Critical Care CME Program

Module 1

CSA is now offering its third CME program. This program's topic is critical care and will consist of eight modules, the first of which appears in this issue of the *Bulletin*. The registration page, test questions and evaluation for this module are located at the end of this article. The nine questions must be answered and submitted to the CSA office with the registration page in order to receive the CME credit. Your CME certificate will be mailed from the CSA office.

Alternatively, the full text of each module of this CME program, along with references, will be accessible through the CSA Web Site, **www.csahq.org**, in the Online CME Program section, and as part of the online *CSA Bulletin*. Instructions to complete Module 1 online are given in the Information pages. After completing the assessment, you may print your CME certificate. Members will need their usernames and passwords to do the modules online.

Important Information about Module 1

The following information must be read and acknowledged before proceeding to the rest of the module. Check the acknowledgement box on the registration page.

Faculty and Disclosures

Any faculty participating in continuing medical education activities sponsored by the California Society of Anesthesiologists is required to disclose any real or apparent conflict(s) of interest related to the content of their presentation(s) or any of the industry sponsors of the program. In addition, authors must disclose when a product is not labeled for the use under discussion or when a product is still investigational.

Michael A. Gropper, M.D., Ph.D., FCCM (Co-Author of Module 1)
Professor and Vice Chair of Anesthesia and Perioperative Care
Director, Critical Care Medicine
Chair for Medical Quality
University of California San Francisco Medical Center

John Taylor, M.D. (Co-Author of Module 1)
Assistant Professor, Department of Anesthesia & Perioperative Care
Division of Anesthesia and Critical Care Medicine
Director, Post Anesthesia Care Unit (PACU)
University of California San Francisco Medical Center

Nitin Shah, M.D. (Editor and Chair of the Critical Care CME Program)
Clinical Professor of Anesthesiology, Director, Neuroanesthesia
UC Irvine, Orange, California
Chief, Combined ICU, Long Beach Veterans Healthcare System
Long Beach, California

Dr. Gropper has received honoraria from Cook, Inc. for his role as speaker.

Dr. Taylor discloses that he has no relevant financial relationships with any commercial entities.

Dr. Shah has received honoraria from Masimo, Abbott, and Baxter for his role as speaker. He owns stock in Masimo Corporation.

Registration/Instructions

Method of Participation: The physician will read and study the materials and complete a quiz and evaluation of the module. Some modules may have slides available online.

To register for and complete this module:

1. First, read and study all of the module pages.
2. Complete the registration page.
3. Complete the quiz found after the CME article.
4. Complete the evaluation that follows the quiz.
5. Submit numbers 2, 3 and 4 to the CSA office by mail or fax (650-345-3691).
6. Your CME certificate will be mailed to you.

Estimated Time to Complete the Module: One hour

Availability

Module 1: Reducing Catheter-Related Infections

Release Date: March 31, 2008
Expiration Date: March 31, 2011

CME Sponsor/Accreditation

The California Society of Anesthesiologists is accredited by the Accreditation Council for Continuing Medical Education to sponsor continuing medical education for physicians.

The California Society of Anesthesiologists Educational Programs Division designates this educational activity for a maximum of 8 *AMA PRA Category 1 Credit(s)™*. Physician should claim only credit commensurate with the extent of their participation in the activity.

Fees

The modules are free to CSA members. Nonmembers pay $25 for each module. Each module is worth *one AMA PRA Category 1 Credit™*.

Target Audience

This program is intended for all licensed physicians, including anesthesiologists and residents.

Evaluation

An evaluation of each module of this series is offered after the test questions.

Privacy Policy

CSA has a privacy policy that is a general policy for information obtained regarding all online interactive pages, including online CME activities. To review this policy, please go to www.csahq.org/privacy.vp.html.

Acknowledgement

To proceed with this module, please acknowledge that you have read everything on these introductory pages by checking the box on the registration page.

