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Effect of a Multidisciplinary Team Approach to Eradicate Central Line Associated Blood-Stream Infections (CLABSI)

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Et al.

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Introduction: CLABSI remains a significant problem in the intensive care unit. **Hypothesis:** A multimodal approach for the insertion and care of central lines will prevent central line associated bloodstream infections (CLABSI). **Methods:** A Critical Care Operations Committee was formed to transform care in eight intensive care units (ICU) in an academic medical center in 9/2004. One goal was to reduce CLABSI. Using evidence based medicine, a clinical practice guideline was developed that incorporated the use of maximum barrier precautions, chlorhexidine skin preparation, avoidance of the femoral insertion site, dedicated catheter cart, a check list, tracking high risk central venous catheters (CVC), anti-septic or antimicrobial impregnated catheters, a recommendation to use ultrasound guidance when inserting a CVC in the internal jugular vein, daily determination of a need for the CVC and treatment of CLABSI as a critical event. CLABSI were adjudicated by the hospital epidemiologist and CVC days were tracked. Rates of CLABSI were followed from 9/2004 through 7/2011. The Spearman correlation coefficient was used for statistical evaluation. A p<0.05 was considered significant. **Results:** CLABSI rates (per 1000 catheter days) declined dramatically from 2004 to 2011 (p<0.05): 2004: 5.86; 2005: 3.46; 2006: 3.74; 2007: 2.89; 2008: 1.34; 2009: 1.12; 2010: 0.84; 2011 (annualized): 0.49. One ICU has not had a CLABSI for over 3 years. **Conclusions:** A multimodal approach to CVC insertion and care reduces CLABSI by over 90%. Our ultimate goal is the complete eradication of CRLASI in our institution.

Introduction

Central venous catheters are essential for the care of the critically ill patient. However, serious complications can occur with their use. One such complication is central line associated bloodstream infection (CLABSI). Although the attributable mortality associated with these infections is likely not affected, the economic costs and morbidity can be substantial.

In 2000, the estimated number of CLABSI in intensive care units (ICU) in the United States per year was 80,000. Since that time, both behavioral and technological interventions have resulted in reduced CLABSI rates. For example, an estimated 25,000 fewer CLABSI occurred in 2009 in US ICUs than occurred in 2001[1]. Hand hygiene, education programs[2-4] and use of maximum barrier precautions[5], catheter bundles[6] and check lists[7] are some of the behavioral changes that have resulted in reductions in CLABSI. Technological advances include aqueous or alcoholic chlorhexidine solutions for skin preparation[8, 9], chlorhexidine patches for catheter site care[10] and antiseptic or antibiotic impregnated catheters[11,12].

Although these aforementioned studies showed significant reductions in CLABSI, the rates remain relatively high. In this study we describe our approach toward reducing CLABSI rates in the intensive care units at UMass Memorial Medical Center, Worcester, MA.

Methods

In 2004, a critical care operations committee (CCOC) was formed at UMass Memorial Medical Center with the intent on providing standardized care to our critically ill patients by developing clinical practice guidelines based on the best published medical evidence[13]. This committee is multidisciplinary and includes physicians, nurses, pharmacists, occupational and physical therapists, hospital administrators and patient representatives. One of the earliest developed committees was charged with reducing the rate of CLABSI. Interventions (Table 1) that were incorporated into the initiative over time included an education program (that also emphasized hand hygiene), use of a dedicated catheter cart that has all of the necessary supplies, catheter insertion using maximum barrier precautions, pre-procedural time out, use of a check list during catheter insertion, empowering the bedside nurse to stop the procedure if elements in the checklist were not followed, incorporation of chlorhexidine solutions for skin preparation and chlorhexidine sponges for catheter dressings, tracking of high risk catheters (i.e. those were inserted during emergencies or in the femoral vein), treating a CLABSI as a critical event and holding a root cause analysis after each one to discern the cause, use of the subclavian vein as the preferred site of catheter insertion, documentation of the catheter insertion with a standardized procedure note, and daily assessment as to the need of the central venous catheter.

