Research Article

The Reduction of Catheter-Related Blood Stream Infections through the Implementation of an Interdisciplinary Healthcare Team

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In December 2012, a multidisciplinary task force was implemented to address the elevated number of central line associated bloodstream infections (CLABSIs) at Newark Beth Israel Medical Center from January 2012 to December 2012. Sixty-eight CLABSIs were documented within the adult inpatient population, resulting in a rate of 14.7 CLABSIs/1,000 central line days in the adult inpatient population. This was well above the national average of 1.87 infections per 1,000 central line days. Most of these infections were noted to be within the critical care units where the rate was at 2.86 CLABSIs/1,000 central line days. However, in 2013, the annual rate was decreased to 0.709 CLABSIs/1000 line days ($P < 0.001$) with similar trends observed across the critical care units.

Analysis of CLABSI data indicates that the implementation of a multidisciplinary task force dedicated to appropriate central line insertion, maintenance, and the removal of unnecessary central venous catheters can have an impact on reducing rates of CLABSIs throughout the adult inpatient population, including those within critical care units.

1. Background

Hospital associated infections (HAIs) are defined by the CDC as “infections that patients develop while they are receiving care in a health care setting for another condition with the estimated incidence of HAIs in the United States in 2012 being 4.5 per 100 patients” [1]. In 1950, the American Hospital Association recommended that hospitals begin surveillance for HAIs due to a surge in infections caused by Staphylococcus aureus seen in postoperative patients. Today, bloodstream infections represent 14% [1] of all HAIs in the United States. Most of these bloodstream infections have been associated with central venous catheters (CVCs), which are defined by the National Healthcare Safety Network (NHSN) as “intravascular catheters that terminate at or close to the heart or in one of the great vessels which is used for infusion, withdrawal of blood, or hemodynamic monitoring” [2]. In the US alone, the associated cost attributed to HAIs in 2012 was approximately 28–33 billion dollars [3]. HAIs continue to be a significant source of morbidity and mortality in the US Healthcare system. Bloodstream infections are divided into two categories: central line associated bloodstream infections (CLABSIs) and catheter-related bloodstream infections (CRBIs). The term CLABSI refers primarily to bloodstream infections in a patient with a central line in place within the 48-hour period before onset of the bloodstream infection that is not related to infection at another site. CRBIs, on the other hand, are bloodstream infections that require specific laboratory testing to identify the catheter as the origin of the infection; this testing is not a part of the criteria for a CLABSI. It is estimated that 41,000 CLABSIs occur in U.S. hospitals annually with an associated cost of $16,550.47 per infection and an increased length of stay [4]. These infections have been associated with an estimated inpatient mortality rate of...
12–25% [5]. For the purposes of surveillance, the definition of a CLABSI is more practical, but it comes with its own limitations. It has been noted by the Joint Commission that this definition may overestimate the actual rate of infections from central lines as opposed to another remote site.

In 2012, at Newark Beth Israel Medical Center (NBIMC), a total number of 68 CLABSIs were recorded in the adult population, and the resulting total represented a figure above the national benchmark. This elevated number of infections prompted the question, “what can we do as a teaching institution to reduce the rate of these bloodstream infections?” In 2011, in the Clinical Journal of Infectious Disease, Mermel et al. made an important note that the pathogenesis of catheter infections is a multifactorial process where both intraluminal and extraluminal causes must be investigated [6]. For this reason, we focused on multiple strategies targeted at reduction. A multidisciplinary CLABSI prevention task force was formed to examine our practices with regard to central line insertion, maintenance, and removal, and to implement a stringent policy that promoted tight adherence to CDC practice bundle elements with a unified approach that involved physicians and nurses actively monitoring each hospital unit. The objective of this paper is to evaluate the impact the implementation of a multidisciplinary task force dedicated to appropriate central line insertion can have on reducing rates of CLABSIs.

