources (JCR) Annual Conference in 2008, the most frequently observed problem with failed improvement efforts was lack of engaged leadership.[1] Engaged, supportive leaders set a clear vision, establish expectations, actively seek updates on the status of projects, offer visible support and encouragement, remove barriers to improvement, fairly consider requests for resources associated with solutions, provide staff with the rationale for decisions made in response to requests for support, and recognize and reward success and effort. Clinical and administrative staff launch improvement projects with the belief that leaders and managers have deemed the project as important. Yet leadership support may not be as visible to staff as it is to leaders. In some instances a project may be clearly linked to a strategic goal; in other cases the connection may be subtle, as in an expectation that every organizational unit will "conduct one performance improvement project every year." To meet this expectation, staff in an organizational unit select a project and in so doing will assume leadership support. The following scenarios are examples of how staff may arrive at the perception that leaders are not engaged or supportive:

- Leaders have approved a project, but an executive sponsor was not identified, leaving the project team on its own to design and implement the improvement.
- Leaders have approved the project, but the lines of communication between the project

team, involved unit, and management are not effectively used to discuss project barriers and needs, leading to lack of awareness (and engagement) on the part of managers and/or leaders.

- Leaders are not even aware that a project approved at a lower level of the organization is under way and in need of leadership support.
- Leaders are aware of project needs and cannot provide the necessary support but fail to communicate the decision to the project team.
- Leaders truly are not engaged and/or supportive, for other reasons.

How can senior leaders address this issue?

1. Define a process for approving new projects based on criteria established by leaders.
2. Establish a communication process that provides the executive team an updated list of projects under way within the organization, including names of project champion and executive sponsor.
3. Establish the expectation that project champions provide updates to managers and communicate directly to the executive sponsor when leadership intervention is necessary for success.
4. Monitor staff perception of support (e.g., with a periodic staff survey) and check leadership's assumption that support is clear with the staff perception of support.

Claim 3: When monitoring adherence to a new process stops, the performance drifts back to the pre-project level.

This is a fairly common problem that goes something like this: *Hospital A conducts an improvement project, and at the end of the project, staff continue to collect and report data on the improvement. After two months, the improvement has been maintained, so monitoring ends. Several months later someone observes that the original problem has returned. When a sample of data is collected again, it is discovered that the improvement has returned to the level that existed before the project. The project is then run again, and this time the monitoring continues indefinitely. Unfortunately, 10 other projects are also being carried out, and now, on top of everything else, there is a growing list of projects requiring data collection and reporting. Staff realize they cannot keep this up, but if monitoring stops, the gain is lost.*

This is a problem that has been increasing, and may be compounded by a misunderstanding of Six Sigma. Six Sigma methodology teaches that the last stage of the DMAIC (define, measure, analyze, improve, control) process—control—is where sustainability is achieved. Further, Six Sigma teaches that monitoring is a key component to achieving control and sustainability, and therein lies a misunderstanding. Specifically, the mistaken conclusion is that monitoring produces sustained performance. In fact, it does not. *Monitoring detects if a change is sustained; it does not produce sustainability.* Monitoring can in fact lead to sustained improvement if the monitoring means there is accountability. However, when monitoring stops, the consequences and accountability also stop, so the improvement

disappears. Monitoring, used this way, is an inefficient and limited path to sustainability. For example, a hand hygiene improvement initiative is much more apt to be sustained when the practice is embedded in existing workflow (such as with increased availability and visibility of sinks and alcohol-based hand disinfectant dispensers) than when compliance is driven solely by the fear of observation and leadership dictate.

Proper monitoring involves assessment for a short time after the project achieves its target level of improvement to determine if the improvement is stable. When the improvement is stable, stop monitoring for a period of time, and then monitor again later to see if the improvement is maintained. If the improvement is stable, then delay monitoring for a longer interval before checking again. If monitoring shows the improvement is not sustained, the answer is not to monitor constantly. The monitoring has done its job—it has demonstrated that sustainability has not been successfully designed into the project. The answer is to return to the design of the improvement and ask how you will either (1) remove the constraints to sustainability, such as a failure to embed the change or weak supporting systems, (2) strengthen the benefits or payoff the improvement provides to the staff, such as saving time or effort, or (3) strengthen the support for the improvement, such as clearer rewards and recognition or leadership support. Those are the ways sustainability is attained. After you make those improvements, your goal is to use monitoring only to check whether your design was successful. Eventually you must phase out all monitoring and have the change sustained by proper design.

