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Treatment Algorithms in Critical Care: Do They Improve Outcomes?

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Abstract

Patients admitted to the intensive care unit (ICU) often have significant underlying morbidities that require complex treatment plans. Because of these complexities, numerous guidelines have been developed to facilitate the management of the critically ill patient. Some of these guidelines include sepsis, community-acquired and ventilator-associated pneumonia, sedation, and glycemic control. Once guidelines are written, a treatment protocol must be developed and implemented within the critical care unit. Our medical center has implemented multiple treatment protocols, often with preprinted order sets with various degrees of success. In 2003, we implemented and later evaluated a sedation order form and protocol. Patients whose sedation was initiated with a standardized order form had more frequent sedation score assessment, less time between sedation vacations, reduced ICU length of ICU stay, and a trend in reduction of ventilator days. However, only 37% of eligible patients were treated using the order form and the protocol, despite the potentially beneficial effects. Some recommendations within guidelines are based on sound clinical evidence supported by randomized controlled trials, although others are based on expert opinion only. The most often-cited reason for protocol noncompliance is disagreement with the published clinical trial data. This paper examines both infectious and noninfectious treatment guidelines and the supportive evidence that they improved patient outcomes. In addition, strategies for successful implementation of a treatment guideline are discussed for clinicians to follow in order to maximize clinical outcomes.

Keywords

critical care, outcomes, sepsis, sedation, pneumonia

Evidence-based clinical practice guideline development was proposed by the Institute of Medicine in 1990 to "assist practitioner and patient decisions regarding appropriate health care for specific clinical situations."[1] Since that time, clinical practice guidelines have increased in numbers and have evolved to strongly influencing almost all areas of clinical practice, including the critical care population. For example, clinical practice guidelines currently exist for the management of sepsis, for the prevention and the treatment of community-acquired pneumonia (CAP) and ventilator-associated pneumonia (VAP), and for the sustained use of sedatives and analgesics in the critically ill adult.

In 2003, our institution updated and modified its previously existing sedation protocol. This update included elements and concepts included in the "Clinical Practice Guidelines for the Sustained Use of Sedatives and Analgesics in the Critically Ill Adult" published in 2002.[2] As a result of this update, a standardized sedation order form was developed and put into use at our institution. This order form included standardized methods for ordering sedative medications, appropriately monitoring patients receiving sedative medications, defining a sedation goal using the Richmond Agitation Sedation Scale (RASS), and providing a daily interruption of sedative medications (DIS). A later analysis of the impact of the use of the order form revealed an association with a reduced length of sedation use, duration of mechanical ventilation, as well as the intensive care unit (ICU) length of stay (LOS).[3]

The use and influence of clinical practice guidelines is not without controversy. Recent attention in the medical literature has been given toward the cardiovascular practice guidelines of the American Heart Association (AHA) and the American College of Cardiology (ACC). These guidelines were criticized for, among other things, the amount or proportion of recommendations made in the guidelines that lack conclusive evidence.[4] A potential controversy associated with clinical practice guidelines includes their conversion into performance

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measures to assess the quality of care in an organization or population.[5] Performance measures potentially based on expert opinion alone without associated evidence would be of obvious concern to practitioners.

The intent of this paper is to explore and discuss the clinical evidence, or lack of evidence, in the form of outcomes associated with the incorporation of clinical practice guidelines into clinical practice in the critical care setting. Focus will be given to clinical practice guidelines for sepsis, VAP, glycemic control, CAP, and the use of sedatives and analgesia used in the critically ill adult.

Evaluation of Guidelines

Methods

An adult sedation order form with a treatment algorithm was developed by a multidisciplinary performance improvement team at The Nebraska Medical Center. This form was subsequently approved by the Pharmacy and Therapeutics Committee and implemented for use in the adult ICUs.

At a later date, an assessment of the impact of the use of this order form and algorithm was desired. The purpose of this assessment was to review the extent to which the order form was being utilized for patient care, to evaluate the effect of order form usage on the frequency of sedation vacations, and to evaluate the effect of order form usage on the frequency of documentation of appropriate patient assessment using the RASS.

