Abstract:

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Results: Twenty-five and 18 patients had PICU-acquired BSI during the baseline and intervention periods respectively, giving infection rates of 88/1000 and 41/1000 admissions. Twenty-two and 11 of these infections were related to central venous catheters during the baseline and intervention periods respectively, giving incidence rates of catheter related (CR) BSI of 25.2/1000 and 9.3/1000 CVC-days (p< 0.05).

The PRISM III score was an independent risk factor for PICU-acquired BSI and the intervention significantly reduced this risk.

Conclusion:
A relatively low-cost investment such as the education of all interns in infection control resulted in a substantial reduction in the incidence of PICU-acquired BSI rates.

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Key words: extended infection control training program, interns, nosocomial blood stream infection, paediatric intensive care unit.
INTRODUCTION

Health-care associated infections (HCAI), particularly intensive care unit (ICU)-acquired bloodstream infections (BSI) pose a serious risk to the critically ill. It is associated with excess lengths-of-stay, higher treatment costs, morbidity and mortality. Central line-associated BSI (CLABSI) have been demonstrated to be preventable, through the implementation of multi-dimensional strategies which include multi-faceted education, hand hygiene, cleaning skin with chlorhexidine, maximal barrier precautions during central venous catheter (CVC) insertion, redesigning of physical barriers between patients’ beds and removing unnecessary catheters. Proper CVC access and maintenance care played the greatest role in preventing infections, in particular, CLABSI. The rates of CLABSI in the pediatric population has dropped markedly due to significant investment in this initiative; the most recent National Healthcare Safety Network (NHSN) report data for 2012 published a pooled rate of 1.4 laboratory-confirmed CLABSI per 1000 CVC days in the paediatric medical ICU in the United States of America (USA). The implementation of a multi-dimensional approach to infection control requires institutional leadership and commitment to resources, teamwork, collaboration and expertise for it to be effective and sustainable.

Intensive care, in particular, paediatric intensive care is a fledgling specialty in resource-limited countries, and despite the major potential impacts, infection control receives little attention compared to other priorities. While HCAI surveillance systems are in place at national/sub-national level in many developed countries, only 23 of 147 (15.6%) developing countries reported a functioning national surveillance system in a survey conducted by the WHO First Global Patient Safety Challenge. A systematic review and meta-analysis revealed a striking difference in incidence of ICU-acquired infections, a pooled density of 47.9 per 1000 patient-days in developing countries compared to an estimated 13.6 per 1000
Thus, the lack of a comprehensive surveillance system for HCAI in resource-limited countries results in an unrecognized serious burden for critically ill patients. A review of CLABSI in limited-resource countries showed the stark reality of poor performance of infection control practices, among which were overcrowded ICUs, insufficient rooms for isolation, lack of sinks, lack of alcohol hand-rubs and chlorhexidine, and the use of vented intravenous containers. Without first addressing these basic infection control practices, it is unlikely that the implementation of the multi-dimensional strategies mentioned above would be sufficient to prevent CLABSI in hospitals in countries with limited resources.

A PICU-initiated nosocomial infection surveillance in 2001 showed a BSI rate of 243/1000 patients in our PICU. This unacceptably high incidence prompted a definitive approach to infection control. An educational training program targeted at all PICU nursing staff, residents and interns rotated to the PICU was introduced in 2002. Although the incidence of nosocomial infections was reduced, it was still high. As there has been no study to assess the impact of training interns in infection control, we extended the training to all pediatric interns from 1st November 2008, including those not rotated to the PICU, but who would provide coverage during out-of-working hours. Our hypothesis was that by educating all these paediatric interns, it will positively impact the rates of nosocomial bloodstream infections in the PICU.

**METHODOLOGY**

**Setting**

This study was approved by the ethics committee at the university hospital, which waived the requirement for written informed consent. The 10-beded tertiary care multi-disciplinary PICU,
under the administration of Department of Paediatrics, admits approximately 400 critically ill patients per year. During working hours, clinical management was undertaken by the PICU team comprising of a pediatric intensivist, two specialists, four residents and two interns who were full time in the PICU for the duration of their 2-month rotation. During out-of-working hours, due to staff shortage, the PICU coverage was, more often than not, provided by medical staff and interns who were not part of the PICU team and who would not been trained in infection control. The nurse to patient ratio averaged 1:1.5 and varied between 1:1 and 1:2 as patient acuity mandated.