How common are these problems? Health care consultants attending the 2008 JCR Annual Conference were asked about their observations of the common causes of ineffective improvement and the failure to sustain improvement. Their rating of the top five causes of each are shown in Table 6-1 and Table 6-2 on page 87.

How can senior leaders address this issue?

1. Require a review and assessment of how monitoring is used. If the current approach is an unnecessary burden on staff, then call for a redesign of the approach to monitoring.
2. Require that project design and implementation include plans for embedding new/revised solutions into the daily workflow to increase likelihood of staff adherence and sustained, improved performance that is not dependent on monitoring.
3. Require that sustainability across all improvements is tracked so that the extent of the problem is measured and clear to management.
4. Assist your quality improvement (QI) team in defining specific strategies for sustainability, independent of monitoring.

Claim 4: The problem being addressed appears to keep shifting.

There are several reasons why the focus of a project may shift during the course of the improvement initiative: (1) the focus may be poorly defined at the start, and, as a result, the

Table 6-1

Top Five Causes of Ineffective Projects (in Order of Priority), as Reported by Experienced Health Care Consultants (N = 63)

1. Lack of clear leadership support for the project
2. Physicians not engaged in the project
3. Frontline staff not involved in the project design
4. Lack of management attention to improvement
5. No effective project champion

Table 6-2

Top Five Causes of the Failure to Sustain Improvement, as Reported by Experienced Health Care Consultants (N = 63)

1. Lack of consistent leadership attention
2. Project results not embedded with the frontline staff
3. No specific plan to sustain the improvement
4. Improvement priorities keep changing
5. Too many projects to sustain them all

definition of the project focus keeps evolving as the team attempts to clarify what they are working on; (2) the team jumps to an intervention that is not supported by careful analysis; (3) a lack of consensus among stakeholders or lack of stakeholder support for the process; and (4) shifting leadership attention.

Without a clear definition of the problem, the focus of the project can become diffused and off base. Clearly defining the problem requires thorough analysis of the situation and data that are raising concerns in the first place. A hasty attempt to solve the problem is closely related to this same deficiency in analysis. People who are close to the work may be tempted to assume they know the problem and jump to the solution. As a result they never develop an in-depth understanding of the problem. When the initial improvement effort turns out to be insufficient, they shift to another focus and then another, pursuing one assumption after another. In this circumstance, a root cause analysis can be utilized to study the situation and data, leading to specification of the problem, including identification of the underlying issues contributing to unacceptable levels of performance.

Different stakeholders may direct the project toward their preferred approach rather then deferring to the team and trusting the team's ability to use evidence and follow a careful project process. This problem speaks to the importance of securing input from all stakeholders

at the initial stages of project definition to increase the likelihood of buy-in from all parties throughout the project. The perspectives of critical stakeholders should be represented by project team members as well.

Finally, when leaders change, or new priorities emerge, the importance of the existing project may change. This reason for changing focus is very different from poor problem definition and analysis. In this situation, a new priority is identified before a current project is completed. As a result the team may cut a project short or divert their attention to the new priority. Ensuring that a project is clearly linked to *strategic* goals will minimize the risk that it will be dropped when a new priority emerges. Certainly priorities can change, but if the project was initially approved according to established criteria, one of which links the project to a strategic priority, the likelihood of continuing attention on the project is increased.

The correction to this problem starts with having a clear improvement process that is followed without shortcuts. The exact model to follow is less of an issue than the attention to careful execution. Put another way, this is more often an issue with careful execution than a problem with a poor model or lack of skill. Consider the following questions:

- Did the project include process mapping for the target process and did the process mapping include walking the process? Actually going out to the care area and walking the process is the only way to know staff concerns.
- Did the project include an analysis that would address core issues, such as failure mode and effects analysis or root cause analysis? Without such analysis, the presumed solutions may be superficial and not adequately address underlying problems.
- Were all important stakeholders included at the initiation of the project?
- Were critical stakeholders included as members of the project team?
- Was the project approved by leaders in the first place?