Objectives

Upon completion of this activity, participants will be able to:

- Define catheter-related bloodstream infection (CRBSI)
- Describe five specific methods to prevent CRBSI
- Discuss the role of antimicrobial catheter technology in the prevention of CRBSI
- Cite the major studies that have demonstrated success in the prevention of CRBSI

Reducing Catheter-Related Infection

By Michael A. Gropper, M.D., Ph.D., FCCM, and John Taylor, M.D.

Dr. Gropper is Professor of Anesthesia and Director of Critical Care Medicine at UCSF. He also serves as Chair for Medical Quality at UCSF Medical Center. He has a longstanding interest in improving outcomes in critically ill patients and has spearheaded successful efforts to reduce hospital-acquired infections in the ICU, especially catheter-related bloodstream infections and ventilator associated pneumonia. His research interests are in the area of respiratory failure, severe sepsis, and transfusion medicine. He has received NIH funding for these projects. Dr. Gropper has published widely, and speaks nationally and internationally on critical care medicine.

John M. Taylor, M.D., is an Assistant Professor of Anesthesia and director of the Post Anesthesia Care Unit at the University of California, San Francisco. He also has board certification in Critical Care Medicine. His primary professional interests are care of the critically ill patient and resident education, both in the operating room and in the intensive care unit.

Introduction

Central venous catheters (CVCs) play a vital role in the care of hospitalized patients; it is estimated that 48 percent of ICU patients have CVCs, often placed by anesthesiologists. Common reasons for insertion include administration of medication, hemodynamic monitoring, and parenteral nutrition. Central venous catheter complication rates of 12 percent to 26 percent have been reported.[1,2] Of the complications related to CVCs, catheter-related bloodstream infections (CRBSIs) have proven to be common, costly, and associated with high mortality.

There are an estimated 3 million to 5 million CVCs placed annually in the U.S., and approximately 80,000 ICU patients per year develop CRBSI.[3] If extrapolated to all hospital patients, this number may be as high as 250,000 infections per year.[4] ICU patients (the most studied group) account for 15 million catheter days per year, with an average of 5.3 infections per 1,000 catheter days. CRBSIs in ICU patients have a reported mortality of 12 percent to 28 percent, which translates to 28,000 deaths per year.[5,6]

While it is not possible to quantify the healthcare costs absolutely, the costs associated with a single CRBSI range from $12,000 to $54,000 and can result in a 22-day increase in hospital length of stay. This makes the estimate of the total economic burden related to CRBSIs $2.3 billion per year. Fortunately, there are a number of interventions that have proven efficacy in reducing the incidence of CRBSI. Most of these interventions are low cost, hinge on education, and involve changes in practice patterns.[7]

Diagnosing CRBSI

Diagnosis of CRBSI can be difficult, and it often has to be inferred from data suggesting clinical infection and bacteremia without another source identifiable other than the CVC. Patients with CRBSI typically have persistent bacteremia or fungemia. There also may be localized infection at the catheter insertion site without actual infection of the catheter. Traditional methods of diagnosing CRBSI include quantitative culture of the CVC tip, and if the number of colony forming units of bacteria reach a threshold, then the catheter is considered the source of infection.[8] This technique obviously requires guidewire exchange or catheter removal, which may be problematic in critically ill patients with limited intravenous access. More recently, clinicians have used the technique of differential time to positivity. This technique involves culturing blood drawn simultaneously from the suspected CVC and a sterile peripheral site. The blood is labeled with the time of sampling and the site from which it was obtained. CRBSI is diagnosed when the blood drawn through the CVC becomes positive for bacterial growth *at least* two hours earlier than the blood culture drawn from a peripheral vein.[9] The advantage of this technique includes increased specificity, and also allows the catheter to be left *in situ* if it is not the source of infection.

