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Successful Implementation of a Unit-based Quality Nurse to Reduce Central Line-associated Bloodstream Infections

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Abstract

Background—Central line-associated bloodstream infections (CLABSI) are an important cause of patient morbidity and mortality. Novel strategies to prevent CLABSI are needed.

Methods—We described a quasi-experimental study to examine the effect of the presence of a unit-based quality nurse (UQN), dedicated to perform patient safety and infection control activities with a focus on CLABSI reduction, on CLABSI rates in a surgical intensive care unit (SICU).

Results—From July 2008 to March 2012 there were 3257 SICU admissions; central line (CL) utilization ratio was 0.74 (18,193 CL days/24,576 patient days). The UQN program began in July 2010; the nurse was present for 30% (193/518) of the days of the intervention period of July 2010 to March 2012. The average CLABSI rate was 5.0 per 1000 CL days before the intervention and 1.5 after the intervention; and decreased by 5.1% ($p = 0.005$) for each additional 1% of days of the month that the UQN was present, even after adjusting for CLABSI rates in other adult ICUs, time, severity of illness, and On the CUSP participation (5.1%, $p = 0.004$). Approximately 11.4 CLABSIs were prevented.

Conclusions—The presence of a UQN dedicated to perform infection control activities may be an effective strategy for CLABSI reduction.

Healthcare-associated infections (HAI) are among the most common complications of hospital care. Nearly 2 million patients develop an HAI each year in the US and approximately 99,000 of them will die as a result ¹. Among HAIs, central line-associated bloodstream infections (CLABSI) are an important cause of morbidity, mortality and increased healthcare cost ^{2,3}. It is estimated that 80,000 infections related to central venous catheters occur in intensive care unit patients each year and these infections are associated with a mortality rate as high as 25%³

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In 2006, Pronovost and colleagues demonstrated a two-thirds reduction in CLABSI rates following an intervention to enhance compliance with proven infection prevention practices⁴. Since then, the use of a checklist to assist with compliance of best practice measures during central line insertion has become standard of care. Despite implementing this best practice, many centers still report high CLABSI rates (http://www.cdc.gov/hai/pdfs/stateplans/SIR_05_25_2010.pdf). Adding to standard implementation of best practices including the “checklist”, a recent multi-faceted approach to improve overall unit culture of safety (i.e. Comprehensive Unit-based Safety Program) was shown to significantly reduce CLABSIs⁵. At our own institution, we noted that CLABSI rates remained above national benchmarks despite implementing a best practice bundle, involving unit champions and educating staff. To combat this we adopted a unique unit-based quality nurse, dedicated to prevention of CLABSI, in the surgical intensive care unit (SICU) as part of our strategy. In this report we discuss our findings related to the effect of this unit-based quality nurse on SICU CLABSI rates using a quasi-experimental study design with a non-equivalent control group. We hypothesize that the presence of the unit-based quality nurse will result in a decrease in CLABSI rates in the SICU. To our knowledge, this is the first study to investigate the use of a single, unit-based nurse dedicated to HAI prevention.

Materials and Methods

We conducted a quasi-experimental study of all patients admitted to the SICU at the University of Maryland Medical Center (UMMC) from July 2008 to March 2012. The UMMC is a 757-bed tertiary care facility, with 333 intensive care beds, located in Baltimore, Maryland. The SICU is a 19-bed unit that provides care to adult patients who have undergone solid organ transplantation, abdominal, genitourinary, orthopedic and otolaryngologic surgery. This study was determined by the University of Maryland Institutional Review Board to be non-human subject research since the intervention and data collection were performed as a quality initiative.

Description of the Problem

Beginning July 2009, CLABSI reduction became an institutional priority. A White Paper outlining a collaborative approach to CLABSI reduction was issued jointly by physician and nursing leadership, key clinical leaders and the hospital epidemiologist. The White Paper emphasized best practices aimed at reducing CLABSI and included the following: practicing appropriate hand hygiene, use of chlorhexidine for skin antisepsis, use of maximal sterile barrier precautions during insertion, avoidance of the femoral vein as an access site and prompt removal of unnecessary catheters. A checklist was required for all central-line insertions in the ICU. Additional measures employed across all ICUs using a bundled-approach included: use of chlorhexidine-impregnated dressings, use of antimicrobial-coated catheters and monthly point-prevalence audits. Further, for each ICU unit-based CLABSI champions were identified. One nurse and one physician leader from each unit with an interest in CLABSI prevention was identified as a “champion”; the role of the “champion” was to act as a liaison between infection prevention and unit-based staff. One year after implementation of this effort, CLABSI rates in the SICU remained above the national benchmark provided by the Centers for Disease Control and Prevention National Healthcare Safety Network (NHSN). In response, the SICU leadership team assessed and revised strategies resulting in the creation of a new position, a unit-based quality nurse.