How can senior leaders address this issue?

1. Define and utilize a clear model and process for performance improvement projects that includes a careful analysis of the problem and underlying causes; require the team to follow the process without taking shortcuts.
2. Include “clear specification of the problem” as an interim step, prior to approval of the team's proposed solution.
3. Require a project charter that includes the problem specification and major parameters of the project, and then require leadership sign-off on the charter.
4. Ensure that all stakeholders have had an opportunity to contribute to the development of the project charter, particularly as related to problem definition and solution identification (this may entail including them on the project team).
5. Equip the project team with an executive champion who is supported by senior leadership (or who *is* a senior leader) and who keeps senior leaders connected to the project.

6. Develop good evidence and then defer to the evidence. This is the best way to limit competition among special interests—gain consensus understanding of the evidence rules and make it clear that everyone is required to defer to that evidence.

Claim 5: Medical staff is not engaged in improving quality or safety.

Physicians are interested in quality and safe care but are accustomed to assessing it one patient at a time—the patient in front of them, the one for whom they are caring at the moment. According to Brennan,[2] the metaphor that informs the medical conscience is "selfless attending on a single patient, no matter what the hour or other calls on the physician's time," yet it is civic professionalism that calls for "systematic quality measurement and improvement."[2(p. 973)] Nevertheless, limited medical staff engagement in the organization's efforts to improve quality and safety overall is a problem often reported by health care organizations. According to Becher and Chassin,[3] guiding principles for physicians' oversight of quality include physician ownership of all aspects of the problem, including overuse, underuse, and misuse issues; specific measures focused on important, precisely defined parameters of quality; improved individual performances and systems of care; and all increasingly engaged and involved physicians.[2,3]

In the aforementioned survey of consultants, lack of physician engagement was the second most often cited barrier to improvement. While it may be easy to blame the medical staff for being too independent and thinking safety and quality are not their concern, more often there are actions or omissions that have the unintended consequence of keeping medical staff from being more involved.

Initially, to generate interest, it is helpful to select a project of keen interest to the medical staff—a "pet peeve" with which members of the medical staff have expressed frustration. They are more likely to participate because there is a vested interest. The management of this project can be an educational opportunity about how to effectively conduct an engaging performance improvement project.

Physicians tend to respond to data about performance, so it is important to ensure that the project is well quantified. It is also important to select a physician who can champion the initial project and subsequent process improvement efforts. Characteristics of a physician champion include professional credibility, competency in teamwork, skills in QI, strong ethic of "volunteerism," active participation in a QI team, and effective relationship with other groups in the hospital.[4]

Consider these questions when evaluating the medical staff's participation in projects:

- Were medical staff engaged at the start of the project—in the definition and development of the project and the solution?
- Do medical staff believe their concerns are represented?

- Is there a champion for the medical staff who (a) has good relations among all the medical staff, (b) is clinically competent and well respected by peers and colleagues, (c) is able to articulate concerns and interests, and (d) has the attention and confidence of the leadership?

How can senior leaders address this issue?

1. Include medical staff leaders in the development of the organization's strategic plan and performance goals.
2. Designate a physician champion for each project.
3. Include leading performance improvement projects in the performance review of physician leaders.
4. Include participation in quality and patient safety projects in the annual performance reviews and reappointment of all members of the medical staff.
5. Establish meeting expectations to ensure efficient and effective meetings, respecting time constraints of all clinicians.
6. Consider additional compensation and reward strategies to support physicians' involvement and recognize their participation.
7. Create a mechanism for recognizing physician support for quality and safety.

Claim 6: Staff are not engaged in safety, nor do they participate in QI.