Training and infection control practices:
Several interventions were introduced in stages to PICU physicians and nurses between 2002 and the start of the study in 2008. Table 1 shows the timelines of the interventions which included the following: The practice of single use sterile alcohol wipes instead of cotton-balls impregnated with antiseptic in non-sterile containers, not re-using single-use vials, discard more than 24-hour-old fluids for dilution of parenteral medications, hand hygiene with chlorhexidine wash and sterile gloves before CVC insertion or manipulation, sterile gauze or transparent sterile dressing to cover insertion site, maintain good condition of sterile dressing, change gauze every 48 hours and transparent dressing every 7 days, remove CVC when not needed, closed intravenous systems, change administration set every 96 hours; unless used for nutrition or blood products, and in this case changed every 24 hours, CVC insertion kits, use maximal sterile barrier precautions during CVC insertion and disinfect line hubs, needleless connectors, injection ports before accessing the CVC and real-time feedback about the CLABSI. As chlorhexidine was not available, povidone-iodine was used for skin preparation.
During the intervention period, 1 November 2008 to 31 December 2009, all paediatric interns, regardless of whether they were posted to the PICU, underwent training to practice hand hygiene and aseptic technique in access of CVC, peripheral venous cannulas and arterial catheters at the start of their rotation to Department of Paediatrics, as listed in Appendix 1. Training was provided by the paediatric intensivist and specialist. These sessions involved groups of 2 to 4 interns and lasted two hours followed by evaluation of the individual’s performance of these infection control practices till the required standard was achieved.

**Patient population and outcome**

Consecutive patients admitted to the PICU between 1 Jan 2008 and 31 Dec 2009 were enrolled into the study. Patients were excluded if they were admitted in an unstable hemodynamic state that required continuous cardiopulmonary resuscitation. All patients were monitored daily for device utilization and development of nosocomial BSI until 48 hours after PICU discharge by a trained study nurse. The primary outcome measure was the development of a PICU-acquired BSI which included clinical sepsis (CS) and laboratory-confirmed BSI (LCBSI) and CLABSI per 1000 CVC days.

A primary BSI included both LCBSI with a positive blood culture not related to infection at another site, and CS. An ICU-associated infection is an infection in an ICU patient that was not present or incubating at the patient’s admission to the ICU but became apparent during the ICU stay or within 48 hours after transfer from the ICU. A BSI is considered to have been acquired in the PICU if a positive blood culture is obtained more than 48 hours after admission to the unit. For clinical sepsis, the patient has at least one of the following, fever or hypotension or oliguria, and a physician instituted treatment for sepsis and there was no apparent infection at another site, and a negative blood culture or no blood culture was
taken.\textsuperscript{22,25} CLABSI is defined as a primary BSI in a patient that had a central line within the 48-hour period before the development of the BSI and is not bloodstream related to an infection at another site.\textsuperscript{26} Infection incidence was expressed as a percentage of the total number of patients with PICU-acquired BSI divided by the total number of patients enrolled during the respective period.\textsuperscript{24}

**Statistical Analysis**

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) software (Release 20.0.0; SPSS: An IBM Company, Chicago, Illinois USA, 2011). Data are presented as number (%) or median (interquartile range, IQR). For actuarial analysis, the event of interest was “nosocomial bloodstream infection” and time-to-event was the number of nosocomial bloodstream infection-free days. Patients with no events were considered as right censored observations. The Kaplan-Meier (product-limit)\textsuperscript{27} method was used to estimate univariate differences in actuarial analysis with differences compared using the two-sided log rank test.\textsuperscript{28} Hazard ratios were calculated by using the multiple Cox proportional hazards regression model\textsuperscript{29,30} after adjusting for significant and clinically important baseline characteristics (Table 3). In this model criteria for entry and removal were p<0.05 and p>0.10 respectively. The assumption of proportionality was confirmed by plotting the log-negative-log of the Kaplan–Meier estimates of the survival function versus the log of time which resulted in parallel curves. All analyses were pre-specified. The level of statistical significance for all analyses was set at p<0.05, using two-tailed comparisons.