Description of the Intervention

Beginning July 2010, rotating senior clinical nurses from the SICU were assigned to the new role. During the initial period, this position was filled by 10 rotating nurses, with a single nurse filling the role from November 2011 until the end of the study period. The unit-based

quality nurse worked 8-hour weekday shifts in which they were dedicated to perform patient safety and infection control activities with a focus on CLABSI reduction. When the nurse was assigned to the task of unit-based quality nurse they were relieved of other duties, including direct patient care. The duties of the nurse were developed by SICU leadership in collaboration with an infection preventionist and hospital epidemiologist. Specific training for the unit-based quality nurse was performed in individual sessions with the SICU Medical Director and the Director of Infection Prevention. Included in the training was a formal lecture on “*Maintaining Sterility and What to Look For During Central Line Insertion*”; nurses also received specific instruction in the evaluation of catheter maintenance (e.g. site care).

In general the goal of the nurse was to help create a culture of safety within the SICU across all disciplines. The unit-based quality nurse helped to educate the SICU staff, increasing awareness of HAIs and arming staff with the knowledge to prevent these infections. They also observed compliance with best practices (e.g. hand hygiene, completion of central line insertion checklist and catheter maintenance) and provided immediate, direct feedback to staff. Other specific activities included: attending daily rounds with the clinical team, performing daily assessments of central line necessity, observing central line insertions (physicians were instructed to page the nurse for all insertions) and routinely monitoring central line dressings for appropriate practices.

Education of SICU nursing staff around CLABSI prevention was coordinated by the unit-based quality nurse and included the following. All SICU nurses were required to complete the same training expected of physicians on central line insertion practices so that they would be better equipped to observe central line insertions and be able to identify breaches in sterility; these trainings included watching a 15 minute video on central line insertion provided by the *New England Journal of Medicine* (<http://www.nejm.org/doi/full/10.1056/NEJMc055053>) and completing a UMMC-developed web-based training course on central line care and maintenance. In addition, all SICU nurses were required to complete one-on-one training with the unit-based quality nurse on central line maintenance care including post-education assessment to evaluate competency. Furthermore, the unit-based quality nurse performed weekly Safety Rounds with all nursing staff; during these rounds, in addition to routine CLABSI prevention messages, any new CLABSI was discussed with the staff with a focus on how each infection may have been prevented.

In December of 2010, the SICU joined the On the CUSP (Comprehensive Unit-based Safety Program) CLABSI Initiative as well. No other unit-based initiatives around CLABSI prevention were initiated during the study period.

Description and Analysis of the Data

Bloodstream infections were classified as CLABSIs by the hospital infection preventionists according to NHSN criteria⁶. In brief, CLABSIs are defined by the CDC as a bloodstream infection (i.e. a pathogen identified in a blood culture) in a patient that has a central venous catheter at the time of or within 48 hours prior to the positive blood culture, in the absence of infection at another site. Monthly CLABSI rates are reported as number of CLABSIs per 1000 central line days. In addition to calculating SICU CLABSI rates, CLABSI rates were calculated for all other adult ICUs at UMMC (1 medical, 1 cardiac, 1 neurosurgical, 1 cardiothoracic surgical, and 3 trauma ICUs). The Acute Physiology and Chronic Health Evaluation (APACHE) III score was used as a measure of severity of illness and was extracted from the APACHE III database, a prospectively gathered quality analysis database⁷. Collection methods for all data elements were the same for all periods of study and analysis. The effect of the unit-based quality nurse (defined as the proportion of days in the month the nurse was present on the unit) on the SICU CLABSI rate was estimated using

overdispersed Poisson regression after adjusting for time (study month), severity of illness (APACHE III), participation in On the Cusp and CLABSI rate in all other adult ICUs (non-equivalent control) ⁸. The latter was done to adjust for facility-wide efforts at preventing CLABSIs.