After lack of physician engagement, lack of staff engagement was the next problem most often observed in QI, according to health care consultants. There are several explanations about what contributes to this problem with engagement: (1) lack of clear expectations about participating in projects; (2) minimal effort made by project team leaders and managers to include frontline staff; (3) projects are not of immediate perceived relevance to the staff's work; (4) staff perceive that their input and participation is not truly desired or valued; (5) participating in projects may require additional time and, even if staff are compensated, may discourage interest and involvement.

Staff are more willing to engage in QI projects when their participation and suggestions are invited and then acknowledged. Inviting staff may occur through formal written performance expectations and through active solicitation to participate in specific projects. Staff interest increases when the project relates to their direct work and offers the promise of improved care for the patient and efficient processes for staff. If participating in the project requires additional time (beyond usual work hours) or is difficult to accomplish (seeking coverage for non–work availability), staff will be reticent to participate without management support.

After staff agree to participate, their suggestions and involvement should be acknowledged on two levels. First, during the project work itself, suggestions and ideas from staff should be seriously included as causes and solutions are identified. Without such an approach, staff will lose interest and assume that managers and leaders did not take their involvement seriously.

Beyond the actual project work, recognizing staff's participation reinforces the value of their input and rewards the individual and team effort.

How can senior leaders address this issue?

1. The most basic way that leaders engage staff is to demonstrate that quality matters by translating vision into action. It shows that the vision is more than words:
   - Get out and talk to staff about their improvement work. When they tell you something, show that it matters by following up.
   - Find out what resources are needed and assist in providing them.
2. Ensure that there is accountability for quality.
   - Require that reward and recognition be aligned with and support QI.
   - Look for quality and safety champions and visibly recognize their efforts.
3. Promote transparency about performance. It shows that performance will be dealt with honestly and objectively.

Claim 7. When one unit does well, others seem unable to learn, if they even know about it.

Like embedding change and sustaining improvement, transfer of learning is an organizational strategy that seems to get no attention until the end of the project. All organizations want to spread what they learn so that they get the greatest benefit from the improvement effort, but most organizations report this to be a major challenge. By the time the project is over, it is very difficult to begin thinking about how others may learn from the effort. Further, communication, transfer, and change are all related mechanisms that require clear methods and champions. This infrastructure needs attention and development just as any other part of the organization's systems and structures. In the absence of this infrastructure, one should not expect that learning and transfer will be likely to occur.

A more basic problem with knowledge transfer is that it is not well understood, and hence the supporting systems and structures are not likely to be developed in the typical health care organization. There is more to transferring learning than communicating a lesson or practice, and information alone is seldom sufficient to prompt transfer and application.[5] Berwick describes seven practices for getting evidence into practice:[6]

1. Find sound innovations.
2. Find and support innovators.
3. Invest in early adopters.
4. Make early adopter activity observable.
5. Trust and enable reinvention.
6. Create slack for change.
7. Lead by example.

For these or any other set of knowledge transfer actions to come about, leadership must create an expectation for this type of activity and then follow through by monitoring to see if it is taking place. Specifically, a leader can do the following:

1. Include the development of an environment for learning and transfer in your vision for quality and safety.
2. Establish clear, consistent mechanisms that can be tracked and measured.
3. Identify an owner of the overall process for learning and knowledge transfer who is accountable for improving learning.
4. Include measures for learning and transfer along with other measures that are routinely tracked.

Claim 8: The hospital's performance improvement model is not applied in a consistent fashion.

A model does not ensure that improvement projects will succeed, but models do matter. Most people understand that improvement often means enhancing processes and creating consistency in work, but the QI method itself is easily overlooked as a process that also needs to be consistent, efficient, and continuously improved. This attention to improvement starts with having a consistent model. An improvement model, when well implemented, should provide the following:

- Consistency in the approach to improvement, which helps staff know what to expect
- Clear approach for supporting systems and processes, such as information technology (for data and reporting) and human resources (for staff development) to align with the improvement process
- A means to assess and enhance your approach to improvement
- An established approach that is not dependent on a few talented people, which in turn helps the organization weather the impact of staff turnover

***Capacity* is a term that has been receiving much attention lately. It generally refers to the structures and processes that determine how quickly and effectively an organization adapts to its environment. Ultimately, it determines competitive advantage and survivability. For example, if the Centers for Medicare & Medicaid Services (CMS) will no longer pay for certain hospital-acquired infections, then hospitals that can quickly adapt to this new reality and effectively control those events have a large competitive advantage over those that are slow to respond or cannot effectively control those events.**

How can senior leaders address this issue?