**RESULTS**

A total of 110 interns were posted to the Department of Paediatrics during the study period from 1\textsuperscript{st} January 2008 till 31\textsuperscript{st} December 2009, with 45 during the pre-intervention and 65 the
intervention periods (Figure 1). During the pre-intervention period, only 13 interns rotated to
the PICU were trained in infection control while all 65 interns posted to the Department of
Paediatrics during the intervention period underwent similar training. The number of interns
who provided PICU coverage during out-of-working hours was 42 and 61 during the pre and
intervention periods respectively.

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2009. Twenty-eight patients were excluded, thus leaving 721 patients for analysis. Of these,
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respectively. Figure 2 shows the enrolment and exclusion of patients during both periods.
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characteristics, such as age, gender, reasons for PICU admission, Pediatric risk of
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were similar during both periods. Invasive device utilization rates were similar for
mechanical ventilators and bladder catheters. A significant decrease in the use of CVC and
arterial catheters (AC) was observed during the intervention period. Figure 3 shows the
percentage of patients with CVC and AC utilization per month throughout the study period.
The dark arrow indicates the start of the intervention on 1st Nov 2008; this was accompanied
by a simultaneous decrease in BSI which remained low throughout the post-intervention
period. An unforeseen shortage of supplies of pediatric-sized CVC and arterial catheters was
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were re-established during the last 4 months of the intervention period. Despite the increased
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period. Day-by-day actuarial BSI stratified by study group is shown in Figure 4. The graphs
were truncated at day 40 of admission as the BSI remained mostly unchanged afterwards.

The overall risk of BSI was higher for pre- compared to intervention period (p=0.048).

The CVC days during baseline and intervention periods were 874 days and 1183 days respectively. Twenty-five patients and 18 patients had PICU-acquired BSI during the baseline and intervention periods respectively, giving the infection incidence rates of 88/1000 and 41/1000 admissions. Of the 25 patients with PICU-acquired BSI during the baseline period, 22 were related to CVC giving an incidence rate of CLABSI of 25.2/1000 CVC-days. The corresponding occurrence during the intervention period was 11 patients with CLABSI, yielding a rate of 9.3/1000 CVC-days, a reduction of 63% in CLABSI during the intervention period (p< 0.05 for both LCBSI and CS). Multivariate analysis (Table 3) revealed that the PRISM III score but not the durations of CVC or AC usage was a significant risk factor for the development of PICU-acquired BSI and that the intervention significantly reduced this risk.

**Discussion:**

During the pre-intervention period less than 30% of all interns who provided out-of-working-hours coverage of the PICU received training in infection control. The extension of this training to all interns in the Department of Paediatrics is associated with reduced rates of both LCBSI and CS by 28% in total BSI and 63% in CLABSI per 1000 CVC days during the intervention period compared to the baseline period. Patient characteristics such as age and gender; severity of illness, use of inotropes, reasons for admission and utilization of invasive mechanical ventilation and continuous bladder catheters were comparable in both populations during the pre- and intervention periods. Although decreased utilization of CVC and AC during the intervention period may have impacted on the BSI rates, multivariate analysis
revealed that usage of these devices was not significant. Furthermore, towards the last four months of the intervention period, an increased utilization did not result in increased BSI rates. This is the first study to report the impact of training of all interns in infection control practices on the incidence of nosocomial BSI in a PICU in a middle income country. Medical interns rotated to the PICU perform tasks that involve central vascular accesses and patient contact, yet it has been reported that only 64% of them have a sufficient level of awareness of infection control practices. Education and training of healthcare providers who insert and maintain catheters are key interventions in the prevention of CR-BSI, and often interns are not involved though they could have potentially a dramatic impact on the rate of infection in the PICU.