Catheter days were tracked by infection control practitioners and were put into a database that was managed by the eICU data coordinator. Definitions of CLABSI were those as published by the Centers for Disease Control and Prevention (Table 2). A panel of physicians that was led by the hospital epidemiologist adjudicated cases of suspected CLABSI. Data were presented to the CCOC on a quarterly basis and to the individual ICUs on monthly basis by means of an electronic newsletter. In addition, the data could be viewed on the CCOC intranet website.

The number of catheterizations was modeled using general linear models with first and second order slopes fit for each type of catheter type to detect linear trends and changes to those trends. Differences in infection rates were evaluated with a Poisson test. The trend in catheter blood infection rates was modeled using Poisson regression.

The distributional assumptions of methods used were evaluated using the Kolmorov-Smirnov goodness of fit test for normality and by visual inspection of frequency histograms, both performed on residuals from models fit to the appropriate design. Poisson regression was performed using LogXact. Linear models were fit using the Mixed procedure (SAS).

Results

From 2004 to 2011 the rate of CLABSI declined significantly from 5.86 to 0.6 infections per 1000 catheter days (p<0.0001). There was a significant consistent downward trend (0.4 fold decrease per year) in the rate of infections (p<0.0001) (Figure 1).

The number of catheterizations differed significantly by type, with approximately eight times as many CVCs being performed than peripherally inserted central catheters (PICCs) (p<0.0001). From 2008 to 2009 catheter usage significantly increased (p=0.0009) whereas from 2010 to 2011 it dropped significantly (p=0.0015). However, the number of PICCs did not significantly change in frequency over time (Figure 2). Table 3 shows the longest CLABSI-free time and APACHE III scores for individual units. Microbiology data are presented in Table 4.

TABLE 1: Key Milestones and Interventions

Year	Milestone and Intervention
2004	CCOC started 9/13
2005	• Bloodstream Infection (BSI) clinical practice guideline (CPG) program recommendations made to the CCOC 2/16 • Standardize education on central venous catheter (CVC) insertions. • Use of maximum barrier precautions during CVC insertions • Use of chlorhexidine skin prep • Use of chlorhexidine sponge for dressing • Empower nurses to monitor catheter placement and stop the procedure when deemed appropriate • Complete a quality assurance (QA) checklist during CVC insertion • Documentation of insertion via a standardized procedure note • Assess need for central or arterial catheters on a daily basis • Avoid femoral catheters whenever possible; the preferred site is the subclavian vein
2006	• BSI CPG approved • E-learning module active 4/4 • Quality rounds focus on CLABSI
2007	• Standardized use of antibiotic or antiseptic catheters in catheter cart 2/28 • Tracking of high risk catheters by location, placement and duration 5/07 • Positive blood cultures reviewed by eICU LIP staff daily 9/07
2008	• BSI eLearning module activated for MDs, residents, affiliate practitioners and fellows 4/08 • UMMMC begins public reporting of CLABSIs to the Mass DPH 7/08 • eICU BSI tool developed 4/08 • Critical event analysis for each CLABSI 4/08 • Atlas of pictures on standardized central line dressing 8/08 • Interventional radiology implemented PICC improvement process
2009	• Reporting of blood culture contamination rates at the CCOC 1/09 • Implement a reporting system on staff completion of eLearning training program 3/09 • Use of only minocycline/rifampin (MR) catheters 6/09 • Transparent occlusive dressing with chlorhexidine (CHG) replaces CHG sponge dressing
2010	• CPG initiated in the Emergency Department (ED) 9/10 • Quality rounds in the ED 10/10 • ED procedure note revised 12/10
2011	• MR catheters used in ED 2/3 • BSI bundle compliance may be obtained via electronic procedure note 4/21

