Impact of a central venous line care bundle on rates of central line associated blood stream infection (CLABSI) in hospitalised children

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Abstract

Central line associated bloodstream infection (CLABSI) reduction programmes in hospitalised children have been focused in the intensive care setting and little data is available on the efficacy and cost effectiveness of such programmes in other clinical areas. Prospective monitoring of hospital acquired CLABSI rates in all clinical areas was performed at Alder Hey Children's Hospital for a period of three years following the implementation of a central venous line (CVL) care bundle. We observed a decrease in CLABSI rates from 220 in the first year following intervention to 108 per 100,000 patient days ($p=0.002$) in the third year of the study, demonstrating a decrease of over 50% in CLABSI rates. Blood culture contamination rates were also significantly reduced. The introduction of a CVL care bundle produced a significant, sustainable reduction in hospital acquired CLABSI rates in a children's hospital setting.

Background and aims

Central line associated bloodstream infection (CLABSI) in hospitalised children leads to significant morbidity and mortality, but also represents a significant financial burden. The cost of a CLABSI in the NHS has previously been evaluated at £6,209 (National Audit Office, 2000). A central venous line (CVL) maintenance care bundle, following the *Saving Lives: Reducing Infection, Delivering Clean Safe Care* UK Department of Health directive was introduced at Alder Hey Children's Hospital in March 2010. The bundle implementation also included the aseptic non touch technique (ANTT). Concomitantly, a surveillance programme was initiated to generate a hospital-wide CLABSI rate using per 100,000 bed days denominator as well as reporting the CLABSI and central line blood cultures contamination

rates. The aim of the programme was to demonstrate a decreased rate of CLABSI within the susceptible paediatric population following the practice change. Here, we report on the outcome three years after the intervention.

Methods

The study took place at Alder Hey Children's Hospital, a 245-bed secondary and tertiary care centre for paediatrics. The institution is a supra-regional centre for cardiac and neurosurgery and a tertiary referral centre for most paediatric specialties. It also provides secondary care for children living in Alder Hey Children's Hospital. All data regarding CLABSI, blood culture contamination rates and inpatient activity data were collected hospital-wide from 1 April 2010 to 1 April 2013. CLABSIs were defined using the Centers for Disease Control (CDC) guidelines (O'Grady et al, 2011). All CLABSIs were prospectively classified as hospital acquired CLABSI as defined by a positive blood culture greater than 48 hours after admission, after readmission within 48 hours of discharge, or following insertion of central venous access within 48 hours of admission.

The hospital acquired CLABSI rate was reported per 100,000 bed days denominator, as recommended by the Health Protection Agency (HPA) guidance. Statistics were performed using Excel software (©Microsoft 2010).

Blood culture contamination rate for central venous line blood cultures was also recorded to provide an additional indicator considered to be a marker for adequate clinical practice adherence (Roth et al, 2010). For this study, the total number of blood cultures taken was used as the denominator, with CVL contaminants used as the numerator.

A dedicated intravenous (IV) team was established in April 2010, comprising three full time specialist nurses. The team implemented ANTT recommended as best practice by the Royal College of Nursing

Table 1. Component of the central venous line maintenance care bundle

1. **Hand hygiene:** decontamination of hands before and after each patient contact
2. **Catheter site inspection:** hourly inspections of site for signs of infection
3. **Dressing:** An intact, dry, adherent transparent dressing must be used
4. **Catheter injection ports:** Injection ports are covered by caps or valved connectors.
5. **Catheter access:** Use of aseptic non touch technique (ANTT) and swab ports or hub with 2% chlorhexidine gluconate in 70% isopropyl alcohol prior to accessing the line for administering fluids or injections. Wait a minimum of 30 seconds to allow alcohol to dry before accessing line.
6. **Administration set replacement to be done:**
  - Immediately following the administration of blood, blood products
  - Following total parental nutrition – after 96hrs with filters in situ, 24hrs for lipids
  - All other fluid sets to be changed as per hospital policy

Figure 1. Central line associated bloodstream infections reported per 100,000 patient days

Standards for infusion therapy. Following ANTT implementation the High Impact Interventions Care Bundles 1 and 2 from *Saving Lives: Reducing Infection, Delivering Clean and Safe Care* were implemented throughout the hospital from April 2010 to September 2010. Some elements of the care bundles needed adjustment to ensure safe paediatric IV therapy practice (Table 1). The most significant of these changes included:

1. Insertion actions: use of 2% chlorhexidine gluconate in 70% alcohol, and allow to dry: The products currently available are not licensed for use on patients less than two months of age. Therefore, for this age group, a 0.5% chlorhexidine gluconate in alcohol solution was used.
2. Ongoing care actions: catheter site inspections for signs of infections recommended 'at least daily' were adjusted to follow paediatric practice of at least 'hourly'. It also included a number of other observations including the intravenous insertion site, venous pressure, volume infused, rate and type of infusate.
3. Administration set replacement: 96 hour endotoxin retentive filters were used within the hospital and this practice had to be taken into account when assessing for compliance with the High Impact Intervention for administration set replacement.