Creating a consistent approach to improvement starts with the general premise that the role of leadership is to develop the organization's core capabilities, including quality improvement. Building on this core premise, other ways that leaders develop the organization's improvement capability include the following:

- Ensure that there is an organizational vision for quality and safety.
- Together with the QI team, adopt a model that will organize the approach to fulfilling the vision for quality and safety.

- Create an expectation that all units will adopt and support the QI model.
- Expect the QI unit to develop, track, and report measures for the QI process itself.
- Expect that some projects will provide an opportunity to enhance the ability to conduct QI in addition to targeting safety or quality outcomes. For example, using your culture survey or other measures of work environment or capacity, look for ways that a basic capacity is a component of a project and use the project to improve this capability. See Sidebar 6-2, below, for an illustration of how this can be achieved.

Claim 9: Just when success seems within reach, turnover at all levels of the organization undermines progress.

Turnover is an issue at many health care organizations. Organizations that depend more on talented staff to maintain a process than having strong systems are far more vulnerable to the effects of turnover. This may seem like an odd statement; after all, doesn't every organization depend on talented staff? The important distinction here is that some organizations rely on talented staff to invent, maintain, and improve the work process, rather than creating a clear, defined process independent of any individual. When a process depends on one or a few people to maintain it, then when those staff leave, the process effectively leaves with them. In contrast to this, a central process is one that is supported and maintained by the

Sidebar 6-2

Case Study

Hospital A is an average community hospital with a new CEO. Recognizing that having a new CEO is an opportunity to impact culture, the CEO decides to make an early statement about quality and safety being a high priority. Two patient safety projects are selected to demonstrate alignment with the CEO's efforts to send a message about safety. Weekly walk-rounds are implemented. During these walk-rounds, the CEO asks the staff about their roles in improvement, how they make use of the QI model used in improvement, and what help they need to better apply the QI model. Staff are also asked about their ideas for the projects, and if they have none, they are asked to look for improvements that they could share on the next week's walk-rounds. In senior staff meetings, department heads are asked how they support the QI projects. Each department is expected to be able to explain their role in major, hospital-wide initiatives, and how they are using current projects to strengthen their capability for the next project. The impact of these efforts is measured using selected scales from the AHRQ Safety Culture survey as indicators of improvement in the quality and safety culture.

CEO, chief executive officer; QI, quality improvement; AHRQ, Agency for Healthcare Research and Quality.

organization independent of any individuals and is less vulnerable to turnover. So what are strong central processes and systems?

- Clearly defined processes that are monitored and to which staff comply
- Management focus on process and not just individuals
- All staff support the process and have a shared expectation that the process will be followed

When these strong processes exist, then the approach to the work is consistent even as staff change, up to a point. Obviously, strong processes require having a critical mass of people who maintain the process. If you turn over an entire department you have to expect that you will be building up the department from scratch. But if your turnover is in the average range (≈17%[7]), you will be able to reduce the impact of turnover on consistency by emphasizing clear work processes that are owned and supported by the people who must carry them out.

How can senior leaders address this issue?

1. Institute a consistent approach to performance improvement projects, as noted for several of the leadership challenges that have already been addressed. The approach should include steps that assign responsibility for the project (i.e., project leader, executive sponsor, team composition).
2. Widen involvement in managing and participating in improvement projects:
   a. Provide performance improvement training to a broad array of staff.
   b. Include frontline staff in projects to build experience and interest in participation.
   c. Select frontline staff to mentor as project team leaders, building "bench strength" for future project management.
3. Implement succession planning strategies for leadership and management positions in particular. These are deliberate activities that prepare staff to assume positions when current managers leave their positions. Incorporate knowledge of core processes in the preparation for succession so that new staff know the work processes and do not reinvent them.