Hand Washing

Hand hygiene is an important part of patient care. Hand cleaning and wearing gloves reduces disease transmission to patients, transmitting disease between patients, and acquiring disease from patients. CDC recommendations state that hand cleaning should be performed before patient contact, before donning sterile gown and gloves in preparation for CVC placement, and after patient contact.[10,11] Also, gloves should be worn with all patient contact.

Strict adherence to hand hygiene is among the most effective nosocomial infection-prevention measures. Alcohol-based hand cleaners are the most efficacious and least time consuming methods to prevent nosocomial infections. The best antimicrobial efficacy can be achieved with ethanol (60 percent to 85 percent), isopropanol (60 percent to 80 percent), and n-propanol (60 percent to 80 percent). Plain soap and water hand washing is the least efficacious.[12]

A recent study shows that use of 85 percent ethanol-based hand rubs for 15 seconds is as effective as the previously recommended 30-second rub in killing most nosocomial hand bacteria. Decreased time needed for hand antisepsis translates into increased compliance. It should also be pointed out that it is not necessary—and not recommended—to wash hands with soap and water after use of alcohol-based hand rubs.[13]

Full Barrier Precautions

Full barrier precautions consist of sterile gloves, long-sleeved sterile gown, mask, cap, and large sterile sheet drape. The sterile drape should be large enough to cover the entire patient; head-to-toe and side-to-side. A single large drape removes the potential for separation of component drapes that may result in a breach in sterility. Use of a large sterile drape is consistent with the sterile draping precautions typical during insertion of tunneled central catheters. Stringent barrier precautions reduce the incidence of CRBSI when compared to minimal precautions (sterile gloves and small sterile drapes). Adherence to full barrier precautions is an efficacious and cost-effective manner of reducing CRBSIs.[14,15]

Skin Antisepsis

The patient's skin is the most important source of contamination during CVC insertion. Preparations of 10 percent povidine iodine have been the most widely used preparations for site cleansing during catheter insertion. A problem with iodine-based solutions is that their efficacy requires that they should be allowed to dry completely prior to the procedure. However, a 2 percent aqueous chlorhexidine gluconate solution has been shown to lower CRBSI rates compared with insertion site preparation with 10 percent povidone iodine or 70 percent alcohol. Skin insertion sites should be vigorously cleansed for at least 30 seconds. Preparations with 0.5 percent chlorhexidine gluconate have not been shown to be any more effective than 10 percent povidone iodine in CRBSI reduction. The 2 percent aqueous chlorhexidine gluconate solutions have also been used effectively for post-insertion site care.[16] Many catheter manufacturers are now replacing iodine-based skin preparation solutions with chlorhexidine gluconate.

Insertion Site

Numerous studies have investigated complications related to CVC insertion site. The 2002 CDC Guidelines for the Prevention of Intravascular Catheter-Related Infections call for avoiding the femoral vein insertion, when possible, in adult patients.[17] Aggregate data indicate femoral CVCs have a higher incidence of infection and deep vein thrombosis.[18-22] Guidelines also favor subclavian vein cannulation over internal jugular (IJ) vein insertion due to an increased risk of infection associated with IJ insertion. These data are not the same for femoral CVC placement in children in which case it is *not* associated with increased CRBSI.[23,24] It should also be noted that studies have *not* shown peripherally inserted central catheters placed in an acute inpatient setting to be superior to CVCs in terms of reducing the incidence CRBSI.[25,26] Catheter

insertion site must be guided by the clinical situation, and there is a clear advantage to the use of real-time ultrasound guidance for the internal jugular site with respect to efficacy of placing the line quickly and without a vascular complication.

Bundled Prevention Strategies

There is good evidence that bundling evidence-based preventative measures is effective in reducing CRBSIs. Education is the cornerstone of implementing these multifaceted preventative strategies. These quality improvement measures are both efficacious and cost effective.

