Impact of New Practice Guideline to Prevent Catheter-related Blood Stream Infection (CRBSI): Experience at the Pediatric Intensive Care Unit of Phramongkutklao Hospital

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Objective: *To demonstrate the incidence of catheter-related blood stream infection (CRBSI) of patients in the pediatric intensive care unit (PICU) after implementing the new guideline to prevent CRBSI.*
Methods: *All patients who were admitted to PICU at Phramongkutklao Hospital between January and December 2006 and had central venous catheter (CVC) inserted from the operation room before admission or CVC placed in the PICU were included in a cohort study with longitudinal assessment of an overall catheter care policy targeted at the reduction of vascular access infection. The guideline included five key components (hand hygiene, maximal barrier precautions, povidine skin antiseptic, optimal catheter site selection, daily review of line necessity with prompt removal of unnecessary lines) called "central line bundle". All nursing staffs in the PICU were asked to attend an educational meeting in order to review the scientific data on vascular access insertion, device use and care. Data regarding age, underlying disease, location of insertion, duration, and complication were recorded.*
Results: *A total of 61 patients were recruited. Average duration of catheterization was 8.7 days. Complications were found in 8 cases (13.1%). Hematoma was the most common complication (6.6%) followed by infection (3.3%). Rate of CRBSI was reduced from 2.6 per 1000 catheter days to 2.4 per 1000 catheter days after implementing the new practice guideline.*
Conclusion: *Rate of CRBSI was reduced after implementing the new "central line bundle" guideline to prevent CRBSI.*

Keyword: *Catheter-related blood stream infection, Central venous catheters*

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Central venous catheters (CVCs) are indispensable in modern-day medical practice, particularly in intensive care units (ICUs). CVCs allow measurement of hemodynamic variables and nutritional support that cannot be given safely through peripheral venous catheters. Unfortunately, the use of CVCs is associated with adverse events that are both hazardous to patients and expensive to treat. The complications include mechanical complications such as hematoma, arterial puncture and local or systemic infection. The incidence of catheter related bloodstream infection (CRBSI) varies considerably by type of catheter, manipulation, patient-related factors and duration of catheter use.

Forty-eight percent of ICU patients in America have CVCs, accounting for about 15 million central venous catheter days per year in ICUs[1-3]. Approximately 5.3 central line infections occur per 1,000 catheter days in ICUs. The attributed mortality for central line infections is approximately 1.8%[1]. During 1992-2001, CDC's National Nosocomial Infection Surveillance System (NNIS) hospitals reported rate of CRBSI in ICU ranging from 2.9 to 11.3 per 1,000 catheter days. The incidence of CRBSI in PICU in America is 7.6 per 1,000 catheter days. The most common pathogens are coagulase-negative Staphylococcus, followed by *Staphylococcus aureus* and gram negative rods[4-6].

In 2005, PICU of Phramongkutklao Hospital implemented a new guideline to prevent CRBSI based

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on the guideline of the Institute For Healthcare Improvement (IHI)[7] called "central line bundle". Five key components of central line bundle include hand hygiene, maximal barrier precautions, povidine skin antiseptic, optimal catheter site selection, daily review of line necessity with prompt removal of unnecessary lines. The purpose of the present study was to demonstrate the incidence of CRBSI in the PICU at Phramongkutklao Hospital after implementing the new guideline to prevent CRBSI.

Material and Method

A prospective descriptive study was conducted. All patients who were admitted to PICU at Phramongkutklao Hospital between January and December 2006 and had CVCs inserted from the operation room before admission or CVCs placed in PICU were included in the cohort study. The patients who had duration of CVCs insertion less than 24 hours were excluded. All nursing staffs in the PICU were asked to attend an educational meeting in order to review the scientific data on vascular access insertion, device use and care.

Data gathering age, sex, underlying disease, location of insertion, duration, method and complication were recorded. The central line checklist and daily goal were developed in order to assure guideline compliance. During CVC insertion, the central line checklist was performed. CVCs data were followed and collected for 14 days or until removing. CDC definition of CRBSI[3] was used and the rate of CRBSI was reported in per 1,000 catheter days. The incidence of CRBSI of the year 2005, before implementing the new guideline, was gathered from the Infectious Control Unit of Phramongkutklao Hospital.

Statistical analysis

Data analysis was undertaken using SPSS statistical software. All descriptive data were presented as mean or percentage. The difference of rate of CRBSI between the study year and the prior year was reported by incidence-rate ratio. The present study was approved by the Phramongkutklao medical ethic committee.

Results

During the study period, 231 patients were admitted in PICU of Phramongkutklao Hospital. A total of 170 patients did not have CVCs therefore 61 patients (26.4%) were recruited. There were 32 (52.5%) males and 29 (47.5%) females with the mean age of 5.5 years old (range 15 days-17 years). All patients had underlying diseases and cardiac problem was the most common (Table 1).

The preferred sites for CVCs insertion were internal jugular (n = 28, 45.9%) and femoral vein (n = 26, 42.6%). Most of the CVCs were used for hemodynamic monitoring and venous access of drug, fluid, or nutrition. Majority of the catheter placements were done by elective procedures (n = 55, 90.2%). The details of central line insertion data were shown in Table 2.