Results

There were 3257 admissions to the SICU, and 25251 admissions to all ICUs, from July 2008 to March 2012. On average there were 69 admissions per month to the SICU before the unit-based quality nurse intervention (July 2008 to June 2010) and 76 admissions per month after the intervention (July 2010 to March 2012). The average APACHE III score at admission to SICU (day 1 of admission) was 59.5; average admission APACHE III score was 58.8 before the intervention and 60.4 after the intervention. There was no significant trend in the average APACHE score over time, and around the intervention. The central line utilization ratio for the SICU was 0.74 (18,193 central line days/24,576 patient days) over the study period; 0.82 (10,622/13,086) before and 0.66 (7,571/11,490) after the intervention. The central line utilization ratio for all other units was 0.63 (157,298/248,427). The unit-based quality infection prevention nurse (i.e. the intervention) was present on the unit for 30% (193/518) of the days of the intervention period (range per month 0 to 61%).

The average CLABSI rate in all adult ICUs combined (excluding the SICU) was 3.9 per 1000 central line days throughout the study period; and these CLABSI rates decreased approximately 4.8% (95% CI: 3.4%–6.2%, $p < 0.001$) per month over this time period (See Figure for CLABSI rates over time). The average SICU CLABSI rate was 3.6 per 1000 central line days throughout the study period. Prior to the unit-based quality nurse intervention the average monthly SICU CLABSI rate was 5.0 per 1000 central line days; and increased by 0.4% per month from July 2008 to June 2010 (i.e. just prior to intervention) that was not statistically significant. Following introduction of the unit-based quality nurse, the average monthly SICU CLABSI rate was 1.5 per 1000 central line days (a 70% reduction). The SICU CLABSI rate decreased by 5.1% (95% CI: 0.8% – 9.2%, $p = 0.005$) for each additional 1% of the days of the month (31 days) that the unit-based quality nurse was present. As an example, if a unit-based quality nurse worked part-time (roughly 12 days per month, which would be 39% of a 31-day month), then you would expect only 31% $\{= (0.051)^{(39)} \times 100\}$ of the infections seen without the nurse intervention (a 69 % reduction, similar to the unadjusted estimate). After adjusting for CLABSI rates in other adult ICUs, time (study month), severity of illness, and participation in On the CUSP, the decrease in average monthly SICU CLABSI rate per nurse percentage working days of the month remained 5.1% (95% CI: 1.9% – 8.2%, $p = 0.004$) relative decrease for each additional day per month (31 days). The effect on CLABSI reduction was not sustained when the unit-based quality nurse was not present (see Figure). By extrapolating the data prior to the unit-based quality nurse intervention and subtracting the observed number of CLABSIs after the intervention, we estimate that 11.4 CLABSIs were prevented in this patient population in one year as a result of the nurse intervention. There was no statistically significant effect of the presence of the unit-quality nurse on CLABSI rates in all other adult ICUs regardless of accounting for overall reduction in CLABSI rates.

Using the estimate of 11.4 CLABSIs prevented in one year and assuming the estimated mean attributable cost of each CLABSI episode is \$18,000 (2005 US Dollars), in one year a total of \$205,200 could be saved by the presence of the unit-based quality nurse⁹.

Discussion

HAIs, including CLABSI, are largely preventable; with adherence to evidence-based best practices and infection prevention “bundles”, up to 70% of these infections may be avoided¹⁰. Although CLABSI prevention “bundles” have demonstrated the capacity to prevent infection⁴, the continued prevalence of CLABSIs in hospitals nationwide suggests implementation of these strategies may be problematic (Dudeck, NHSN report, 2010). In fact, a report by McGlynn and colleagues demonstrated that adult patients in the US receive recommended care only 54% of the time¹¹. Here we show that the presence of a single, unit-based clinical nurse dedicated to ensuring that these best practices are followed resulted in a significant reduction in CLABSI. In fact, while total number of admissions to the SICU increased and the severity of illness (admission APACHE) of the patients on the unit remained the same, device day utilization and CLABSI rates decreased after the intervention of a unit-based quality nurse. In our model, a part-time unit-based quality nurse led to a 70% reduction in CLABSI even after adjusting for decreasing CLABSI rates in other ICUs, time, participation in On the Cusp and severity of illness. Further, in our model there were 8 consecutive months in which the unit-based quality nurse worked full time (3 days out of a 7-day work week) and during that time period there was only a single CLABSI among 2,833 central-line days for a rate of 0.0003. In addition, we showed that the presence of the unit-based quality nurse prevented 11.4 CLABSI episodes in one year. Assuming the estimated mean attributable cost of each CLABSI episode is \$18,000 (2005 US Dollars), in one year a total of \$205,200 could be saved by the presence of the unit-based quality nurse; a dollar amount significantly higher than the \$70,000 average annual salary for a medical/surgical registered nurse in the US ⁹(<http://www.bls.gov/oes/current/oes291111.htm>).