2. Methods

This study took place at NBIMC, a single center site with an urban patient population, from January 2012 to December 2013. This teaching hospital is university-affiliated and has 673 beds and approximately 23,000 annual admissions. This facility employs 149 full-time physicians and 96 part-time physicians, along with 855 full-time registered nurses and 239 part-time nurses.

All patients admitted to any adult unit, including the Intensive Care Units, from January 2012 to December 2013 were included in this study. The control period was January through December 2012, and the intervention period, after development of the CLABSI Task Force Prevention Team, was from January through December 2013. Patients who were seen solely on an outpatient basis were not included in this study (e.g., outpatient hemodialysis and individuals receiving chemotherapy). Patients admitted to the inpatient population of NBIMC but who did not receive a central line during their admission, or who were admitted before January 2012 and after December 2013, were also not included. CLABSIs were defined as recovery of a pathogen from a blood culture (a single blood culture for organisms not commonly present on the skin) in a patient who had a central line at the time of infection or within the 48-hour period before development of infection. The infection could not be related to any other infection the patient might have and must not have been present or incubating when the patient was admitted to NBIMC. All CLABSIs were documented.

Initially, the interdisciplinary task force met weekly starting in December 2012, and each unit was assigned champions [8] who were responsible for reviewing every central line inserted, promoting the removal of unnecessary lines, and conducting a review of any potential CLABSIs (positive blood cultures in patients with central lines).

The use of evidence-based insertion and maintenance bundles was paramount to the success of the task force initiative and helped to standardize central line care within all units of NBIMC. Bundles were defined previously as “groupings of best practices with respect to a disease process that individually improve care, but when applied together result in substantially greater improvement” [9]. The science supporting the bundle of components is sufficiently established to be considered the standard of care [9]. The CVC insertion bundle used at NBIMC included the following best practices: hand hygiene, the use of Aseptic technique (which includes maximal barrier protection and preparation of the skin with chlorhexidine, specifically 2% concentration), the use of ultrasound guidance with all line insertions, the placement of a biopatch [10–13] at all line entry points, avoidance of the femoral vein for use as an insertion site, and prompt removal of all CVCs not deemed unnecessary by the task force. The maintenance bundle used at NBIMC was based on a previous construct from the CDC 2002 guidelines which includes: assessing the continued need for the catheter every day, performing catheter site care with chlorhexidine at dressing changes and changing gauze dressings every 2 days and clear dressings every 7 days (and more frequently

(i) ICU Director led interdisciplinary rounds and querie
d each of the practitioners as to their specialty area.

(ii) Infectious Control representatives and Infectious
Disease attendings gave information about whether
active infections were considered to be community
versus hospital acquired and whether or not infec-
tions were related to catheters.

(iii) The nursing staff provided the front line presentation
of the patient’s active medical problems, current evi-
dence of infection, and daily white blood cell count
and fever curve. From this group, hospital unit cham-
pions were elected.

(iv) Pulmonary Critical Care attendings and fellows en-
sured that all physicians performing central lines were
adequately trained and became accredited in CVC
insertion. Accreditation was achieved by performing
10 assisted central line insertions with supervision
from any accredited physician.
if soiled, damp, or loose). Using a 2% chlorhexidine for daily skin cleansing was established by Munoz-Price et al. after they evaluated the effect of chlorhexidine bathing of patients on the rate of CLABSI in a 70-bed long-term acute care hospital [14]. Their work demonstrated that this intervention reduces the rate of CLABSI from 9.5 to 3.8 per 1,000 catheter days. Also included in our maintenance bundle was the replacement of administration sets and add-on devices no more frequently than every 72 hours unless contamination occurred. Replacing tubing used to administer blood, blood products, or lipids within 24 hours of start of infusion was also monitored, along with changing IV port protectors no more often than 72 hours (or according to manufacturer’s recommendations and whenever the administration set was changed).

