Antibiotic Stewardship in the Intensive Care Unit
An Official American Thoracic Society Workshop Report in Collaboration with the AACN, CHEST, CDC, and SCCM

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Abstract

Intensive care units (ICUs) are an appropriate focus of antibiotic stewardship program efforts because a large proportion of any hospital’s use of parenteral antibiotics, especially broad-spectrum, occurs in the ICU. Given the importance of antibiotic stewardship for critically ill patients and the importance of critical care practitioners as the front line for antibiotic stewardship, a workshop was convened to specifically address barriers to antibiotic stewardship in the ICU and discuss tactics to overcome these. The working definition of antibiotic stewardship is “the right drug at the right time and the right dose for the right bug for the right duration.” A major emphasis was that antibiotic stewardship should be a core competency of critical care clinicians. Fear of pathogens that are not covered by empirical antibiotics is a major driver of excessively broad-spectrum therapy in critically ill patients. Better diagnostics and outcome data can address this fear and expand efforts to narrow or shorten therapy. Greater awareness of the substantial adverse effects of antibiotics should be emphasized and is an important counterargument to broad-spectrum therapy in individual low-risk patients. Optimal antibiotic stewardship should not focus solely on reducing antibiotic use or ensuring compliance with guidelines. Instead, it should enhance care both for individual patients (by improving and individualizing their choice of antibiotic) and for the ICU population as a whole. Opportunities for antibiotic stewardship in common ICU infections, including community- and hospital-acquired pneumonia and sepsis, are discussed. Intensivists can partner with antibiotic stewardship programs to address barriers and improve patient care.

Keywords: antibiotic stewardship; antibiotic resistance; pneumonia; sepsis
Introduction

Increasing rates and types of antibiotic resistance and a limited antibiotic pipeline, particularly for gram-negative pathogens, have led to an international crisis. In the United States, a Presidential Executive Order directed government research emphasis and resources to address this issue (1). A major component of the action plan for the Combating Antibiotic-Resistant Bacteria initiative is the enhancement of antibiotic stewardship programs (ASPs) to preserve the activity of current and future antibiotics (1).

Intensive care units (ICUs) are an appropriate focus of ASP efforts because a large proportion of any hospital’s use of parenteral antibiotics, especially broad-spectrum, occurs in the ICU (2). The ICU is also the locus of many patients with life-threatening infections due to multidrug-resistant (MDR) bacteria (3). However, despite general support for ASPs by intensivists (4–6), the philosophical approaches and priorities of critical care practitioners and ASPs can differ (7). Although all involved desire the best patient outcomes, the potentially competing goals of adequate empirical antimicrobial therapy and antibiotic stewardship sometimes create tension. If stewardship efforts are to succeed, this conflict must be addressed. The goal of most critical care practitioners is rapid provision of the appropriate initial therapy. ASPs must work with ICU clinicians to ensure the rapid delivery of effective antibiotics to critically ill infected patients, and intensivists must work with ASPs on efforts to tailor or stop antibiotics when indicated. Regardless of which approach is used, antibiotic stewardship efforts are likely to be frustrated without a substantial buy-in by the clinicians who are primarily caring for the patients (8, 9).

Notable antibiotic stewardship efforts have already been established at a national and international levels, including guidelines for implementing ASPs (10). The current guidelines were principally developed for ASPs and do not directly address initiatives for clinicians who are primarily responsible for patient care, particularly in the ICU.

Given the importance of antibiotic stewardship for critically ill patients and the importance of critical care practitioners as the front line for antibiotic stewardship (6, 11), a workshop was convened to specifically address barriers to antibiotic stewardship in the ICU and discuss tactics to overcome them. This report represents a synthesis of the major themes that emerged from discussions among the participants.