Our institution utilizes midazolam and propofol as continuous infusion sedatives for adult patients requiring mechanical ventilation in the critical care units. Therefore, all patients who received midazolam or propofol continuous infusions between October and December of 2006 were identified retrospectively by a query of the CareCast computer system.

Data collection was conducted by the Drug Utilization and Evaluation (DUE) department at our institution using a standardized data collection form. A chart review with data collection of 118 patients representing 147 separate orders for continuous infusion midazolam or propofol during the months identified was completed. This data collection resulted in the identification of the patients who were sedated with the use of the order form. As a result, the usage of the order form was able to be identified, and patients sedated with the use of the order form were able to be compared to those who were sedated without the use of the order form. Other parameters that were evaluated included medication used, infusion rates, primary service that ordered sedation, length of intubation and sedation, monitoring of patients sedated longer than 24 hours, monitoring of patients sedated less than 24 hours, effect of adult sedation order form on the frequency of monitoring RASS scores, monitoring by location of ICU, monitoring by primary services, and length of ICU stay.

Results

A total of 118 patients representing 147 orders for sedation were evaluated. Of these patients, 44 (37.4%) used the sedation order form and 74 (62.6%) did not. Patient groups were similar in respect to age, weight, gender, and medical service using the order form.

Our results indicate that a standardized method of ordering continuous infusion sedative medications resulted in improved management of the sedated mechanically ventilated patient. Those patients whose sedation was initiated by using the order form had more frequent sedation score assessment (2.1 vs 3.1 hours; $P < .05$), less time between sedation vacations (30.1 vs 41 hours; $P < .05$), and a reduced ICU LOS after sedation was discontinued (4 vs 4.6 days; $P < .05$), when compared to those patients whose sedation was initiated without the use of the order form. Our results also indicated a trend toward an improvement in the duration of mechanical ventilation (4.7 vs 5.1 days; $P > .05$) and ICU LOS (7.5 vs 7.8; $P > .05$) in those patients whose sedation was initiated by using the sedation order form.

Further analysis of our data independent of order form usage revealed that the ICU LOS was shorter in those patients who received a daily sedation vacation versus those who did not (6.6 vs 8.3 days; $P < .05$), and the length of mechanical ventilation was shorter in those patients who received a daily sedation vacation versus those who did not (3.5 vs 5.8 days; $P > .05$).

Treatment Guidelines Discussion

Sedation

The 2002 Society of Critical Care Medicine Clinical Practice Guidelines for Sedation and Analgesia suggests several recommendations for providing care for those patients requiring sedation in the ICU. Among other recommendations, the guidelines suggest establishing and adjusting as necessary a sedation goal or end point with sedative therapy (grade C), the use of a validated sedation assessment tool (grade B), systematic tapering or daily interruption of sedation to minimize prolonged sedative effects (grade A), and the use of a sedation algorithm or protocol (grade B; Tables 1 and 2).[2]

The use of a nursing-implemented sedation protocol including the use of a sedation assessment tool and sedation goal resulted in a reduced duration of mechanical ventilation, reduced hospital and ICU LOS, and the need for tracheotomy among critically ill patients with respiratory failure when compared to nonprotocol-directed sedation.[6] Many sedation scales have been utilized and no one scale has been shown to be superior to the others in terms of clinical outcomes. Prior to 2003, our institution utilized the Ramsay Scale but transitioned to the RASS.

Daily interruption of sedative medications in mechanically ventilated patients has been shown to be a valuable intervention within the critical care setting. A study published in 2000 highlighted the benefits from daily interruption of continuous infusion sedative agents and emergence to a desired end point in adults undergoing mechanical ventilation. The results of this study indicated those that were in the ''intervention'' group and received a daily interruption of their midazolam or propofol

Table 1. Results of Interventions Using Sedation Protocol in Critically Ill Patients[3]