A part of the task force initiative included thorough education of all team members on best practices, which was accomplished through several mediums including the following: weekly meetings with all members of the task force initiative; informational displays visible on every adult inpatient unit, including the critical care floors; and mandated certification in central line insertion for all physicians, including residents and fellows. Hand washing was emphasized to all staff members of NBIMC through the CINCO (clean in and clean out) protocol. CINCO is a pinnacle part of the insertion bundle, as it should be conducted prior to palpating the site of catheter insertion, before and after inserting the catheter, and before and after accessing, replacing, repairing, or dressing the catheter.

2.1. Data Collection. A retrospective analysis of data from January 2012 to December 2012 was conducted. Data from January to December 2013 was collected and analyzed. The data collected during both periods included the date of admission, date of the first positive culture, organism confirmed on culture, the site of the central line, and evidence of compliance with bundles. During data collection, each CLABSI was specified by the organism present on culture and grouped by their Gram stain and morphology, as previously done by other examples in the literature [15]. Compliance with bundle elements was monitored through three forms: central line insertion note, nursing checklist, and time out form. A copy of the nursing checklist and insertion note is included in this discussion. The central line note was used as a tool to verify that physicians inserting these lines documented the location of the inserted line and that the elements of the insertion bundle were completed effectively. The nursing checklist was designed with an additional focus—it required the nurse to verify that insertion and maintenance best practices were occurring with every line. If the procedure was compromised in anyway, as in whether a time out was not performed or maximal sterile barrier precautions were compromised, the nurse also would ensure that the insertion would be stopped. Overall, adult rates of CLABSI hospital-wide, CLABSI in all critical care areas, and CLABSI that occurred exclusively in medical/surgical Intensive Care unit were collected. All three areas were compiled to show the rate per quarter of CLABSI within all adult units at NBIMC.

### Table 1: Number of CLABSI in the adult population at NBIMC.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of CLABSI in all adult units</td>
<td>68</td>
<td>18</td>
</tr>
<tr>
<td>Total number of CLABSI in the critical care units</td>
<td>32</td>
<td>7</td>
</tr>
<tr>
<td>Total number of CLABSI in the medical/surgical units</td>
<td>36</td>
<td>11</td>
</tr>
</tbody>
</table>

### Table 2: Number of CLABSI within critical care units.

<table>
<thead>
<tr>
<th>Units</th>
<th>Number of CLABSI in 2012</th>
<th>Number of CLABSI in 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical surgical ICU</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>Cardiothoracic ICU</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Coronary care unit</td>
<td>12</td>
<td>5</td>
</tr>
</tbody>
</table>

### Table 3: Location of central venous catheters in CLABSI patients.

<table>
<thead>
<tr>
<th>Sites of lines</th>
<th>Quantity seen in 2012 CLABSI patients</th>
<th>Quantity seen in 2013 CLABSI patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal jugular</td>
<td>31</td>
<td>9</td>
</tr>
<tr>
<td>Subclavian</td>
<td>24</td>
<td>9</td>
</tr>
<tr>
<td>Femoral</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>External jugular</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Unknown</td>
<td>19</td>
<td>0</td>
</tr>
</tbody>
</table>

2.2. Statistical Analysis. Data were expressed as means and standard deviations (SD) for continuous variables and percentages for qualitative variables. We used Student’s t-test for comparisons of two means and the Chi-square test to compare proportions. Critical alpha was set to $P < 0.05$.