Our PICU is typical of one in middle-income countries. Dependence on itinerant staff during out-of-working-hours makes infection control, its education and surveillance challenging, especially when infection control practices receive little attention in the other areas of the hospital. Due to resource limitation, process surveillance and feedback of performance of infection control practices were not performed. Sustained compliance to hand hygiene, fundamental to the control of nosocomial infection, is poor among health care workers. However implementation of a frequent performance feedback, in addition to education and training, as recommended by International Nosocomial Infection Control Consortium (INICC) increased hand hygiene adherence from 23.1% to 64.5% in 2 ICU’s, with overall reduction of nosocomial infections from 47.55 to 27.93 per 1000 patient-days. Compliance with CVC-site care improved with sequential implementation of an education and performance feedback program coinciding with reduction in rates of intravenous device-associated BSI after implementation of an educational program with further reduction after implementation of a performance feedback program.
This is a single PICU-based study in a teaching hospital and the results cannot be considered representative of PICU in other middle income countries. The unintentional decreased utilization of CVC and AC during part of the intervention period may have affected the impact of the intervention program. Though the reported BSI density was reduced, it was still higher than that in US and other developing countries which had implemented CVC bundle care.\textsuperscript{36}

In conclusion, education of interns in infection control is a relatively low-cost investment which has led to a substantial reduction in the incidence of nosocomial BSI in our PICU. We believe that the implementation of similar strategies in other parts of the hospital can lead to substantial reduction in nosocomial BSI in vulnerable patients.

**Conflict of interest statement:**

We declare that we have no conflict of interest. The authors have indicated they have no financial relationships relevant to this article to disclose.

**Acknowledgment:**

MM Ho, research nurse; A Kassim who initiated the first surveillance on nosocomial infections in the PICU in 2001; F Bakar, ward manager who provided moral and technical support and staff of the PICU.
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Figure Legends:

Figure 1: Flow chart for intern population

Figure 2: Flow chart of study population

Figure 3: Rates of nosocomial bloodstream infection and usage of central venous and arterial lines among patients admitted to PICU before (Jan – Oct 2008) and during (Nov 2008 – Dec 2009) intervention. The arrow indicates the start time of implementation of an extended infection control training program.

Appendix: Preliminary Orientation of House-officers posted to Department of Paediatrics

Table I: Dates of introduction of key interventions to reduce CLABSI in PICU

Table II: Characteristics of patients admitted to Paediatric Intensive Care Unit before (Jan-Oct 2008) and after (Nov 2008 – Dec 2009) implementation of an extended infection control training program

Table III: Multivariate Cox-regression analysis of factors associated with nosocomial bloodstream infection (BSI) among patients admitted to Paediatric Intensive Care Unit pre (Jan-Oct 2008) and post (Nov 2008 – Dec 2009) implementation of an extended infection control training program

Figure 4: Day-by-day Kaplan-Meier product-limit of nosocomial bloodstream infection (BSI, event) among patients admitted to Paediatric Intensive Care Unit before (Jan-Oct 2008) and after (Nov 2008 – Dec 2009) implementation of an extended infection control training program. Graph was truncated at day 40 of admission.
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proportional hazards regression model\textsuperscript{29,30} after adjusting for significant and clinically
important baseline characteristics (Table 3). In this model criteria for entry and removal were
p<0.05 and p>0.10 respectively. The assumption of proportionality was confirmed by
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statistical significance for all analyses was set at p<0.05, using two-tailed comparisons.
RESULTS

A total of 110 interns were posted to the Department of Paediatrics during the study period from 1\textsuperscript{st} January 2008 till 31\textsuperscript{st} December 2009, with 45 during the pre-intervention and 65 the intervention periods (Figure 1). During the pre-intervention period, only 13 interns rotated to the PICU were trained in infection control while all 65 interns posted to the Department of Paediatrics during the intervention period underwent similar training. The number of interns who provided PICU coverage during out-of-working hours was 42 and 61 during the pre and intervention periods respectively.