Intervention (118 patients)	Frequency of sedation assessment (hours)	Time between sedation vacations (hours)	Duration of sedation (days)	Duration of mechanical ventilation (days)	ICU length of stay after sedation ended (days)
Order form used (44)	2.1	30.1	2.6	4.7	4
Order form not used (74)	3.1	41	3	5.1	4.6
P value	<.05	<.05	<.05	>.05	.045

infusion benefitted by having a reduced quantity of time on mechanical ventilation and a reduced LOS in the ICU.[7]

More recent observations include the study of combining DIS with daily spontaneous breathing trials. The results of the Awakening and Breathing Controlled (ABC) trial suggest that pairing daily spontaneous awakening trials with daily spontaneous breathing trials results in better outcomes for mechanically ventilated patients.[8]

A 2008 study compared 2 proven successful interventions against one another. Daily interruption of sedative medications was compared to a nursing-implemented sedation algorithm in medical intensive care patients. The results of the trial indicated that the use of a sedation algorithm was associated with reduced duration of mechanical ventilation and LOS compared to DIS.[9]

The 2002 Sedation Guidelines provide recommendations for selection of sedative agents. Lorazepam is recommended for sedation of most patients either by continuous infusion of intermittent therapy. The guidelines also recommend midazolam be utilized for short-term sedation only (less than 48 hours) due to concerns related to awakening after prolonged infusion.[2] Lorazepam is not approved for use at our institution as a continuous infusion agent secondary to concerns related to product precipitation in solution.

A recent comparison of continuous infusion propofol with daily interruption and intermittent lorazepam resulted in the authors concluding that continuous infusion propofol resulted in significantly fewer ventilator days than did intermittent lorazepam.[10] This is of particular interest as a previous investigation revealed that continuous IV sedation resulted in prolonged mechanical ventilation.[11] However, this investigation included very few patients who received propofol as a continuous infusion agent.

In summary, by including key elements of the 2002 Sedation Guidelines into a standardized order form at our institution, we were able to achieve an improvement in clinical outcomes within our ICU population. Thus, one can conclude that the implementation of key elements of these guidelines may improve patient outcomes.

Glycemic Control

Glucose control has emerged as a controversial intervention in the critical care setting over the last decade. An important trial in the progression of tight blood glucose control in the critically ill population was published in 2001, by Van den Berghe and colleagues.[12] This randomized, controlled, single-center trial involved 1548 surgical intensive care patients (62.7% cardiac surgery) and enrolled diabetic and nondiabetic patients (13% diabetic). Patients enrolled in the study were assigned to receive intensive insulin therapy (target blood glucose 80-110 mg/dL) or conventional therapy (target blood glucose 180-200 mg/dL). The primary outcome for the study was death from any cause during intensive care. Patients receiving the intensive insulin therapy had reduced mortality during their ICU stay when compared to those patients receiving conventional therapy (4.6% vs 8%, respectively; $P < .04$). The improvement in mortality was most notably witnessed in patients receiving critical care for greater than 5 days. In those patients receiving critical care for greater than 5 days, patients receiving intensive insulin treatment had an intensive care mortality rate of 10.6% and those receiving conventional treatment had a mortality rate of 20.2% ($P = .005$).[12]

A similar trial in medical ICUs was undertaken and published in 2006 (again by Van den Berghe and colleagues).[13] This prospective, randomized, single-center, controlled study enrolled and randomized 1200 patients to receive either conventional insulin treatment (goal blood glucose 180-200 mg/dL) or intensive insulin treatment (goal blood glucose 80-110 mg/dL). The primary outcome measure in this trial was death from any cause in the hospital. An analysis of outcomes in the intention-to-treat group indicates a nonsignificant reduction in hospital deaths in the intensive insulin treatment group versus the conventional group (37.3% vs 40%; $P = .33$). Separating the intention-to-treat group into a group whose LOS in the ICU was greater than or equal to 3 days reveals an improvement in hospital mortality in the intensive treatment group versus the conventional treatment group (43% vs 52.5%, respectively; $P = .009$)

The Efficacy of Volume Substitution and Insulin Therapy in Severe Sepsis study (VISEP) compared intensive insulin therapy with conventional insulin therapy in severely septic patients. This multicenter, randomized study also compared hydroxyethyl starch (HES) with Ringer's lactate for fluid resuscitation in this population.[14]