Summary

For each of the challenges discussed, leaders have a role and an opportunity to make a difference, and across all of these issues, there are a few themes. Quality and safety are most effective in an environment rich in recognition and feedback and where there is a clear and engaging vision for quality that is put into action, transparency about performance, expectations for everyone to support quality, and accountability for action. Where these conditions exist there can still be the types of problems listed, but the problems tend to be more manageable, the solutions more effective, and the results longer lasting.

References

1. Boan, D.: Visioning the Future for JCI: Executing and Sustaining Improvement. Presentation at the Joint Commission Resources Annual Invitational Training Conference, Oak Brook, IL, 2008.
2. Brennan T.A.: Physicians' professional responsibility to improve the quality of care. *Acad Med* 77:973–980, Oct. 2002.
3. Becher E.C., Chassin M.R.: Taking health care back: The physician's role in quality improvement. *Acad Med* 77:953–962, Oct. 2002.
4. Holmboe E.S., et al.: Characteristics of physician leaders working to improve the quality of care in acute myocardial infarction. *Jt Comm J Qual Saf* 29:289–296, Jun. 2003.
5. Van de Ven A., Schomaker M.: Commentary: The rhetoric of evidence-based medicine. *Health Care Manage Rev* 27:89–91, Summer 2002.
6. Berwick D.: Disseminating innovations in healthcare. *JAMA* 16;289:1969–1975, Apr. 2003.
7. Jones C., Gates M.: The costs and benefits of nurse turnover: A business case for nurse retention. *Online J Issues Nurs* 12, American Nurses Association, Sep. 2007. http://www.nursingworld.org/MainMenuCategories/ANAMarketplace/ANAPeriodicals/OJIN/TableofContents/Volume122007/No3Sept07/NurseRetention.aspx (accessed Sep. 7, 2008).

On the CD

Eight Dimensions of Capacity for Change
Before a more detailed and tactical assessment of the organization's capacity for change can be undertaken, the overall climate and readiness for change needs to be considered. This tool, consisting of eight provocative questions, will compel senior clinical and administrative leaders to realistically and honestly confront the culture of the institution. An open discussion based on these points should make for a valuable senior management meeting or board retreat.

Assessing Structures and Systems
No matter your hospital's current readiness for change, every organization must seize the opportunity to improve capacity. This tool provides a comprehensive assessment for use by leaders or a project team to identify and exploit opportunities for successful change. The semi-quantitative tool requires that a rating be assigned to each selected category for both support and control. This tool could be particularly valuable at the inception of a new improvement project targeting MDROs or could be more broadly applied to improve the entire organization's capacity for change.

Project Charter Template
This template brings discipline to presenting a project to leadership for approval. It requires the team to respond to specific questions that will help clearly assess the value of the project to the organization and why it should be supported by leadership. Moreover, the charter establishes a standardized framework within which organizational quality and safety leaders can evaluate the merit of potential projects.

Project Prioritization Matrix
What are the priorities for selecting a specific improvement project and committing resources to design and implement it? The matrix will help teams and leaders establish priorities and make the best decisions about resource allocation. For each project, the tool requires the team to determine the relationship of the project to key indicators of importance, such as fit with organization mission, risk to patients, or the expectations of regulatory and accreditation bodies.

Sustainability Rating Scale
MDRO prevention is not a campaign but a commitment. By rating the attributes of sustainability, an improvement team can evaluate and plan for success in maintaining an improvement when it has been implemented. A high positive score indicates that change is likely to be supported and sustained, and negative scores indicate that resistance to the change is likely and the project should be redesigned or reconsidered.

CEO Talking Points
The success of an MDRO control program is not exclusively dependent on access to particular content expertise or even the availability of comprehensive implementation aids. Ultimately, the effectiveness of a control plan demands the timely, efficient, and effective execution of strategies that are tailored to the specific needs of the organization, all of which are led by CEOs. Use this slide presentation to reinforce key concepts with your leadership team and with frontline staff.

CHAPTER 7

Call to Action

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Why you? Why now?