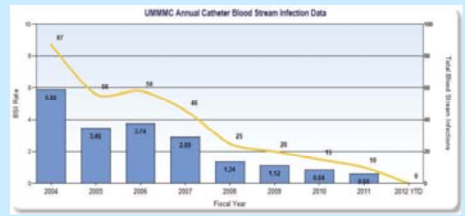

Figure 1

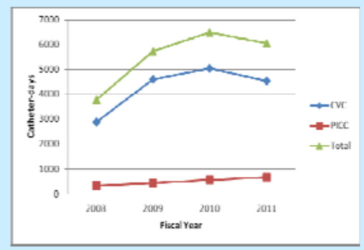

Figure 2

TABLE 3: CLABSI-Free Time and APACHE III Scores

Unit	Current 12 month rolling mean CLABSI rate (events/1000 catheter-days)	Longest time free of CLABSI (Days)	Second quarter 2011 APACHE III score
Neuro-Trauma	1.0	381	53.7
General and Transplant	0.4	334	66.2
Cardiothoracic	0.4	729	52.5
Medical 1	0.6	329	69.9
Medical 2	1.1	329	68.8
Pediatric	0.0	1432	N/A
Medical/Surgical	0.0	788	53.8
Medical 3	0.4	327	59.9

TABLE 2: Definitions of CLABSI

Criterion 1	Patient has a recognized pathogen cultured from one or more blood cultures and the cultured organism is not related to an infection at another site
Criterion 2	Patient has at least one of the following signs or symptoms: fever (>38ºC), chills or hypotension; and signs and symptoms and positive laboratory results are not related to an infection at another site; and common skin commensal is cultured from two or more blood cultures drawn on separate occasions
Criterion 3	Patient $\le$ 1 year of age has at least one of the following signs: fever (>38ºC core), hypothermia (<36ºC core), apnea or bradycardia; and the signs and symptoms and positive laboratory results are not related to an infections at another site; and common skin commensal is cultured from two or more blood cultures drawn on separate occasions.

TABLE 4: Microbiology of CLABSI

Pathogen	2004	2005	2006	2007	2008	2009	2010	2011
Coagulase Negative Staph aureus	√	√	√	√	√	√	√	√
Staph aureus	√	√		√	√		√	
Methicillin-Resistant Staph aureus	√	√	√	√	√			
Enterococcus	√	√	√	√	√	√		√
Vancomycin Resistant Enterococcus	√		√	√		√	√	√
Candida species	√	√	√	√	√	√	√	√
Serratia marcescens	√							
Pseudomonas aeruginosa	√	√		√				
Klebsiella pneumoniae	√		√					
Proteus mirabilis			√			√		
Group B streptococcus			√					
Pseudomonas putida			√					
Enterobacter cloacae			√	√				
Citrobacter freundii				√				
Extended Spectrum Beta Lactamase Klebsiella pneumoniae				√	√			
Escherichia coli				√		√	√	√
Streptococcus viridans					√			
Enterobacter agglomerans					√			
Enterobacter aerogenes						√		

Discussion

Similar to other published reports, the primary finding of our study is that a multimodal approach to the insertion and care of central venous catheters will result in significant reduction in rates of CLABSI. However, our study is different in several important ways from previous investigations. Other investigations included a single ICU that did not use antiseptic catheters[3, 6] or were collaborative cohort studies which included a large number of different ICUs (community hospitals versus tertiary medical centers)[7]. In addition to the elements of the Pronovost study[7], we included use of chlorhexidine sponges and antibiotic impregnated catheters. The time period in our study is also the longest for studies of this type.

The neuro-trauma unit has one of the highest CLABSI rates in the medical center yet has one of the lowest APACHE III scores. The lower APACHE III score likely reflects the fact that stroke patients are also admitted to this unit, which would "dilute" the acuity of the patient population. Since the protocol as to how we care for these catheters does not change from unit to unit, it is surprising that the rates are as high as they are in the neuro-trauma unit and the Medical 2 ICU particularly since similar units have a much lower rate. We do not have a ready explanation for this finding.

Our CVC utilization rate peaked in 2010 and decreased in 2011. This observation is most likely the result of better adherence to catheter removal when indicated and to an increasing reliance on PICCs.

In summary, use of a multimodal approach to catheter care resulted in over an 89% decrease in CLABSI over a 7-year period.

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