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The CVC days during baseline and intervention periods were 874 days and 1183 days respectively. Twenty-five patients and 18 patients had PICU-acquired BSI during the baseline and intervention periods respectively, giving the infection incidence rates of 88/1000 and 41/1000 admissions. Of the 25 patients with PICU-acquired BSI during the baseline period, 22 were related to CVC giving an incidence rate of CLABSI of 25.2/1000 CVC-days. The corresponding occurrence during the intervention period was 11 patients with CLABSI, yielding a rate of 9.3/1000 CVC-days, a reduction of 63% in CLABSI during the intervention period (p< 0.05 for both LCBSI and CS). Multivariate analysis (Table 3) revealed that the PRISM III score but not the durations of CVC or AC usage was a significant risk factor for the development of PICU-acquired BSI and that the intervention significantly reduced this risk.

Discussion:

During the pre-intervention period less than 30% of all interns who provided out-of-working-hours coverage of the PICU received training in infection control. The extension of this training to all interns in the Department of Paediatrics is associated with reduced rates of both LCBSI and CS by 28% in total BSI and 63% in CLABSI per 1000 CVC days during the intervention period compared to the baseline period. Patient characteristics such as age and gender; severity of illness, use of inotropes, reasons for admission and utilization of invasive mechanical ventilation and continuous bladder catheters were comparable in both populations.
during the pre- and intervention periods. Although decreased utilization of CVC and AC
during the intervention period may have impacted on the BSI rates, multivariate analysis
revealed that usage of these devices was not significant. Furthermore, towards the last four
months of the intervention period, an increased utilization did not result in increased BSI
rates. This is the first study to report the impact of training of all interns in infection control
practices on the incidence of nosocomial BSI in a PICU in a middle income country. Medical
interns rotated to the PICU perform tasks that involve central vascular accesses and patient
contact, yet it has been reported that only 64% of them have a sufficient level of awareness of
infection control practices. Education and training of healthcare providers who insert and
maintain catheters are key interventions in the prevention of CR-BSI, and often interns are
not involved though they could have potentially a dramatic impact on the rate of infection in
the PICU.

Our PICU is typical of one in middle-income countries. Dependence on itinerant staff during
out-of-working-hours makes infection control, its education and surveillance challenging,
especially when infection control practices receive little attention in the other areas of the
hospital. Due to resource limitation, process surveillance and feedback of performance of
infection control practices were not performed. Sustained compliance to hand hygiene,
fundamental to the control of nosocomial infection, is poor among health care workers. However implementation of a frequent performance feedback, in addition to education and
training, as recommended by International Nosocomial Infection Control Consortium (INICC)
increased hand hygiene adherence from 23.1% to 64.5% in 2 ICU’s, with overall reduction of
nosocomial infections from 47.55 to 27.93 per 1000 patient-days. Compliance with CVC-
site care improved with sequential implementation of an education and performance feedback
program coinciding with reduction in rates of intravenous device-associated BSI after
implementation of an educational program with further reduction after implementation of a performance feedback program.\textsuperscript{35}

This is a single PICU-based study in a teaching hospital and the results cannot be considered representative of PICU in other middle income countries. The unintentional decreased utilization of CVC and AC during part of the intervention period may have affected the impact of the intervention program. Though the reported BSI density was reduced, it was still higher than that in US and other developing countries which had implemented CVC bundle care.\textsuperscript{36}

In conclusion, education of interns in infection control is a relatively low-cost investment which has led to a substantial reduction in the incidence of nosocomial BSI in our PICU. We believe that the implementation of similar strategies in other parts of the hospital can lead to substantial reduction in nosocomial BSI in vulnerable patients.

(Word count: 2423)

This work was performed in the Paediatric Intensive Care Unit, University Malaya Medical Centre, Kuala Lumpur, Malaysia.

Conflict of interest statement:

We declare that we have no conflict of interest. The authors have indicated they have no financial relationships relevant to this article to disclose.

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Figure Legends:

**Figure 1:** Flow chart for intern population

**Figure 2:** Flow chart of study population

**Figure 3:** Rates of nosocomial bloodstream infection and usage of central venous and arterial lines among patients admitted to PICU before (Jan – Oct 2008) and during (Nov 2008 – Dec 2009) intervention. The arrow indicates the start time of implementation of an extended infection control training program.