Methods

The Acute Pneumonia Working Group of the Pulmonary Infections and Tuberculosis Assembly of the American Thoracic Society (ATS) originally initiated a proposal for a Workshop on Antimicrobial Stewardship in the ICU. The ATS convened the workshop and invited other members of the Critical Care Societies Collaborative and the Centers for Disease Control and Prevention to participate, and each sent representatives. Potential conflicts of interest were disclosed and managed in accordance with the policies and procedures of the ATS. A multidisciplinary group of 26 Pulmonary, Critical Care, Surgery, Infectious Diseases, Nursing, and Critical Care Pharmacist practitioners participated in the workshop, which was held May 13, 2016. The primary focus was to identify issues and recognize opportunities for antibiotic stewardship targeted toward individual patients by ICU clinicians at the bedside. Further details regarding the workshop are included in the online supplement.

General

Several major themes emerged from the workshop (Table 1); this report focuses on these general principles and offers some illustrative examples.

As endorsed by workshop participants, the working definition of antibiotic stewardship is “the right drug at the right time with the right dose for the right bug for the right duration.” Implicit in this definition is that stewardship involves substantially more than antibiotic de-escalation or discontinuation. Throughout the discussions, clinical outcomes remained the primary concern, with the clear recognition that antibiotics prescribed for one patient may have deleterious effects on other patients.

This working definition of antibiotic stewardship did not include the words “at the right cost.” A heavy emphasis on acquisition costs and access restriction in prior ASP initiatives had such a negative connotation that alternative terminology, such as “antibiotic optimization,” was considered. However, the participants chose to continue using this more standard terminology while emphasizing the breadth of issues involved.

Table 1. Major themes in antibiotic stewardship in the intensive care unit

- Critical care practitioners are important causes of and potential solutions to the crisis of antibiotic resistance.
- Antibiotic stewardship should be considered a core competency of critical care practitioners.
- Antibiotic stewardship must address the fear of inadequate empirical treatment in the critically ill to be effective.
- The adverse effect of excessive antibiotic treatment on the individual patient needs greater emphasis.
- Antibiotic stewardship programs must ensure that improving overall antibiotic use, not simply reducing antibiotic costs or increasing de-escalation, is the primary focus.
- The hope of rapid diagnostics is currently largely unfulfilled.
- A shift in emphasis to an individualized approach to antibiotic therapy is needed.
Antibiotic Stewardship Should Be a Core Competency of Critical Care Practitioners

The first theme that emerged is that antibiotic stewardship should be a core competency of critical care practitioners. Compared with other hospital clinicians, critical care practitioners disproportionately confront antibiotic resistance. The point prevalence of antibiotic use in ICUs is 70%, with only 45% of patients having culture- or imaging-confirmed infection (12). Although the local incidence of MDR pathogens varies among institutions, they can cause up to 30% of cases of gram-negative bacteremia (13, 14). Patients who fail inpatient antibiotic therapy are more likely to have resistant pathogens and often require transfer to the ICU. Broad-spectrum antibiotic therapy is often prescribed empirically for patients with community-acquired pneumonia (CAP) who have been transferred to the ICU, even though there are multiple other reasons for the apparent treatment failure. Even short courses of empirical broad-spectrum antibiotics may increase the risk of further antibiotic resistance, leading to a vicious cycle of escalating antibiotic resistance. Therefore, antibiotics prescribed by critical care practitioners may contribute substantially to antibiotic resistance.

Critical care practitioners are also a major part of the solution. Their expertise, logistics, and existing multiprofessional teamwork, along with the limited ASP staffing and time, place critical care practitioners at the front line of decisions regarding antibiotics in the ICU. The rapidly changing condition of many critically ill patients requires the same type of on-site, dynamic team decision-making for antibiotic treatment as is done routinely by critical care practitioners for issues involving hemodynamics, ventilator use, and other ICU problems (15). Empowering staff to speak up and ask about antibiotic therapy is imperative. Critical care pharmacists are well positioned to ensure rapid delivery of antibiotics for an individual patient. In many cases, antibiotic use begins outside the ICU, before patients are transferred from other inpatient units, referring hospitals, or the emergency department. Antibiotic optimization can be accomplished most efficiently immediately upon transfer, with subsequent refinement by an ASP.