3. Results

The number of CLABSI cases within the adult population by unit at NBIMC for the pre- and postintervention periods is provided in Table 1. The highest number of CLABSI in the preintervention period was observed in the Medical Surgical ICU ($n = 36$), which represents 22% of all central line-associated bloodstream infections seen in 2012 at NBIMC (see Table 2). This percentage is not surprising, as the ICU is the focus of many major landmark studies centered on reduction strategies [16]. This focus on ICU units is due to the fact that while bloodstream infections can occur in multiple demographics; CLABSI with organisms that have antimicrobial resistance occur more within the ICU than in the general inpatient population [17]. The sites of line placement are provided in Table 3. A statistically significant decrease in the overall number of CLABSI from the preintervention period ($M = 14.7/1000$ line days) to the postintervention period...
The results of this study demonstrate that the implementation of a multidisciplinary CLABSI prevention task force reduced the rates of infection from an average of 2.7359 infections per month to 0.7071 infections per month in 2013. This success can be attributed to the implementation of the multidisciplinary task force that focused on implementing evidence-based strategies based on 2011 CDC guidelines and ensuring compliance with these measures. While maximal sterile barrier precautions and the use of chlorhexidine 0.5% have been shown to reduce infections in prior studies, these strategies alone do not explain the dramatic improvement in the rates of infection between pre- and postintervention periods in our study. Without the task force addressing the issue of education, it is predicted that these results would be less dramatic and even more so less permanent [18, 19]. When providers are not appropriately educated in best practices and sterile techniques, this increases the risk for insertion-related contamination from improper skin decontamination and breaks in the sterile field, an increased number of skin punctures, and increased manipulation of the catheter during insertion, all of which increase the risk of catheter-related bloodstream infections [20]. Therefore, one of the requirements of providers at NBIMC is that they become certified in central venous catheter insertion. This certification is granted specifically to providers that display competence in insertion of CVCs and have performed insertion of at least 10 central venous catheters using ultrasound guidance [13] under direct supervision from a certified attending or fellow. All central venous catheters inserted during this study period were performed by physicians who were accredited in central venous catheter insertion.

Another strategy that had a profound impact on the rates of infection was the completion of a time out prior to procedure and a central line insertion note was completed after insertion of a central venous catheter. Nurses are central in hospital efforts to improve quality care and “empowering the nurse who is present at bedside, to lead the bundle implementation, increased personal ownership and compliance and ultimately improved practice and patient outcomes in previous examples from the literature” [7, 9].
Burton et al. remarked in JAMA 2009 that MRSA infections traditionally accounted for 50% of all CRBIs seen within the critical care unit, but they reiterated that the landscape of causative pathogens continues to change based mostly on antimicrobial resistance, among other factors [21]. Therefore, we expected that most of the CLABSIs observed would be positive for MRSA; however, our data demonstrates that the primary organism during the preintervention period at NBIMC in the critical care unit was Staphylococcus epidermis. This was the anticipated trend for the preintervention period. It was not surprising, as the presence of Staphylococcus epidermis suggested that the normal skin flora was introduced during the insertion of the line; the organisms observed indicate the mechanism of pathogenesis. The prevalence of Staphylococcus epidermis is easily explained by the mechanism of organism migration via insertion through the skin into the cutaneous catheter tract. It is the most common route of infection for short-term catheters per a 1991 American
Nursing Checklist for Central Venous Catheter Insertion:

| Purpose: To evaluate current infection prevention practices and identify opportunities for improvement. |
| When: During all central venous or central arterial line insertions or re-wires |
| By whom: Primary Nurse or Charge Nurse |

If there is an observed violation of infection control practices, line placement should stop immediately and the violation should be corrected. If a correction is required, mark Yes to #13