A 2004 prospective cohort study showed that implementation of five quality improvement measures reduced the incidence of CRBSI at one teaching institution from 11.3 infections per 1,000 catheter days to zero infections at the close of the study, a significant savings of life and hospital acquired costs.[27] The implemented measures, based on CDC guidelines, were:

1. Provision of a web-based module and lecture series on evidence-based practices to limit CRBSI to healthcare providers;
2. Creation of a CVC insertion cart;
3. Implementation of a daily goal form that asked the ICU team to justify need for CVC on daily rounds;
4. Creation of a preprocedure checklist that was completed at the bedside prior to CVC insertion to ensure adherence to evidence-based guidelines;
5. Empowerment of ICU nurses to stop nonemergent procedures if evidence-based guidelines were not followed.

These interventions provided both immediate and lasting improvement in CRBSI rates. It was estimated that 43 CRBSIs were prevented, eight lives saved, and approximately $2 million saved in heath care costs per year. The bundled interventions also proved sustainable, with CRBSI incidence being less than one in 1,000 catheter days 15 months after the study ended.[27]

In 2006, Pronovost's study evaluated the incidence of CRBSI after five evidence-based quality measures recommended by the CDC were implemented in ICUs statewide in Michigan.[28] Healthcare providers also received education on the quality improvement measures in the study by Berenholtz.[27] For the Pronovost study, the interventions were:

1. Hand washing,
2. Using full-barrier precautions during the insertion of central venous catheters,

3. Cleaning the skin with chlorhexidine,
4. Avoiding the femoral site if possible, and
5. Removing unnecessary catheters.

One hundred three ICUs provided data on 375,757 catheter days. Implementation of these five evidence-based measures resulted in a 66 percent decrease in CRBSI that was sustained for 16 to 18 months after the study concluded.[28]

The literature supports the use of bundled evidence-based strategies to reduce CRBSIs. These quality-improvement measures significantly decrease the incidence of CRBSI and are cost-effective, easily taught, and sustainable in both teaching and nonteaching hospitals.

Antimocrobial Impregnated Catheters

The advent of the technology allowing impregnation of central venous catheters has led to significant device development. The major antimicrobial strategies include coating the catheter with chlorhexidine/silver sulfadiazine (Arrowgard®), or impregnating the catheter with the antibiotics minocycline/rifampin (Cook Spectrum®). Both technologies limit colonization of the catheter and subsequent bloodstream infection significantly. In a head-to-head trial, the minocycline/rifampin catheter was found to be more effective in preventing both colonization and bloodstream infection.[29] Although these catheters are more expensive, they can be cost-effective in reducing CRBSI.[30] There has not been significant antibiotic resistance demonstrated in patients with these catheters. Now that the Centers for Medicare and Medicaid Services has ruled that they will not pay for prolonged hospitalization due to hospital-acquired infections such as CRBSI, it should be considered carefully whether these devices should be routinely adopted. Conversely, they are clearly less effective than the routine insertion precautions described above, and should not be purchased unless the basic precautions are being followed stringently. Finally, in the large study described by Pronovost, it is not clear what percentage of patients, if any, received these devices.[28]

Other Measures

Dressing Care

There have been several studies addressing the issue of CVC dressings. A Cochrane database systematic review of six studies in 2003 failed to show significant difference in CRBSI between transparent polyurethane compared to gauze and tape dressings for central venous catheters. A potentially beneficial characteristic of transparent dressings is site observation for evidence of infection

without having to remove dressings.[31] When choosing a dressing, one should consider influencing factors such as availability, preference, and cost. One caveat: If the insertion site is oozing, a gauze dressing may be considered to aid with dressing adherence to skin.