Critical care practitioners may be optimally situated to educate trainees regarding antibiotic stewardship. Decisions about antibiotics are frequently made by residents and fellows who are taught to cover broadly and often are not empowered to stop the use of unnecessary or inappropriately broad-spectrum antibiotics. Innovative dosing based on optimization of pharmacokinetics/pharmacodynamics, such as continuous or prolonged β-lactam infusions (16), is most pertinent to the critically ill, and modifying the initial antibiotic orders in accordance with such a strategy provides an opportunity to teach important pharmacokinetic/pharmacodynamic principles. Making the direct instruction of trainees regarding antibiotics and formal review of antibiotic choices on ICU rounds an integral component of clinical care benefits not only the individual patient but all subsequent patients (17).

Importantly, integration of critical care practitioners with ASPs has important implications for ASP implementation in the critical care environment. Audit and feedback to the primary service, an important ASP intervention (10), can be performed in different ways. Much ASP feedback, particularly for trainees, is for individual cases rather than for overall patterns. For such feedback to be effective, comprehensive data need to reach individual prescribers and units, not just ASPs. Feedback that benchmarks appropriate antibiotic use relative to peers may motivate proper use, in a manner similar to tactics used previously for surgical site infections. Importantly, no disincentive for overuse of antibiotics currently applies directly to critical care practitioners, representing another opportunity for collaboration with ASPs. A multiprofessional approach to antibiotic stewardship is appealing because it would provide multiple opportunities to optimize the use of antibiotics (18).

The practical implication of this workshop conclusion is that critical care training programs need to develop a curriculum to incorporate this educational agenda. In addition, practicing clinicians need to participate in continuing medical education on critical care antibiotic stewardship.

Fear Drives Much Excess Antibiotic Use

Fear, rather than a knowledge deficit, is the greatest barrier to avoiding excessive use of antibiotics (8). Shorter times to initiation of the appropriate antibiotic therapy are consistently associated with better outcomes for infections in the critically ill (19). Fear of missing the causative pathogen, with resultant adverse clinical outcomes, is a major theme. Because critical care practitioners often manage undifferentiated critically ill patients whose infectious etiology, antibiotic susceptibility, and even site of infection may be unknown, empirical treatment that is much broader than what would ultimately be required once these factors are known is usually necessary (20). However, therapy is narrowed for only 30–40% of patients on empirical broad-spectrum antibiotics when evidence of resistant pathogens is lacking (21, 22).

Fear of missing a pathogen also drives broadening antibiotic coverage for infections in which deterioration or even a lack of improvement early in the course of treatment is expected. For example, new-onset hypotension after the first dose of a β-lactam antibiotic often results in escalation from usual CAP treatment to broad-spectrum antibiotics, despite a low likelihood of missing pathogens (23). This fear often leads to friction and a breakdown in trust with ASPs (24). For intensivists, curing the patient is paramount, whereas costs or antibiotic use metrics are perceived by many to be ASP priorities. This tension reflects the inherent conflict between patient-level and societal priorities (25). The conflict can be complicated further if documentation of ASP antibiotic directives is not placed in the patient’s medical record (20). Unless this fear of missing pathogens is acknowledged and addressed, efforts to improve antibiotic use for critically ill patients will be blunted. More and high-quality studies are needed to demonstrate the safety of narrower/less antibiotic therapy (26, 27). Importantly, these studies must assess the safety of narrowing or stopping antibiotic therapy in culture-negative patients, who may experience adverse outcomes equivalent to those of culture-positive patients (28).

Greater Emphasis on the Adverse Effects of Antibiotics Is Needed

A corollary to the fear of missing causative pathogens is the general impression that antibiotics “can’t hurt.” This belief is particularly true for the critically ill patient, where the false assumptions of “spiralizing empiricism”—sicker patients require more antibiotics, sicker patients require broader-spectrum antibiotics—are commonly invoked (29). Stewardship efforts must emphasize the evidence regarding the
adverse effects of excessive antibiotics to correct this knowledge deficit (30, 31).