(1) Sulfa allergies? No Yes If Yes (use non-impregnated catheter)
(2) Date: ______/_____/______ Time: ______________ AM/PM
(3) Indication:
- Multiple Drugs/Drips
- Multiple Lines
- TPN
- No peripheral access
- Other
(4) Location:
- Room #_______
- Cath Lab
- ER
- Interventional Radiology
- OR
(5) Procedure:
- New Central Line Placement
- Rewire
- Arterial Line
- Other
(6) Site:
- Subclavian
- Jugular
- Umbilical
(7) Type of CVC:
- TLC
- Swan Ganz
- Cordis
- Dialysis
- Portacath
- PICC
(8) Is the procedure:
- Elective
- Emergency
(9) Who was the primary inserter?
- Attending
- Intern
- Resident
- Fellow
- Other
(10) Central line insertion checklist utilized noted in the Universal Protocol Documentation
- Yes
- No
(11) Before the procedure, did the inserter:
- Perform a Time out
- Yes
- No
- Wash Hands with chlorhexidine
- Yes
- No
- Was hand washing directly observed?
- Yes
- No
For age 2 months and older:
- Prep insertion site with 2% CGH-30 second, scrub (groin-2 min scrub) and 30–60 second air dry.
- For age less than 2 months or patients that are allergic to chlorhexidine:
- Prep insertion site with 70% alcohol swab from center to periphery
- Using a circular motion for a total of three times, allow to dry and then
- Prepare insertion site with povidone iodine form center to periphery
- Using a circular motion three times around site followed by greater than 30 s. dry time.
- Apply sterile field/field barriers including full body drape
- and additional draping as needed.

(12) During the procedure, did the inserter:
- Use sterile Gloves
- Yes
- No
- Use hat, mask, sterile gown?
- Yes
- No
- Maintain a sterile field?
- Yes
- No
- Did all personnel assisted (within 3 feet)
- Yes
- No
- follow the above precautions:
- Yes
- No
- Ultrasound guidance—was it available?
- Yes
- No
- If Ultrasound guidance was available—was it used?
- Yes
- No

(13) After the procedure:
- Was a sterile dressing applied to the site?
- Yes
- No
- Was a procedure note written?
- Yes
- No

(14) Was a correction required to ensure compliance with infection control procedures (please circle)
- Yes
- No

Comments: ____________________________________________________________
Signature RN: _______________________________________________________

If any time, the answer is No, The RN is to stop the procedure.
Journal of Critical Care Medicine study on pulmonary artery catheters by Mermel et al. [22].

The present study has certain limitations, which include lack of blinding to intervention allocation and the multidisciplinary task force itself, which may be considered by some smaller single centers as a complex intervention. The establishment of a task force may cause critical care units to believe that they will be reliant on dedication from at least one expert advocate with sufficient experience in management of CLABSI reduction, or at least infection control, to have the same results. Although this study was conducted at a single center, potentially limiting external validity, it should be noted that our interventions can be broadly implemented. Where most other single center studies fail to show theoretical or empirical evidence to support widespread intervention, our findings are strongly supported by several existing landmark articles addressing strategies designed to reduce the rate of central line associated bloodstream infections. The interventions implemented within our study are merely representative of a combination of the existing best practices into one functional construct supported by a multidisciplinary team, which decreases the risk of failure in comparison to prior strategies where one protagonist was responsible for motivating and ensuring adherence to bundle elements. As previously mentioned, compliance to the nursing checklist did not reach statistical significance. Nonadherence to the nursing checklist and compliance with this portion of the protocol were later addressed by the multidisciplinary task force and nursing management. Another limitation was the lack of good documentation as it pertains to the sites of central venous catheter insertion. Initially, we wanted to examine the difference between rates of infections and insertion locations of the central venous catheters. However, because of the lack of reporting in this area, we were unable to assess the significance of this element at our center.

In 2012 during the preintervention study period, the greatest number of CLABSIs hospital-wide occurred during the month of September 2012, which could be explained by the lack of training within new providers (new intern classes are unfamiliar with bundle elements and correct technique) inserting central venous catheters, decreased nursing involvement, and a lack of strict adherence to proven best practices. Future studies would benefit from the inclusion of multiple hospital sites to increase the power of the data. In addition, identifying how a multidisciplinary task force may affect other components of patient care (e.g., ventilator days and proper nutrition within the ICU) would be worthy areas of exploration.

Appendix

See Figures 2 and 3.

Conflict of Interests

The authors declared no potential conflict of interests with respect to the research, authorship, and/or publication of this paper.

References