Patients receiving conventional insulin therapy were assigned goal blood glucose levels of 180 to 200 mg/dL. Patients randomized to receive intensive insulin therapy were assigned goal blood glucose levels of 80 to 110 mg/dL. The primary end points were the rate of death from any cause at 28 days and morbidity as measured using the Sequential Organ Failure Assessment (SOFA).[14]

The portion of the trial comparing intensive versus conventional insulin was halted after the first safety analysis, when it was found that the patients receiving intensive insulin were experiencing an increased number of hypoglycemic events. Patients in the intensive insulin group had a 17% incidence of hypoglycemia ($\leq$40 mg/dL) versus the conventional group that had an incidence of 4.1% ($P < .001$).[14]

Analysis of mortality at 28 days in the insulin therapy group indicates that patients receiving intensive insulin therapy had a mortality rate of 24.7% versus a 26% mortality of patients receiving conventional insulin therapy ($P = .74$).[14]

In an effort to determine the optimal target range for blood glucose in critically ill patients, a parallel-group, randomized, controlled trial involving adult medical and surgical patients admitted to the ICUs of 42 hospitals in multiple countries was conducted and published in March of 2009.[15]

More than 6100 patients were randomized to receive either an intensive glucose control group (goal blood glucose between 80 and 108 mg/dL) or a conventional glucose control group (insulin infusion initiated to keep blood sugar less than 180 mg/dL but stopped if blood sugar was below 144 mg/dL). The primary outcome measure was death from any cause within 90 days after randomization. The trial enrolled a mixture of medical and surgical ICU patients. Patients receiving intensive glucose control were found to have a mortality rate at 90 days of 27.5% versus a mortality rate of 24.9% for those receiving conventional glucose control ($P = .02$).[14] Rates of severe hypoglycemia were found to be 6.8% for the intensive glucose control group versus 0.5% for the conventional glucose control group ($P < .001$).[15]

The most recent American Diabetes Association (ADA) Position Statement released in January of 2009 makes specific recommendations for diabetes care in the hospital setting and for those patients requiring critical care.[16]

In this position statement, the ADA recommends that goal blood glucose levels for critically ill surgical patients be kept as close to 110 mg/dL as possible and generally less than 140 mg/dL. The recommendation also includes the statement that this population would require an intravenous insulin protocol that has demonstrated efficacy and safety in achieving this desired blood glucose level. This recommendation is given the highest grade of "A" in the ADA evidence grading system for clinical practice recommendations.[16]

The ADA notes that goal blood glucose levels for critically ill nonsurgical patients are less well defined. The goal blood glucose level recommended for this population is less than 140 mg/dL. Similar to the recommendation for critically ill surgical patients, the ADA recommends the use of intravenous insulin infusion protocols that effectively and safely keep blood glucose levels within range. This recommendation is given the classification of "C" in the ADA evidence grading system.[16]

The recently released American Association of Clinical Endocrinologists (AACE) and ADA Consensus Statement on Inpatient Glycemic Control has some updated recommendations that consider recent clinical data. The recommendations adjust the ADA recommendations mentioned above due to incorporation of recent clinical trials. The summary of recommendations includes a section specific for critically ill patients. The recommendations suggest that insulin therapy should be initiated for treatment of persistent hyperglycemia, starting at a threshold of no greater than 180 mg/dL and that once therapy has been initiated a glucose range of 140 to 180 mg/dL be targeted for the majority of critically ill patients. The recommendations suggest that intravenous insulin infusion is the preferred method of achieving glycemic control in critically ill patients and that frequent glucose monitoring is essential to minimize the occurrence of hypoglycemia and achieve optimal glucose control.[17]

Sepsis

During the last 7 years, there has been a large push toward standardizing the treatment of septic patients with the specific goal of reducing mortality. The Surviving Sepsis Campaign (SSC) is the result of an international effort initiated in 2002 by the Society of Critical Care Medicine, the European Society of Intensive Care Medicine, and the International Sepsis Forum.[18,19]

The campaign itself consists of 3 phases. Phase I of the campaign involved leaders introducing the campaign at major critical care conferences. The introduction included a 6-point action plan aimed at producing a 25% relative reduction of mortality at 28 days from severe sepsis in 5 years.[19] Phase II of the campaign involved the creation and development of guidelines. A group of international critical care and infectious disease experts representing 11 organizations convened in June 2003 to develop these guidelines that were ultimately published in March 2004.[18] Phase III of the campaign involves translating guidelines into clinical practice and also the chart review and collection of data for measurement of the impact of the campaign on outcomes.[19] (See Table 2.)