An individual patient’s risk of adverse events from excessive antibiotic therapy counterbalances the fear of missing pathogens more effectively than the societal argument. A predisposition to subsequent nosocomial infections, including *Clostridioides difficile* infection, is recognized, but the frequency is underappreciated (32–34). Unnecessary or excessively broad-spectrum antibiotics even predispose to subsequent sepsis (35). Although the substantial nephrotoxicity associated with the ubiquitous empirical combination of vancomycin and piperacillin/tazobactam is increasingly recognized (36), the risk of many other combinations is underappreciated. Rapid de-escalation appears to ameliorate this risk (37).

**Optimizing ASP Implementation**

ASPs often focus on compliance with antibiotic treatment guidelines promulgated by specialty societies. However, rigid adherence to these guidelines may not improve antibiotic stewardship (38). The primary goal of guidelines is to decrease suboptimal care, and this has been achieved in many instances (39–41). However, decreasing the variability of antibiotic treatment by strictly following guidelines may actually prevent superior care in some cases. For example, monotherapy may be more appropriate for a patient with CAP and many gram-positive diplococci in a high-quality sputum specimen than the guideline-recommended treatment (β-lactam/macrolide combination). Optimal antibiotic stewardship would shift the range of treatments out of suboptimal treatment but retain the superior care, improving care overall.

ASPs must also ensure that improving overall antibiotic use, not simply reducing the cost of antibiotics, is the primary focus. Previously, some ASPs heavily emphasized cost in response to pressure from hospital leadership to save money on antibiotics. Likewise, ASPs must be continually vigilant to ensure that stewardship efforts, especially antibiotic restrictions, do not lead to unanticipated increases in the use of unrestricted agents and subsequent resistance to them (42).

Finally, ASPs must take additional steps to monitor the safety of stewardship interventions, especially for critically ill patients. The limited available data suggest that stewardship interventions are generally safe (43); however, safety is not mentioned in many ASP studies (24, 44). Likewise, most stewardship studies do not specifically attempt to address concerns that providers might have about implementing an intervention. During the design of stewardship interventions, ASPs should partner with providers, especially intensivists, to determine which safety measures should be tracked along with reduced antibiotic use and to discuss potential concerns about implementation.

**The Hope of Rapid Diagnostics Is Currently Unfulfilled**

Narrowing or discontinuation of antibiotics is much more likely to occur when the appropriate diagnostics are obtained at the onset of infection, especially before initiation of antibiotic treatment (21). The benefits of rapid diagnostic tests for clinical care and their ability to decrease excessive antibiotic use are highly anticipated. However, this optimism requires extensive clinical validation, especially with regard to de-escalation (45). The availability of rapid diagnostics may change management strategies if turnaround times and operating characteristics are sufficient to affect clinical decisions. Validation of a diagnostic test must be sufficient to overcome clinicians’ fear of missing pathogens or antibiotic resistance if antibiotic management is based on the result (46–48). A rapid test sensitivity equivalent to culture for pathogen detection is easier to achieve than the molecular diagnosis equivalent of culture-based antibiotic susceptibility. The lowest-hanging fruit may be *Staphylococcus aureus*, where a single mutation predicts methicillin resistance (26, 49). Determining antibiotic susceptibility by a rapid test for *Pseudomonas aeruginosa* or other MDR pathogens is much more complex (50).

Rapid diagnostics other than those used for positive blood cultures are a crucial need. Bacteremia rates are low even among critically ill patients with well-established sites of infection. Rapid diagnostics for pathogen detection directly from blood samples (without a culture step) and specimens from other sources, especially respiratory sources, are critical for antibiotic stewardship in the ICU. Quantitation becomes a major challenge in samples where microbial colonization is common, such as tracheal aspirates and catheterized urine. Lower cost effectiveness compared with empirical therapy and culture-based diagnosis may be a major barrier to the routine use of rapid diagnostics. Clearly, neither antibiotic stewardship nor cost effectiveness will improve if clinicians ignore the results of rapid diagnostics and continue to use empirical antibiotics (45). Critical care practitioners are in a great position to act on the results of rapid diagnostic tests in a timely manner, and should be included in the implementation plan.