Both ANTT and the High Impact Interventions were implemented following a structured programme and ongoing audit. Following the

initial implementation and training, a three monthly re-audit of all staff for practice compliance was performed during the study. Once compliance to both interventions was achieved, this was adjusted to an ongoing weekly audit of clinical practice for one intravenous administration in each area for ANTT compliance and the High Impact Interventions. Written feedback regarding compliance for the interventions was completed every 10 weeks, as per the High Impact Interventions 10 observations of practice recommendations.

Results

At the initiation of the surveillance programme and the start of the bundle implementation (April–June 2010) the hospital acquired CLABSI rate was reported at 222.5 per 100,000 patient days (Figure 1). A decrease in rates was observed during the course of the study with CLABSI rates of 74.2 per 100,000 patient days reported in the last quarter (January to March 2013). In the first year following the intervention the average CLABSI rate was reported at 220.3 per 100,000 (95% confidence interval (95% CI): 204.4–236.2). In the third year following intervention the CLABSI rate averaged 108.5 per 100,000 (95% CI: 72.7–144.3) demonstrating an overall decrease of over 50% reduction in the hospital acquired CLABSI rate ($p=0.0021$). The decrease was significant in medical, surgical and intensive care areas but not in oncology.

Similarly, the central line blood culture contamination rates showed a continuous decrease from of 4.92% in April to June 2010 to 1.53% in January to March 2012 ($p=0.0038$).

Discussion

This study shows that a CVL care bundle incorporating ANTT has a significant impact in reduction of CLABSI in hospitalised paediatric patients, with a 50% decrease in CLABSI rates observed within three years of implementation. A CVL insertion and maintenance care bundle had been previously shown to be successful in the PICU setting with a study involving 29 US PICU showing a sustained and statistically significant decrease from 5.2 to 2.3 CLABSI per 1,000 catheter days three years after intervention (Miller et al, 2010, 2011). Effectiveness of a hospital-wide implementation of central line insertion and maintenance bundles in paediatrics has also been demonstrated with a decrease in CLABSI from 3.0 to <1.0 CLABSI per 1,000 line-days four years after implementation of such a programme (Wheeler et al, 2011). This study confirms these findings in showing that the efficacy of implementing a CVL maintenance care bundle in a children's hospital setting is feasible and benefits not only patients in intensive care but also those in general medical and surgical areas.

The decrease in CLABSI was progressive and continuous during the two years of the study. We observed an increase in the CLABSI rate in January 2011 which was associated with increased clinical activity due to the H1N1 flu pandemic. CLABSI rates dropped the following month and rates continued to decrease after this. In June 2011 a further peak was noted, and when investigated, this was apportioned to a specific clinical area (oncology). Adherence to one element for maintenance care of CVLs – catheter site inspection being carried out and recorded hourly – had decreased significantly. After input from the IV team and further audit the CLABSI rates were back to previous months. This demonstrates that the need for ongoing audit mechanisms for adherence to the use of paediatrics-specific central line maintenance care bundles is key in continually decreasing CLABSI rates.

Significant decrease was observed in intensive care, medical and surgical areas. However, CLABSI rates in oncology, although showing a trend downwards, were not significantly decreased. There are multiple possible reasons for this difference including the increase in immune suppression of the host, mucositis and possible translocation of bacteria via the intestinal tract. Further strategies are being developed to assess how to further improve the CLABSI rates in oncology, including the use of chlorhexidine patches and alcohol line locks.

The study also reports a decrease in blood contamination rates, a proxy marker for adequate clinical practice adherence. Reduction in blood culture contamination also has a possible impact on the quality of patient care, with fewer courses of unnecessary antibiotics and a reduction in potential side effects associated with therapy. It has also

been shown to have a beneficial financial impact in reducing lengths of patient stay and use of broad-spectrum antibiotics, both of which are associated with increased antibiotic resistance and patient morbidity (Roth et al, 2010).

It is important to acknowledge that this hospital-wide reduction in CLABSI was achieved after investment in three full time, permanent nursing staff members to implement and monitor the programme. The responsibilities of the team have changed somewhat over time from training and implementation to ongoing maintenance and monitoring, and finally the delivery of a cannulation and long line placement service. Overall it is estimated that the team have created a potential cost saving to the hospital of £2.3 million during the two-year study period (by decreasing infections and reducing the need for long line placement in theatre).

A limitation of the study is that both surveillance and implementation of the bundle were started at the same time, potentially underestimating the true decrease in CLABSI rates. In addition the study was performed in a single tertiary paediatric centre dealing with specific and complex paediatric patients. We, however, believe that a paediatric-specific programme such as this would be successful in a variety of settings. Another limitation includes the use of per 100,000 patient days as a denominator, which, although useful for internal benchmarking, does not readily allow comparison with other centres or with the published literature. We have recently started to report hospital-wide CLABSI rates per 1,000 catheter days, which is a more appropriate denominator in paving the way for a paediatric surveillance network in the UK.

In conclusion, the introduction of a CVL care bundle produced a significant, sustainable reduction in CLABSI and central line blood culture contamination rates in a paediatric setting. Further multicentre studies looking at the impact of such an intervention in various paediatric settings is desirable to validate these findings and help define an optimal bundle for the paediatric patient.

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Declaration of conflicting interest

The author declares that there is no conflict of interest.

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