Line Changes

There have been many studies and much debate regarding scheduled CVC changes. Studies of ICU patients to determine efficacy of scheduled CVC changes failed to show any difference in groups of patients having scheduled CVC changes versus those having line changes as needed.[32,33]

A meta analysis of 12 randomized controlled trials examining scheduled guidewire exchanges compared to CVC catheter changes done on an as-needed basis showed no benefit of planned catheter exchanges. CVC changes only need to be done if the catheter is not functioning properly or has evidence of local or systemic infection.[34] The use of a guidewire for replacement of malfunctioning catheters has become a safe and accepted method of preserving vascular access, provided there is no evidence of insertion site infection.[35]

While most studies regarding CRBSI have enrolled ICU patients, patients arriving in the postanesthesia care unit with newly placed central lines comprise another group of patients that deserve scrutiny. Intraoperative CVCs may be placed for temporary hemodynamic monitoring, medication administration, or volume resuscitation. At the conclusion of surgery, the need for a CVC may be obviated. As such, patients in the PACU should be screened for appropriateness of catheter removal prior to discharge from the PACU, as it is not possible for patients to develop a CRBSI if they do not have a CVC.

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Questions

1. Choose the indications when healthcare workers should clean their hands in relation to CVC management:
    a. Before and after palpating CVC insertion sites
    b. Before and after inserting a CVC
    c. Before and after accessing, repairing, or dressing a CVC, including touching administration sets and access ports.
    d. All of the above

2. When inserting a CVC, maximal sterile barrier precautions are required. This includes all of the following except:
    a. Surgical cap and mask
    b. Sterile gown and sterile surgical gloves
    c. Surgical hand scrub
    d. Draping of the entire body of the patient
    e. Preparation of the skin at the insertion site

3. What antiseptic is routinely recommended for preparation of the patient's skin prior to insertion of a CVC?
    a. 70% isopropyl alcohol
    b. 2% chlorhexidine gluconate
    c. 1% Povidone iodine
    d. 4% chlorhexidine gluconate

4. What is the recommended time for applying the skin antiseptic to the skin?
    a. 30 seconds
    b. 1 minute
    c. 2 minutes
    d. 5 minutes

5. After applying the skin antiseptic to the skin, when should the catheter be inserted?
    a. Immediately
    b. After drying the site by wiping with a gauze square
    c. After it has been allowed to air dry completely
    d. After two minutes

6. In most clinical situations, which is the preferred site for central CVC insertion?
   a. Internal jugular
   b. Subclavian
   c. Femoral

7. CVC exchange over a guidewire is appropriate for the following situations except:
   a. Patients who are strongly suspected of having a CRBSI
   b. Replacing a malfunctioning CVC
   c. Downsizing a pulmonary artery catheter to a CVC

8. When timed culture results for blood drawn simultaneously from the suspected CVC and a sterile peripheral site become positive within one hour of one another, the CVC is considered the source of the infection and should be removed.
   a. True
   b. False

9. An example of bundled CRBSI prevention strategies include all of the following recommendations, except:
   a. Hand washing
   b. Using full-barrier precautions during the insertion of central venous catheters
   c. Cleaning the skin with chlorhexidine
   d. Scheduling CVC changes
   e. Avoiding the femoral site if possible
   f. Removing unnecessary catheters

Evaluation of Module 1

As part of the CSA Educational Programs Division's ongoing efforts to offer continuing medical education, the following evaluation of this program is requested. This is a useful tool for the EPD in preparing future CME programs.

1. How well were the learning objectives of this program met?

Very Well	5	Above Average	4
Average	3	Below Average	2
Not Well at All	1		

2. How relevant was the information in this program to your clinical practice?

Very Relevant	5	Above Average	4
Average	3	Below Average	2
Not Relevant	1		

3. How would you rate this program overall?

Excellent	5	Above Average	4
Average	3	Below Average	2
Poor	1		

4. Did you detect any commercial bias in this module? Yes No

Registration

Complete this form, the test, and the evaluation, and **mail or fax** all three to the CSA office at 951 Mariner's Island Boulevard #270, San Mateo, CA 94404 or FAX to 650-345-3269. The CSA CME journal courses are also available on the CSA Web Site at www.csahq.org.

Critical Care CME Course, Module 1
Available March 31, 2007, to March 31, 2010

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❑ I acknowledge that I have read the Important Information about Module 1