Biomarkers can assist antibiotic stewardship as well. Most currently available biomarkers target the host inflammatory response and therefore are notoriously less accurate for establishing a diagnosis in critically ill patients with multiple other causes of inflammation or impaired immune function. However, a consistent pattern of safely shortening the duration of antibiotic treatments based on a marked improvement or normalization of biomarkers, such as procalcitonin and C-reactive protein, has been demonstrated in critically ill patients with a variety of infections (51–54).

**A Shift in Emphasis to Individualization Is Needed**

A recurring theme is that individualization—to a specific hospital, unit, or even patient—optimizes the prescribing of antibiotics. ASPs tend to look to professional society guidelines for recommendations regarding antibiotic therapy for specific infections. However, each major guideline for hospital-acquired pneumonia/ventilator-associated pneumonia (HAP/VAP), CAP, and sepsis recommends local adaptation of guideline-recommended therapy (55–58). Guideline recommendations tend to reflect the type of hospital where most of the guideline authors practice, with a consequent bias toward large academic centers. However, the strategies used by ASPs in large academic centers likely differ from the best approaches for community-based, nonteaching, nonacademic hospitals. Only recently have guidelines offered assistance to determine when primary recommendations might be altered, such as when empirical methicillin-resistant *S. aureus* (MRSA) coverage is needed for HAP/VAP (55).

Guidelines emphasize the need for ICU-specific antibiograms, but many hospitals are unable to provide these reports.
In addition, antibiograms tend to emphasize "reliable" cultures, which often excludes respiratory cultures. The HAP/VAP spectrum of etiology and antibiotic susceptibility patterns differs substantially from a spectrum based solely on bacteremia or urinary tract infection, depending on the reliability of the respiratory culture. In this setting, the clinical experience of critical care practitioners may be more accurate than hospital-wide antibiograms. Attempts to limit antibiotic access or de-escalate before obtaining positive cultures based on hospital-wide antibiograms and guidelines may therefore meet with resistance. Tools for ICUs to assess their individual need for diagnostic/treatment algorithms that differ from those recommended by a professional society are sorely needed.

Individualization to the patient-specific level is ideal. Although individualization will be challenging until rapid, accurate diagnostics are routinely available, prudent steps can be taken. For example, avoidance of repeated courses of the same antibiotic regimen is prudent, even if the agent is guideline recommended (59). Altered volumes of distribution and fluctuating renal function can make standard dosing regimens inadequate for acutely ill patients. Dosing of antibiotics also needs to be individualized, especially for patients with augmented renal clearance (58, 60). Nonstandard antibiotic dosing and therapeutic drug monitoring, when available, may be necessary.

**Critical Care Specific Opportunities**

To address these challenges, ASPs can collaborate with intensivists to develop local treatment guidelines that might be based on national guidelines but are tailored to local data and expertise. Workshop participants also discussed opportunities to improve antibiotic stewardship for three specific infections pertinent to critical care practitioners (CAP, HAP/VAP, and sepsis/septic shock), which were chosen a priori based on existing society guidelines, frequency of occurrence in the ICU, and associated morbidity/mortality.

**Community-acquired Pneumonia**

One of the greatest current opportunities for antibiotic stewardship is the elimination of the healthcare-associated pneumonia (HCAP) designation for some patients with CAP (61). Although they are consistently more common in patients admitted to the ICU, the incidence of pathogens that are resistant to usual CAP antibiotics is very low (62–65). The HCAP paradigm resulted in significant overtreatment of CAP, with evidence of actual adverse consequences in retrospective cohorts (62, 66). The term "HCAP" is now eliminated from pneumonia guidelines, but the efficacy and safety of management based on risk factors for specific pathogens that are resistant to the usual CAP antibiotics will require future validation.