Institutional chief executives are uniquely positioned to contribute to the end of the era of antibiotic resistance. Antibiotic resistance has been growing since the first resistant organisms were detected soon after the introduction of penicillin in the 1950s. Since that time, many efforts have attempted to curb the spread of antibiotic resistance with limited success:

- *Individual clinicians, medical educators, and professional societies, with knowledge of the contribution of antibiotic misuse to the emergence and spread of multidrug-resistant organisms (MDROs), have undertaken efforts to promote the appropriate use of antibiotics. However, new MDROs continue to emerge.*
- *An entirely new profession—infection prevention and control and health care epidemiology—has been founded, matured, and now flourishes. Their recognition of the significance of cross-transmission of MDROs in hospitals has resulted in the development and promotion of many risk-reduction strategies. However, health care workers still fail to embrace the most basic measures for prevention, and MDROs continue to spread.*
- *Patient advocacy groups have identified the very real threat posed by MDROs in the hospital and are increasingly recognizing the failure of established experts to bring about control. These groups have become outspoken in their demand for improvement. However, until recently, clinical and policy leaders have allowed their calls to go unheeded, and the public increasingly believes that hospitals cannot or will not address this problem.*
- *Legislators have recognized the imminent threat of MDROs to their voting constituencies and have enacted well-intentioned laws to prevent their proliferation; however, the laws have been met by opposition and skepticism and are yet to show a benefit. Serious and coordinated MDRO control policies remain elusive.*
- *Media groups have increasingly focused on the topic of MDROs, printing warnings and exposés about patient experiences and unresponsive health care organizations. These accounts have captured the attention of the public, legislators, and health care providers. Although compelling, this attention is yet to produce meaningful change.*

The hospital executive stands at the nexus of these interests. As an advocate for patients, you are entrusted to protect their interests and safety while they are under your care. As a manager and leader, you can demand that those who work under you and in collaboration with you, including physicians, meet the standards of care. As a financial leader, you are uniquely positioned to ensure that those professionals who are committed to improving care at your hospital have the tools to do so, and as an officer of the organization, you have fiduciary responsibility to ensure that the operations of your hospital are as effective and efficient as they can be. In short, the job of controlling and eradicating MDROs is the job of many, but the responsibility must ultimately be borne by organizational executives like you, rather than any other group or individual.

The threat posed by MDROs becomes more serious every day—not only because of the failure to control known pathogens but also because of the emergence of entirely new strains, which add to the burden of prevention. The intensity and sophistication of treatment in your hospital can save patients who previously would have no antibiotic options available to them and therefore little hope for cure. At the same time, these patients are the most vulnerable to the catastrophic effects of an MDRO infection. As the numbers of patients being saved increases, so too will the size of the population vulnerable to these infections. From a clinical perspective, the stakes have never been higher.

Economically, the situation may be even more dramatic. MDROs have captured the attention of the public. Media reports have not only spurred fear about so-called "superbugs" but also inspired the conspiratorial notion that many in health care, whether *at* the bedside or in support of those who are, do not care. Many patients are angry and are demanding accountability and transparency, and legislators are working in their support. While policy efforts to date have been clumsy at times, as the movement strengthens, it is clear that no organization can afford to be made an example. Moreover, the direct financial implications of MDROs are multiplying. Payers are taking heed, demanding nonpayment for infections caused by MDROs that are felt to be preventable, while the costs of care for patients with MDRO infections are increasing. With all this in mind, can you and your organization really afford to *not* take action?

Of course, it is also crucial to appreciate that while this is certainly a time of great risk to patients and economic peril to health care organizations, it is also a time of unparalleled opportunity. The proliferation of MDROs and the failure of past efforts at control have compelled scientists to apply the latest technology and sophisticated methods to prevent their spread. Simultaneously, new perspectives on existing control strategies, fueled by experience and methods from other industries, are reinvigorating efforts to optimize and even perfect these established methods. The combined pressures of legislative mandates and the increased expectations of payers have encouraged collaboration between institutions and integration of efforts across entire regions.