The contents of the guidelines developed and published in 2004 include evidence-based recommendations regarding different components of the acute management of sepsis and septic shock. The components include initial resuscitation, diagnosis, antibiotic therapy, source control, fluid therapy, vasopressors, inotropic therapy, steroids, recombinant human activated protein C, blood product administration, mechanical ventilation of sepsis-induced acute lung injury, sedation, analgesia, neuromuscular blockade, glucose control, renal replacement, bicarbonate therapy, deep vein thrombosis (DVT) prophylaxis, stress ulcer prophylaxis, consideration for limitation of support, and pediatric considerations. These recommendations are graded based on the level of supportive evidence in the medical literature.[18] In 2008, updates to the original guidelines were published.[19]

As part of Phase III, the SSC partnered with the Institution of Healthcare Improvement (IHI) to develop 2 sepsis bundles. The first sepsis bundle addresses management of the septic patient within the first 6 hours of identification of sepsis. This bundle is referred to as a sepsis resuscitation bundle and includes multiple tasks to be completed within the first 6 hours of sepsis identification. These tasks include measurement of serum lactate, obtaining blood cultures, administering antibiotics in a timely fashion, delivering intravenous crystalloids or colloids to achieve appropriate responses if hypotension or elevated serum lactate is present, initiation of pressor

Table 2. Summary of Sepsis Treatment Interventions Utilizing Treatment Guidelines, Order Sets, or Educational Programs to Improve Outcomes

Study	Treatments/ interventions evaluated	Design	Patient number and population	Results
Ferrer et al[21]	Therapeutic goals and treatments for sepsis	Prospective, multicenter, observational	2796 ICU patients with severe sepsis.	Early antibiotic administration (within 1 hour) and drotrecogin alfa associated with lower hospital mortality
McCabe et al[23]	CAP guideline concordant therapy	Retrospective, multicenter	54 619 non-ICU patients from 113 centers with CAP	Guideline concordant therapy associated with decreased hospital mortality (OR = 0.7, CI 0.63-0.77), sepsis (OR 0.83, CI 0.72-0.96), and renal failure (OR = 0.79, CI 0.67-0.94)
Micek et al[49]	Order set for the management of septic shock	Single-center before-and-after study	120 patients with septic shock presenting in the emergency department	Patients in after (order set) group had a lower risk of 28 day mortality than those in the before group (48.3% vs 30%, $P = .04$)
Ferrer et al[21]	Educational program for management of sepsis	Multicenter before-and-after study	2319 patients	Patients in postintervention group had lower risk of 28-day mortality (44% vs 39.7%, $P = .04$)

Abbreviations: CAP, community-acquired pneumonia; CI, confidence interval; ICU, intensive care unit; OR, odds ratio.

agents to maintain mean arterial pressures (MAPs) above 65 mm Hg to those who do not respond to intravenous crystalloids or colloids, maintenance of a central venous pressure (CVP) $\geq$8 mm Hg in the presence of persistent hypotension, and maintaining appropriate oxygenation as measured by central venous oxygen saturation or mixed venous oxygen saturation.[20] The second sepsis bundle relates to management of the patient within the first 24 hours of identification. This second bundle includes administration of low-dose corticosteroids if indicated, administration of recombinant activated protein C if indicated, glucose control, and maintaining a median inspiratory plateau pressure <30 cm H_2O for mechanically ventilated patients.[20]