**Appendix:** Preliminary Orientation of House-officers posted to Department of Paediatrics

**Table I:** Dates of introduction of key interventions to reduce CLABSI in PICU

**Table II:** Characteristics of patients admitted to Paediatric Intensive Care Unit before (Jan-Oct 2008) and after (Nov 2008 – Dec 2009) implementation of an extended infection control training program

**Table III:** Multivariate Cox-regression analysis of factors associated with nosocomial bloodstream infection (BSI) among patients admitted to Paediatric Intensive Care Unit pre (Jan-Oct 2008) and post (Nov 2008 – Dec 2009) implementation of an extended infection control training program

**Figure 4:** Day-by-day Kaplan-Meier product-limit of nosocomial bloodstream infection (BSI, event) among patients admitted to Paediatric Intensive Care Unit before (Jan-Oct 2008) and after (Nov 2008 – Dec 2009) implementation of an extended infection control training program. Graph was truncated at day 40 of admission.
TITLE PAGE

Title:
Impact of Infection Control Training to Interns on PICU-acquired Bloodstream Infections in a Middle-Income Country

Type of manuscript: Original article

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Figure 1: Flow chart for intern population

Study period
1 Jan 2008 to 31 Dec 2009
110 Interns posted to Department of Paediatrics

Pre-intervention
1 Jan 2008 to 31 Oct 2008
45 Interns

13 Interns rotated to PICU, trained in infection control and provided PICU coverage
32 Interns not rotated to PICU, not trained in infection control, 28 provided PICU coverage

Intervention
1 Nov 2008 to 31 Dec 2009
65 Interns

21 Interns rotated to PICU, trained in infection control and provided PICU coverage
44 Interns not rotated to PICU, all trained in infection control, 40 provided PICU coverage
Figure 2: Flow chart of study population

749 PICU patients 1 Jan 2008 to 31 Dec 2009

295 patients Pre-intervention
- 10 patients met exclusion criteria
- 285 patients enrolled

454 patients During intervention
- 18 patients met exclusion criteria
- 436 patients enrolled
Figure 3: Rates of nosocomial bloodstream infection and usage of central venous and arterial lines among patients admitted to PICU before (Jan – Oct 2008) and during (Nov 2008 – Dec 2009) intervention. The arrow indicates the start time of implementation of an extended infection control training program.

The dark arrow indicates the start of the intervention on 1st Nov 2008; this was accompanied by a simultaneous decrease in BSI which remained low throughout the post-intervention period. A decrease in usages of arterial and central venous catheters occurred from May through August 2008 followed by increased device utilization beginning from September till the end of the study. Despite the increased device utilization, BSI rates remained significantly lower than during the pre-intervention period.
Figure 4:

A Kaplan-Meier survival curve showing the cumulative survival over time to BSI (days). The graph compares different time periods:
- **Pre-intervention**
- **Post-intervention**
- **Pre-intervention censored**
- **Post-intervention censored**

The p-value for the comparison of the survival curves is p = 0.048.
Table I: Dates of introduction of key interventions to reduce CLABSI in PICU

<table>
<thead>
<tr>
<th>Implementation date</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 2003</td>
<td>Single-use sterile alcohol wipes instead of cotton-balls impregnated with antiseptic. No re-using single-use vials, discard more than 24-hour-old fluids for dilution of parenteral medications.</td>
</tr>
<tr>
<td>Jan 2003</td>
<td>Mandatory nurse education in hand hygiene with chlorhexidine wash.</td>
</tr>
<tr>
<td>Jan 2005</td>
<td>Mandatory nurse and doctor education in sterile gloves before CVC insertion or manipulation, sterile gauze or transparent sterile dressing to cover insertion site, maintain good condition of sterile dressing, change gauze every 48 hours and transparent dressing every 7 days, remove CVC when not needed. Closed intravenous systems, change administration set every 96 hours; unless used for, nutrition or blood products, and in this case changed every 24 hours,</td>
</tr>
<tr>
<td>Jan 2007</td>
<td>CVC insertion kits, use maximal sterile barrier precautions during CVC insertion.</td>
</tr>
<tr>
<td>Jan 2008</td>
<td>Training of PICU doctors in disinfection of line hubs, needleless connectors, injection ports before accessing the CVC and real-time feedback about the CLABSI. As chlorhexidine was not available, povidone-iodine was used for skin preparation.</td>
</tr>
<tr>
<td>Nov 2008</td>
<td>Training of all paediatric interns.</td>
</tr>
</tbody>
</table>
Table II: Characteristics of patients admitted to Paediatric Intensive Care Unit before (Jan-Oct 2008) and after (Nov 2008 – Dec 2009) implementation of an extended infection control training program