We hope that this resource can serve as a starting point for your organization to capitalize on the opportunities available at this time. The critical examination of the clinical and financial impact of antibiotic resistance—both in general and at your organization specifically—should help you to prioritize this problem among the many others you face. The detailed examination of time-tested and evidence-based strategies for prevention—through transmission control and antibiotic stewardship—will equip you and your organization to either begin a new program or strengthen your existing activities. Finally, the examination of barriers to change allows for a new perspective on the culture of your institution and how such enormous tasks as MDRO control and prevention can be brought about efficiently and effectively.

Ultimately, what is made of these opportunities at your organization is entirely in your hands. Will yours be the hospital named in an MDRO malpractice action? Will your organization be singled out by patient advocates and the media because of a needless patient death? Or will your hospital be held up as a model of how MDROs can be controlled and even eradicated—celebrated in the media and studied by your peers? The choice is yours and the time for action is now.

On the CD

Health Care Executive Checklist
This tool provides a useful summary of the key points for reducing antibiotic resistance and MDROs in hospitals, including performing a risk assessment of MDROs at your institution; obtaining a detailed assessment of the clinical and financial risks of MDROs; performing a comprehensive performance assessment of strategies for preventing transmission of MDROs; implementing or enhancing an antibiotic stewardship program; and enhancing improvement and change initiatives within the organization. This tool can be used simply as a reminder of key points discussed in this toolkit or, more actively, as a checklist on your path to success.

Metrics for Senior Leaders
This tool provides a sample of questions that might be posed by the leadership to staff about the prevalence of MDROs in the facility, including deaths, specific infections, and acquisition in the organization versus acquisition in the community. The tool is intended to provide leaders with knowledge about rate calculations and other metrics that will provide them insight into the challenges faced by their institution regarding MDROs.

APPENDIX

Additional Readings

- Boyce J.M., Pittet D.: Guideline for hand hygiene in health-care settings: Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HIPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. *Am J Infect Control* 30:S1–S46, Dec. 2002.
- Cohen A.L., et al.: Recommendations for metrics for multidrug-resistant organisms in healthcare settings: SHEA/HICPAC position paper. *Infect Control Hosp Epidemiol* 29:901–913, Oct. 2008.
- Cosgrove S.E., Carmeli Y.: The impact of antimicrobial resistance on health and economic outcomes. *Clin Infect Dis* 36:1433–1437, Jun. 2003.
- Dellit T.H., et al.: Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America guidelines for developing an institutional program to enhance antimicrobial stewardship. *Clin Infect Dis* 44:159–177, Jan. 15, 2007.
- Goldmann D.A., et al.: Strategies to prevent and control the emergence and spread of antimicrobial-resistant microorganisms in hospitals. A challenge to hospital leadership. *JAMA* 275:234–240, Jan. 17, 1996.
- The Joint Commission: *Measuring Hand Hygiene Adherence: Overcoming the Challenges*. Oakbrook Terrace, IL: Joint Commission Resources, 2009.
- Mannion R., Davies H.T., Marshall M.N.: Cultural characteristics of "high" and "low" performing hospitals. *J Health Organ Manag* 19:431–439, 2005.
- Narine L., Persaud D.D.: Gaining and maintaining commitment to large-scale change in healthcare organizations. *Health Serv Manage Res* 16:179–187, Aug. 2003.
- Perencevich E.N., et al.: Raising standards while watching the bottom line: Making a business case for infection control. *Infect Control Hosp Epidemiol* 28:1121–1133, Oct. 2007.
- Prybil L.D.: Size, composition and culture of high performing hospital boards. *Am J Med Qual* 21:224–229, Jul.–Aug. 2006.
- Siegel J.D., et al.: 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Health Care Settings. *Am J Infect Control* 35:S65–S164, Dec. 2007.
- Siegel J.D., et al.: Management of multidrug-resistant organisms in health care settings, 2006. *Am J Infect Control* 35:S165–S193, Dec. 2007.
- World Health Organization: *WHO Guidelines on Hand Hygiene in Health Care*. Geneva, Switzerland: World Health Organization, 2006.
- Yokoe D.S., et al.: A compendium of strategies to prevent healthcare-associated infections in acute care hospitals. *Infect Control Hosp Epidemiol* 29:S12–S21, Oct. 2008.