Results of the impact of the implementation of these guidelines from the SSC are currently not available. However, a recent before-and-after study (Edusepsis) involving the implementation of an educational program based on the SSC improved process of care variables and improved mortality. The 28-day mortality of patients in this study, which included 59 medical–surgical ICUs throughout Spain, was reduced from 36.4% in the preintervention cohort to 31.1% in the postintervention cohort ($P = .009$). The implementation in this study involved the use of the sepsis bundles described in Phase III of the SSC.[21]

A prospective observational study that is yet to be published evaluated the effectiveness of components of the sepsis bundles used in the Edusepsis study. The primary outcome of this observational study was hospital mortality. The results of this study indicate that the treatments associated with lower hospital mortality include early broad spectrum antibiotic treatment and drotrecogin alfa treatment.[22]

Community-Acquired Pneumonia

Community-acquired pneumonia treatment guidelines was one of the first comprehensive infectious treatment guidelines published in 1993 by the American Thoracic Society (ATS).[23-25] Since that time, the CAP guidelines have been updated several times and most recently, in conjunction with the Infectious Diseases Society of American (IDSA).[25] Although fundamentally correct when first published, many of the recommendations were based on expert opinion of the guideline writers. Initial suggested treatment recommendations were primarily based on large randomized trials of an elderly Medicare population with little outcome data available on seriously ill hospitalized patients and critically ill patients.[26,27] Since that time, numerous studies have documented improvement in clinical relevant outcomes.[28-32]

In a 5-year study of 28 700 patients admitted with pneumonia, the 30-day mortality rate was decreased by 3.5% with the guideline (odds ratio [OR] 0.69; 95% confidence interval [CI] 0.49-0.97) compared to physicians not using the guideline.[30] Other smaller studies have demonstrated a favorable outcome trend in mortality reduction but were underpowered to show a statistical significant change.[33-35]

Using protocols that implement the guidelines have also resulted in improved outcomes. In a study of 31 hospitals that collectively developed a CAP treatment protocol based on the ATS recommendations, a mean decrease in LOS from 7 days to 5 days ($P < .001$) was demonstrated when the protocol was followed.[36]

One of the difficulties with any treatment protocol is prescriber use. A 7-site, physician-developed treatment guideline was compared to the same guideline, but strategic initiatives that increased utilization of protocol were also implemented. Although not statistically significant, both the duration of antibiotic treatment and the hospital LOS were decreased by implementation of the strategies.[37] In a study of 5 community hospitals, patients were stratified into guideline-concordant and discordant groups as defined by the 2001 ATS and the 2003 IDSA guidelines. The guideline-concordant antibiotic therapy group was associated with a significant decrease in time to switch therapy ($P < .01$), LOS ($P < .01$) and in-hospital mortality ($P < .04$) for both per-protocol and

Table 3. ATS/IDSA Criteria for Community-Acquired Pneumonia ICU Admission

Major criteria
Invasive mechanical ventilation respiratory rate ≥30 breaths/min
Septic shock with the need for vasopressors PaO_2/FiO_2 ratio ≤250
Minor criteria
Multilobar infiltrates
New-onset confusion/disorientation
Uremia (BUN level ≥20 mg/dL)
Leukopenia (WBC count <4000 cells/mm^3)
Thrombocytopenia (platelets <100 000 cells/mm^3)
Hypothermia (core temperature <36°C)
Hypotension requiring aggressive fluid resuscitation

Abbreviations: ATS, American Thoracic Society; BUN, blood urea nitrogen; ICU, intensive care unit; IDSA, Infectious Diseases Society of America; WBC, white blood cell.
Note: Adapted from Rello, 2008.[42]

intention-to-treat analyses.[38] The impact of treatment guidelines is less clear in severe CAP requiring ICU admission. At least 2 clinical trials have evaluated the impact of the ATS/IDSA treatment guidelines on the management of severe CAP. Adherence to these guidelines significantly improved mortality from 33% to 24% ($P = .05$) in a cohort of 529 severe CAP patients treated at 33 Spanish hospitals.[39] In a further study of 99 US patients, adherence to IDSA guidelines significantly decreased LOS from 6.8 to 4.5 days ($P < .01$) and resulted in lower hospital costs ($P < .05$).[40,41]