The greater consensus regarding empirical antibiotic treatment for CAP than is the case for most other ICU infections allows for greater implementation of several antibiotic stewardship principals for this infection (40). Adherence can be improved by making the use of suggested antibiotics via guideline-compliant electronic order sets the easiest/default strategy (67). Automated prompts and decision support from electronic health records may further reinforce the appropriate use of antibiotics in CAP (68).

Audit and feedback benchmarking appropriate antibiotic use relative to peers may be helpful and motivate proper use. Previous HCAP guidelines changed prescribing patterns and payments for CAP (69, 70). Currently, there is no disincentive for overtreatment of CAP. Disincentives promulgated by the Centers for Medicare and Medicaid Services or other groups may provide one way to move past the influence of previous HCAP guidelines regarding prescriptions for CAP.

In contrast to HAP/VAP, regional antibiograms for CAP are probably more important than local data. The risk of antibiotic-resistant *S. pneumoniae* is significantly lower as the result of pediatric (and now adult) protein-conjugate pneumococcal vaccines (71). Conversely, the prevalence of extended-spectrum β-lactamases in Enterobacteriaceae causing CAP is increasing, as is the prevalence of community-acquired MRSA (61). However, the incidence of each still remains very low (63, 64, 72, 73). Specific risk factors for community-acquired MRSA can both identify patients who likely need empirical coverage and minimize the use of vancomycin or linezolid (74, 75). A simple need for ICU admission is not a sufficient risk factor for universal anti-MRSA coverage (76).

Two major issues remain for antibiotic stewardship of CAP: severe CAP (SCAP) and possible viral SCAP. Whereas the frequency of specific etiologies in SCAP varies from noncritically ill patients (more *S. aureus, Legionella spp.*), the association between severity at presentation and the need for broad-spectrum antibiotic therapy is weak (72, 77). Because patients with SCAP are routinely excluded from clinical trials of new antibiotics, most antibiotic recommendations rely on etiologies identified in observational cohorts. When patients with CAP deteriorate and require delayed ICU transfer, differentiating between missed pathogens and an exaggerated host response despite appropriate antibiotic therapy is difficult for clinicians.

Molecular tests detect viruses in a high proportion of CAP cases, including in critically ill patients (63), and studies have shown that assessment of procalcitonin levels may allow safe avoidance of antibiotics in outpatients and hospitalized patients with probable viral pneumonia (52). However, patients with SCAP were specifically excluded from these studies, and procalcitonin may correlate more highly with severity than with etiology in these patients (78).

**Hospital-acquired/Ventilator Associated Pneumonia**

Treatment guidelines for HAP/VAP are increasingly difficult to write, and the applicability to individual ICUs is correspondingly compromised (55, 57). The benefit of compliance with guidelines is less well demonstrated for HAP/VAP than for CAP (38, 79, 80). Increased frequency and new patterns of antibiotic resistance occur faster than completion of novel treatment studies. Therefore, treatment studies available for evidence-based guideline meta-analyses are often outdated or inconclusive at the time of guideline development (81). Most antibiotic treatment studies are pharmaceutical-sponsored registration trials, from which many critically ill patients with HAP/VAP (e.g., those with compromised immune systems or liver failure) are specifically excluded. Therefore, algorithms based on local culture patterns or antibiotic susceptibilities are more meaningful than algorithms based on national data. Review of an individual’s recent antibiotic therapy is crucial to avoid resuming a drug for which prior treatment is unnecessary.
pressure is likely to select for resistant pathogens.

The greatest opportunity for antibiotic stewardship may be stopping antibiotics for culture-negative HAP/VAP (34, 82, 83). This approach is critically dependent on obtaining accurate early cultures, which is much more feasible in intubated patients. In many of these cases, an alternative cause of symptoms/signs of pneumonia can be found, such as a nonpulmonary infection that requires different-spectrum antibiotics, device removal, or drainage procedures for optimal management (84, 85). In circumstances where pneumonia is still suspected clinically, although it does not necessarily rule out pneumonia, a negative respiratory culture from an intubated patient has a high negative predictive value for MDR pathogens such as *P. aeruginosa*, *Acinetobacter* spp., and MRSA, at least compared with nonculture techniques (26, 86). Antibiotic therapy can be correspondingly de-escalated, potentially decreasing the emergence of MDR pathogens (87).