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Pre-intervention (n = 285)</th>
<th>Post-intervention (n = 436)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>1.0 (0.2-5.6)</td>
<td>0.8 (0.1-4.9)</td>
<td>0.219</td>
</tr>
<tr>
<td>Male gender</td>
<td>155 (54.9)</td>
<td>260 (59.6)</td>
<td>0.188</td>
</tr>
<tr>
<td>Inotropes use</td>
<td>68 (23.9)</td>
<td>97 (22.2)</td>
<td>0.680</td>
</tr>
<tr>
<td>Elective admissions</td>
<td>53 (18.6)</td>
<td>72 (16.7)</td>
<td>0.589</td>
</tr>
<tr>
<td><strong>Reasons for PICU admission</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-surgery support</td>
<td>82 (28.8)</td>
<td>112 (25.7)</td>
<td>0.406</td>
</tr>
<tr>
<td>Respiratory support</td>
<td>102 (35.8)</td>
<td>165 (37.8)</td>
<td>0.642</td>
</tr>
<tr>
<td>Cardiovascular support</td>
<td>33 (11.6)</td>
<td>64 (14.7)</td>
<td>0.280</td>
</tr>
<tr>
<td>Respiratory and hemodynamic support</td>
<td>52 (18.2)</td>
<td>72 (16.5)</td>
<td>0.624</td>
</tr>
<tr>
<td>Neurological support</td>
<td>16 (5.6)</td>
<td>23 (5.3)</td>
<td>0.995</td>
</tr>
<tr>
<td><strong>Invasive device utilization</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical ventilation</td>
<td>167 (58.6)</td>
<td>250 (57.3)</td>
<td>0.797</td>
</tr>
<tr>
<td>Duration of mechanical ventilation (days)</td>
<td>4.0 (2.0-10.0)</td>
<td>5.0 (2.0-8.0)</td>
<td>0.202</td>
</tr>
<tr>
<td>Central venous catheter</td>
<td>98 (34.4)</td>
<td>116 (26.6)</td>
<td>0.031</td>
</tr>
<tr>
<td>Duration of central venous catheter (days)</td>
<td>5.5 (3.0-10.0)</td>
<td>6.0 (3.0-12.0)</td>
<td>0.369</td>
</tr>
<tr>
<td>Peripheral arterial catheter</td>
<td>156 (54.7)</td>
<td>208 (47.7)</td>
<td>0.077</td>
</tr>
<tr>
<td>Duration of arterial catheter (days)</td>
<td>5.0 (3.0-10.0)</td>
<td>4.0 (3.0-7.0)</td>
<td>0.041</td>
</tr>
<tr>
<td>Continuous urinary bladder drainage</td>
<td>131 (46.0)</td>
<td>180 (41.3)</td>
<td>0.245</td>
</tr>
<tr>
<td>Duration of continuous urinary bladder drainage (days)</td>
<td>4.0 (2.0-7.0)</td>
<td>4.0 (3.0-7.0)</td>
<td>0.360</td>
</tr>
<tr>
<td><strong>Bloodstream nosocomial infections</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time to onset of BSI (days)</td>
<td>5.0 (2.0-9.0)</td>
<td>5.0 (3.0-9.0)</td>
<td>0.624</td>
</tr>
<tr>
<td>Laboratory confirmed</td>
<td>13 (4.6)</td>
<td>10 (2.3)</td>
<td>0.140</td>
</tr>
<tr>
<td>Clinical sepsis</td>
<td>12 (4.2)</td>
<td>8 (1.8)</td>
<td>0.095</td>
</tr>
<tr>
<td>Total BSI</td>
<td>25 (8.8)</td>
<td>18 (4.1)</td>
<td>0.016</td>
</tr>
<tr>
<td>CR-BSI</td>
<td>22 (7.7)</td>
<td>11 (2.5)</td>
<td>0.002</td>
</tr>
<tr>
<td>CVC days</td>
<td>874</td>
<td>1183</td>
<td></td>
</tr>
<tr>
<td>CR-BSI per 1000 CVC days</td>
<td>25.2</td>
<td>9.3</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Length of PICU stay (days)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRISM III score at 24 hrs</td>
<td>5.0 (2.0-10.5)</td>
<td>5.0 (3.0-10.0)</td>
<td>0.791</td>
</tr>
<tr>
<td>PICU mortality</td>
<td>26 (9.1)</td>
<td>39 (8.9)</td>
<td>0.935</td>
</tr>
</tbody>
</table>