Over a decade ago, our medical center implemented a treatment protocol for CAP and severe CAP. Any treatment protocol for severe CAP must originate in the emergency department, which is the central focus for initial triage. Since severe CAP requiring admission to the ICU can result in up to 50% mortality, a systemic use of objective criteria is important to assure uniform treatment and maximize treatment outcomes in this patient population. The objective severity of illness criteria such as a pneumonia severity of illness (PSI) or the CURB-65 (confusion, urea, respiratory rate, blood pressure, age ≥ 65) scoring systems aid point-of-care decisions. However these scoring systems are still emerging, and it would seem prudent, and supported by the ATS/IDS guidelines that protocols for severe CAP include these scoring and patient triage systems.[25,42] Rello[42] has suggested the implementation of a treatment bundle-based 5 evidence-based variables that include risk assessment, early fluid resuscitation, prompt oxygenation, immediate combination antibiotic therapy, and consideration for ICU admission for patients meeting preset institutional criteria and those outlined by the ATS/IDSA. Admission criteria to include in a treatment protocol are outlined in Table 3. Patient with major criteria, combined with the treatment bundle, should have immediate ICU transfer and care.

Ventilator-Associated Pneumonia

The attributable mortality associated with VAP ranges from 30% to 50% and even higher among highly resistant pathogens such as *Pseudomonas aeruginosa*. In this issue of the journal, Micek and Skrupky have thoroughly reviewed the treatment approaches that have been demonstrated effective in randomized clinical trials. Thus, the discussion that follows examines the utilization of guidelines, their effectiveness, and implementation. Prospective randomized trials that follow the ATS guidelines improve clinical outcomes among ICU patients with VAP. We conducted a prospective randomized, multicenter trial among 10 US medical centers that evaluated patients with VAP pre- and postimplementation a treatment algorithm. Over 570 patients were evaluated and demonstrated a significant reduction in mortality, decreased LOS, and reduced resource utilization.[43-45] A similar single-institution study evaluated a newly developed guideline on the antimicrobial use practices.[46] After the guideline was implemented, antimicrobial therapy was more frequently tailored based on quantitative culture results with a mean reduction in the duration of therapy (12.0 vs 10.7 days; $P = .0014$).

Unfortunately, nonadherence is common among clinicians, and clinical practices are inconsistent with the guidelines and level of available evidence.[47] The most often-cited reasons by physicians for not following guidelines was disagreement in interpretation of clinical trials (35%) and lack of resources (31%). Perhaps, a more efficient approach is the common practice to implement bundled practices, which have been shown to decrease infection rates. Risk strategies included in the bundles are routine hand hygiene, elevation of the head-of-the-bed to ≥30°, oral intubation, draining of ventilator circuits on a schedule, and regular oral hygiene. Babcock and colleagues[48] implemented a treatment bundle and were able to demonstrate decreased VAP rates by 58% and 46% in teaching and community hospitals.

Challenges to Implementation

Implementation of practice guidelines in the form of protocols or order sets at health care institutions can be extremely challenging. Our own development and implementation of a standardized order form for sedation involved numerous obstacles. Lawrence Summers has stated, "no one in the history of the world has washed a rented car." Likewise, without ownership or buy-in of a guideline or treatment protocol, implementation is sure to fail.

Physicians are often hesitant or reluctant to modify their current practice to fit a standardized method of treatment of all patients. Often, they see their own methods as effective, and changing an approach that is perceived as successful may not completely make sense. Modifying current practice may involve a modification of established workflow for nurses, pharmacists, and other health care professionals, which may potentially negatively impact efficiency if more global modifications are not undertaken. This can potentially lead to poor compliance to the introduced guidelines and ultimately failure of their implementation.

Evidence to highlight the challenges seen with guideline implementation can be found in the previously mentioned before-and-after study conducted in Spain, which explored whether a national education program based on Surviving Sepsis Guidelines could improve outcomes in septic patients. Early success was seen with the program but a 2-month evaluation conducted 1-year after implementation indicated that adherence to the guidelines had returned to near baseline values.[21]

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