Many units struggle to reach benchmarks in best practices and oftentimes feel the goals are unrealistic. “Our patients are sicker or different” is a phrase often heard. In fact, this unit has previously published risk factors for CLABSIs in the era of the “checklist” and other best practices¹². These risk factors included severity of illness, need for emergency surgery and the open abdomen. In the present report, we show that even in a high-acuity tertiary care ICU with a high severity of illness (the average day 1 Acute Physiology Score, APS, for this unit was 50 during the study period compared to mean scores in the literature between 33 and 40), significant reductions in CLABSI rates are possible¹³.

To our knowledge, this is the first study to show that a single, unit-based nurse dedicated to patient safety and infection prevention tasks can have a significant impact on HAI rates. Although a newer concept in the US, infection control ‘link nurses’ have been used in other countries to act as a liaison between clinical areas and the infection control team¹⁴. More recently, data from US centers has shown that nurse-driven change in unit culture can lead to improvement in other patient outcomes such as reduction in CLABSI and catheter-associated urinary tract infections (CAUTI) and decreased transmission of multidrug-resistant organisms ^{5,15,16}, supporting our findings. In a recent study, Marsteller and colleagues reported an association between unit participation in the On the CUSP “Comprehensive Unit-based Safety Program”, a unit-driven interdisciplinary program designed to promote change in unit culture toward improvements in patient safety, and reduction in unit CLABSI rates ⁵. Results from this study suggest that in addition to these activities, improvement in safety may be achieved by designating a new nursing position (i.e. the unit-based quality nurse) to promote change. While this unit participated in the On the CUSP program starting December 2010, a decline in CLABSI rates was seen prior to participation. Furthermore, despite ongoing participation, CLABSI rates increased during times when the unit-based quality nurse was not present. This data also supports the idea that while the “checklist” is critical, it is the content of and compliance with the checklist that drive improvements in patient outcomes.

A unit-based quality nurse dedicated to patient safety and infection prevention tasks may have other potential benefits that are worthy of future investigation. First, this intervention may be theoretically expanded to the prevention of other HAIs and to other quality initiatives such as fall prevention and avoidance of medication errors a potential area for further investigation. Second, having a dedicated unit-based nurse to assure compliance with and document adherence to infection control protocols may relieve some of the pressure placed on already over-extended critical care nurses to complete these tasks, freeing up time for direct patient care activities. Further, interruptions in nurse-directed patient care have been associated with nurse burnout, which in turn has been linked to patient dissatisfaction, increased medical errors and increased rates of HAIs^{17–20}.

There are several limitations to this study. First, this intervention was performed in a single ICU at a single medical center and may not be generalizable to other areas. Second, hospital-wide CLABSI reductions efforts may have contributed to declining CLABSI rates in the SICU. However, by examining the effect of the intervention on SICU CLABSI reduction while adjusting for CLABSI rates in other ICUs (non-equivalent control group) we showed that this effect was independent of efforts external to the SICU. Finally, while the effect of the intervention on CLABSI reduction was pronounced, this effect was not sustained during periods when the nurse was not present. While this supports the positive effect of the nurse on CLABSI prevention, further investigation is needed to understand how this effect can be sustained.

Conclusions

Presence of the unit-based quality nurse was highly correlated with CLABSI reduction, even after accounting for overall reduction in CLABSI across ICUs, time and severity of illness. A unit-based quality nurse should be considered in the armamentarium against CLABSI, particularly in areas with high-risk patients and in those areas with high CLABSI rates refractory to other measures.

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All authors report no conflicts of interest relevant to this article.

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Figure 1.

Impact of SICU Unit-based Quality Nurse on CLABSI Rate

Top Panel: Monthly CLABSI rates from July 2008 to March 2012 (black = SICU; grey = All other adult ICUs). Enhanced CLABSI reduction efforts began in all ICUs in July 2009. The intervention, the SICU unit-based quality nurse, began in July 2010

Bottom Panel: The proportion of days per month (31 days) that the SICU unit-based quality nurse was present on the unit

Abbreviations: SICU = surgical intensive care unit; CLABSI = central line-associated bloodstream infection; BSI = bloodstream infection; CL = central line; UBQN = unit-based quality nurse