CHEST Postgraduate Education Corner

CONTEMPORARY REVIEWS IN CRITICAL CARE MEDICINE

SMART Approaches for Reducing Nosocomial Infections in the ICU*

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Nosocomial infections are problematic in the ICU because of their frequency, morbidity, and mortality. The most common ICU infections are pneumonia, bloodstream infection, and urinary tract infection, most of which are device related. Surgical site infection is common in surgical ICUs, and *Clostridium difficile*-associated diarrhea is occurring with increasing frequency. Prospective observational studies confirm that use of evidence-based guidelines can reduce the rate of these ICU infections, especially when simple tactics are bundled. To increase the likelihood of success, follow the specific, measurable, achievable, relevant, and time bound (SMART) approach. Choose specific objectives that precisely define and quantify desired outcomes, such as reducing the nosocomial ICU infection rate of an institution by 25%. To measure the objective, monitor staff adherence to tactics and infection rates, and provide feedback to ICU staff. Make objectives achievable and relevant by engaging stakeholders in the selection of specific tactics and steps for implementation. Nurses and other stakeholders can best identify the tactics that are achievable within their busy ICUs. Unburden the bedside provider by taking advantage of new technologies that reduce nosocomial infection rates. Objectives should also be relevant to the institution so that administrators provide adequate staffing and other resources. Appoint a team to champion the intervention and collaborate with administrators and ICU staff. Provide ongoing communication to reinforce educational tactics and fine-tune practices over time. Make objectives time bound; set dates for collecting baseline and periodic data, and a completion date for evaluating the success of the intervention.

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Key words: catheter-related bloodstream infection; prevention; surgical-site infection; urinary tract infection; ventilator-associated pneumonia

Abbreviations: BSI = bloodstream infection; CI = confidence interval; CVC = central venous catheter; ETT = endotracheal tube; HICPAC = Healthcare Infection Control Practices Advisory Committee; RR = relative risk; SMART = specific, measurable, achievable, relevant, and time bound; SSI = surgical site infection; UTI = urinary tract infection; VAP = ventilator-associated pneumonia

The Centers for Disease Control and Prevention[1] estimates that 1.7 million nosocomial infections occurred in the United States in 2002. ICUs had the highest rates of infection, at 13 per 1,000 patient-days, and mortality, ranging from 11% for surgical site infection (SSI) to 25% for bloodstream infection (BSI).[1] The most common ICU infections are pneumonia, urinary tract infection (UTI), and BSI,[2] and are usually device related. The rate of device-related ICU infections has decreased during the last 25 years (Fig 1).[3–6]

The US government is providing new incentives for further improvement. The Centers for Medicare and Medicaid Services will stop reimbursing hospitals for care made necessary by eight preventable complications as of October 1, 2008.[7] Two of these are ICU complications: vascular catheter-related BSI and catheter-associated UTI. Other ICU infections are expected to follow, such as ventilator-associated pneumonia (VAP) and methicillin-resistant *Staphylococcus aureus* infection.

The need for improvement has generated many articles on ICU infections,[8–13] including the excellent review by Eggimann and Pittet,[13] and evidence-based guidelines.[14–20] Many of these guidelines will be updated in 2008, so they are summarized only briefly in this review. Observational studies confirm that evidence-based approaches can reduce infection

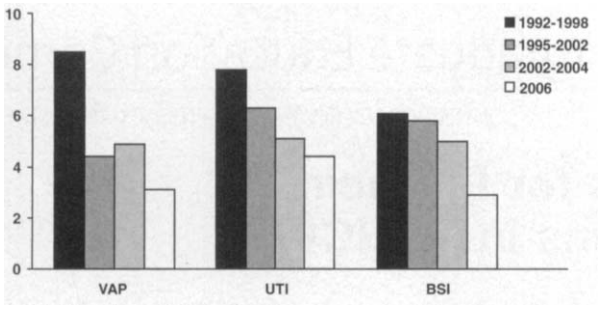

FIGURE 1. Device-related infections in medical ICUs as reported by the National Nosocomial Infections Surveillance System[3,5] and National Healthcare Safety Network.[6]

rates. For example, a single surveillance tactic involving German ICUs significantly reduced rates of catheter-related BSI rates (relative risk [RR], 0.80), VAP (RR, 0.71), and SSI (RR, 0.72).[21] Analyses of studies showed that bundled interventions were even more effective and reduced rates of catheter-related BSI by a range of 29 to 95%[22] and VAP by 31 to 57%.[23]

Management guru Peter Drucker conceptualized management by objectives > 50 years ago[24] and advocated the use of specific, measurable, achievable, relevant, and time-bound (SMART) objectives. The purpose of this review is to summarize recent studies of preventive interventions in the ICU, with the aim of identifying SMART objectives to further reduce the infection rate. A PubMed search was conducted to identify observational studies of bundled interventions that aimed to prevent nosocomial infections; studies published since the year 2000 were selected whenever possible.

> No decision has been made unless carrying it out in specific steps has become someone's work assignment and responsibility.
>
> Peter F. Drucker, management guru

INTRAVASCULAR CATHETER-RELATED BSI

The Healthcare Infection Control Practices Advisory Committee (HICPAC) guidelines[14] for preventing intravascular-catheter-related BSI include educating health-care workers, assessing their knowledge of and adherence to guidelines, and using designated, trained personnel to insert and maintain catheters (Table 1). The guidelines also include routine monitoring to determine infection rates in patients with central venous catheters (CVCs), trends in those rates, and lapses in infection-control practices.[14] Surveillance should include a written plan, maintaining intensity and consistency over time, adequate personnel and other resources, and annual evaluation.[25]

Table 1—*Guidelines for Preventing Intravascular Catheter-Related Infections

Effective interventions (category IA)
Education of health-care workers, with assessment of knowledge of and adherence to guidelines
Designated, trained personnel to insert and maintain catheters
Proper hand hygiene with antiseptic-containing soap and water or with waterless alcohol-based gel or foam
Aseptic technique during catheter insertion and care
Clean gloves for insertion of peripheral catheters and sterile gloves for arterial and central catheters
Maximal sterile barrier precautions for CVC insertion
Care of catheter site
Skin disinfection with 2% chlorhexidine or 70% alcohol
Use of sterile gauze or transparent, semipermeable dressing
Replacement of damp, loose, or soiled CVC dressing
Selection of catheter, insertion technique, and site with lowest complication risk
Prompt removal of catheter that is no longer essential
Replacement of administration sets not more frequently than every 72 h (unless infection is suspected)
Cleansing of injection port with 70% alcohol or iodophor before access
Appropriate preparation and quality control of intravenous admixtures
Surveillance to determine infection rates, trends, and lapses in infection control
Interventions to be avoided
Routine antibiotic prophylaxis including topical, intranasal, and systemic formulations
Routine use of antibiotic lock solution
Routine use of arterial or venous cut-down for catheter insertion
Routine use of in-line filters for infection control

*From O'Grady et al.[14] Category IA = strongly recommended for implementation and strongly supported by well-designed studies.

Prospective observational studies[26–32] confirm that bundled interventions can significantly reduce infection rates (Table 2). Success rates, however, are highly variable depending on institution-specific factors, such as the baseline infection rate, preventive tactics chosen for bundles, and adherence to the tactics. Success rates also vary depending on study design, especially duration of observation, as well as many other variables.

My colleagues conducted a series of studies[26–28] at our 1,200-bed facility beginning in 1998. Specific

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