Data is expressed as number (%) or median (interquartile range). BSI denotes bloodstream nosocomial infections; CR, catheter-related; CVC, central venous catheter and PICU, paediatric intensive care unit.
**Table III:** Multivariate Cox-regression analysis of factors associated with nosocomial bloodstream infection (BSI) among patients admitted to Paediatric Intensive Care Unit pre (Jan-Oct 2008) and post (Nov 2008 – Dec 2009) implementation of an extended infection control training program

<table>
<thead>
<tr>
<th>Variable</th>
<th>HR (95% CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post- vs pre intervention</td>
<td>0.443 (0.199 - 0.989)</td>
<td>0.047</td>
</tr>
<tr>
<td>Duration of central venous catheter (days)</td>
<td>1.014 (0.991 - 1.037)</td>
<td>0.243</td>
</tr>
<tr>
<td>Duration of arterial catheter (days)</td>
<td>1.018 (0.979 -1.058)</td>
<td>0.377</td>
</tr>
<tr>
<td>PRISM III score</td>
<td>1.079 (1.016 - 1.145)</td>
<td>0.013</td>
</tr>
</tbody>
</table>

Values are hazard ratio (95% confidence interval) and p-value. All covariate included in the multivariate models are included in the table.
Appendix 1: Preliminary Orientation of House-officers posted to Department of Paediatrics

Date:_______________

Name of House Officer:__________________________

Date of posting to department of Paediatrics:_______________

Please note that you have to present yourself to the PICU within 48 hours of being posted to the Department of Paediatrics

Orientation of PICU by Clinical Nurse Consultant & PICU lecturer/specialist

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Demonstrated by specialist or senior MO (signature &amp; date)</th>
<th>Assessed by Sister_____ (date)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Hand-washing</td>
<td></td>
<td>Satisfactory To repeat</td>
</tr>
<tr>
<td>2. Access of arterial lines</td>
<td></td>
<td>Satisfactory To repeat</td>
</tr>
<tr>
<td>3. Access of central venous lines and Administration of medications</td>
<td></td>
<td>Satisfactory To repeat</td>
</tr>
<tr>
<td>4. Access of peripheral venous line and administration of medications</td>
<td></td>
<td>Satisfactory To repeat</td>
</tr>
<tr>
<td>5. Arterial blood gas analyser</td>
<td></td>
<td>Satisfactory To repeat</td>
</tr>
<tr>
<td>6. Capillary gas sampling</td>
<td></td>
<td>Satisfactory To repeat</td>
</tr>
<tr>
<td>7. Safety in blood transfusion</td>
<td></td>
<td>Satisfactory To repeat</td>
</tr>
<tr>
<td>8. Safety in medication administration</td>
<td></td>
<td>Satisfactory To repeat</td>
</tr>
</tbody>
</table>

• Important points to note during procedures:
  • Preparation before access of vascular devices
  • Inform patient or parent before procedure
  • Perform the actual procedure with
    • Aseptic considerations and neatness
    • Flushing the line to maintain patency
    • Ensuring no air bubbles in the vascular system

• If your assessment is not satisfactory in any of these areas, you will be assessed at another date before your first call in the PICU.

Once the assessment has been completed satisfactorily, please submit this document to PICU Ward Manger.