The duration of the appropriate therapy is another important area for HAP/VAP antibiotic stewardship (24, 27). Previously, the duration of antibiotic therapy was arbitrary and based on the calendar rather than on evidence. Recent studies demonstrated that ≤8 days of treatment is adequate for the majority of patients (33, 51). Major guidelines recommend a 7- to 8-day course as the standard, with caveats for populations that were not included in the original studies, such as immunocompromised patients (33, 55, 57). It is feared that shorter courses may lead to inadequate control of infection and recurrence when the antibiotics are stopped, particularly in the case of VAP due to *P. aeruginosa* and other MDR pathogens. Whether a longer course of the same antibiotic regimen improves outcomes for these pathogens remains controversial, with high recurrence rates and mortality thus far appearing to be independent of the duration of antibiotics (27, 33, 88).

An additional opportunity that is most pertinent to HAP/VAP but is also applicable to antibiotic stewardship of other infections is appropriate evaluation or desensitization of patients with a poorly documented β-lactam “allergy.” The use of non-β-lactam regimens in hospitalized patients is associated with worse outcomes (89). Conversely, skin testing and desensitization protocols are low risk (90), even in the critically ill.

### Sepsis/Septic Shock

Early administration of appropriate antibiotics consistently improves survival of patients with CAP, HAP/VAP, and sepsis in general, while also decreasing associated organ failure, including progression to septic shock, acute respiratory distress syndrome, and acute kidney injury (19, 91–95). In retrospective studies, the effect of time to first appropriate antibiotic in patients with hypotension is measured in hours (96, 97). Workshop participants therefore expressed great concern regarding the ASP strategy of requiring preauthorization of certain antibiotics for critically ill patients (10), particularly hypotensive ones.

Because of the heterogeneity of patients with sepsis or septic shock, a single recommended regimen for “sepsis” will likely result in inappropriately broad treatment for a large proportion of patients and occasionally a too-narrow spectrum. For example, a default “sepsis” regimen of piperacillin/tazobactam and vancomycin is inappropriate and potentially dangerous for patients with CAP simply because they are hypotensive (36, 62, 66); pan-susceptible *S. pneumoniae* is still the most likely pathogen and is optimally treated with the standard ceftriaxone and macrolide. Antibiotic protocols that are appropriate for the suspected source and patient profile are likely to be equally effective and exert less antibiotic pressure. The development of such local guidelines presents an excellent opportunity for ASPs to partner with intensivists.

Antibiotic stewardship for the critically ill surgical patient introduces another major consideration (98). The adequacy of source control by the surgical procedure or drainage has major implications for the duration of antibiotic therapy. Communication with the operating surgeon/proceduralist regarding the initial adequacy of source control and ongoing assessment is critical for antibiotic management. Appropriate timing and duration of perioperative antibiotic prophylaxis and therapy also impact the risk of subsequent surgical site infections.

The current focus on improving outcomes in patients with sepsis presents an important opportunity for collaboration between ASPs and intensivists. Ideally, hospitals should take a multiprofessional approach toward determining the optimal antibiotics for various types of patients presenting with sepsis, and ensuring that antibiotics are delivered promptly. After antibiotic therapy is initiated, ASPs and intensivists can work together to optimize the therapy (e.g., by broadening, narrowing, or stopping it). Stopping antibiotics is an important consideration because data suggest that up to 40% of patients with suspected sepsis may not have an infection (99).

### Summary

Antibiotic stewardship should be a core competency of critical care practitioners, and training programs and continuing medical education are needed to address and assess this skill. The idea of incorporating intensivists into a multiprofessional approach to antibiotic stewardship is appealing, and would provide opportunities to optimize ICU antibiotic management. Future research should address the fear of missed pathogens and MDR organisms through outcome studies and clinical trials, to avoid hindering antibiotic stewardship for critically ill patients.
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