Thirty CVCs (49.2%) were inserted by the anesthesiologists. Mean duration of catheterization

Table 1. Demographic data (n = 61)

Characteristic	Number (%) (n = 61)
Sex	
Boys	32 (52.5)
Girls	29 (47.5)
Organ systems and types of underlying diseases	
Kidney	6 (9.8)
Central nervous system	5 (8.2)
Respiratory tract	11 (18.0)
Genetic	1 (1.6)
Cardiac (Heart and circulation)	30 (49.2)
Infection	2 (3.3)
Blood and hematologic malignancy	4 (6.6)
Gastrointestinal tract	1 (1.6)
Skin	1 (1.6)

Table 2. Central line insertion data (n = 61)

Characteristic	Number (%) (n = 61)
Character of catheter	
double lumens	27 (44.3)
triple lumens	34 (55.7)
Type of catheters	
CVC, not hemodialysis	57 (93.5)
CVC, hemodialysis	4 (6.5)
Type of placement	
emergency	6 (9.8)
elective	55 (90.2)
Place of CVC insertion	
operation room	31 (50.8)
PICU	30 (49.2)
Site of insertion	
subclavian vein	7 (11.5)
internal jugular vein	28 (45.9)
femoral vein	26 (42.6)

was 8.7 ± 9.3 days (range 2-41 days) and mean attempt of central line insertion was 2.67 times. The mean and SD of duration of central line insertion procedure was 21.9 ± 18.4 minutes. The compliance to the new guideline was 96.7-100% in all keys components of the central line bundle except the use of maximal barrier precaution (88.5%) (Table 3). There were 8 cases (13.1%) with complications and hematoma found most common. (n = 4, 6.6%). There was 1 case of CRBSI and hematoma (n = 1, 1.6%) and 1 case of local infection even he achieved all key components (Table 4). The causative organism in the both cases was coagulase negative Staphylococcus.

Rate of CRBSI during the study period in 2006 decreased as compared to the rate in 2005, from 2.6 to 2.4 per 1,000 catheter days. The incidence-rate ratio was 0.92. The catheter days were reduced after implementing the new practical guideline from 772 to 404 days.

Table 3. Compliance of "The central line bundle" (n = 61)

Intervention	Compliance (%)
Hand hygiene	98.4
Maximal barrier precautions	88.5
Used a hat, mask, sterile gown	90.2
Used sterile gloves	100
Draped the procedure site in a sterile fashion	96.7
Povidine skin antiseptic	96.7
Optimal catheter site selection	100
Daily review of line necessity	100

Table 4. Complication of central venous catheter insertion (n = 61)

Complication	Insertion site	Number	Percentage (%)
Hematoma	Femoral vein	4	6.6
Infection		2	3.3
- Local infection	Internal jugular vein	1	1.6
- CRBSI	Femoral vein	1	1.6
Bleeding	Subclavian vein	1	1.6
Pneumothorax	Subclavian vein	1	1.6
Thrombosis	Femoral vein	1	1.6

1 case had hematoma and CRBSI

Discussion

The CRBSI rate of present study was 2.4 per 1,000 catheter days, which is consistent with the study reported by Salzman[8]. Although the present study shows the reduction of CRBSI rate from 2.6 per 1,000 catheter days to 2.4 per 1,000 catheter days, the CRBSI was not eliminated after implementing the new guideline which was demonstrated in the study of Barenholtz[1] and Pronovost[9].

Several studies in adult[2-3,7,10] showed the correlation between complications and site of catheter insertions, particularly the site at femoral vein. In the present study, although mechanical complications of femoral site insertion such as hematoma and thrombosis were found more than other sites, they were not serious complications. The femoral site insertion did not increase the incidence of CRBSI. Kanter[11] demonstrated that femoral catheters inserted in pediatric patient had a low incidence of mechanical complications and might have an equivalent infection rate to that of non-femoral catheters, depending on underlying diseases of patients and surgeon's skill.

The present study showed that CRBSI occurred on the 12th day after CVC insertion. The pathologen was coagulase negative Staphylococcus. It is clear that the risk of infection increases by the duration of catheter insertion. In the present study, the patient who had CRBSI had congenital heart disease and tracheoesophageal fistula. He also had many surgical procedures which put him at a higher risk of acquiring infections.

The incidence of CRBSI of the year 2005, before implementing the new guideline, was gathered from the Infectious Control Unit of Phramongkutklao Hospital. Unfortunately, there was no raw data to compare the risk factors between before and after implementing the new guideline.

Because of the small subject number of this study, the authors suggest that multicenter study should be performed to further determine the impact of this new practice guideline.

Conclusion

The rate of CRBSI was reduced after implementing the new "central line bundle" guideline to prevent CRBSI.

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การศึกษาอุบัติการณ์การติดเชื้อในกระแสเลือดที่เกี่ยวเนื่องกับสายสวนหลอดเลือดดำส่วนกลางในผู้ป่วยเด็กที่เข้ารับการรักษาในหออภิบาลผู้ป่วยเด็กภาวะวิกฤตในโรงพยาบาลพระมงกุฎเกล้าหลังการใช้แนวทางป้องกันการติดเชื้อในกระแสเลือดจากการใส่สายสวนหลอดเลือดดำส่วนกลางแบบใหม่

สุพิชญา จึงจิตรักษ์, สนิตรา ศิริธางกูล, ดุสิต สถาวร, ชลิดา เลาหพันธ์

วัตถุประสงค์: *เพื่อศึกษาหาอุบัติการณ์การติดเชื้อในกระแสเลือดที่เกี่ยวเนื่องกับสายสวนหลอดเลือดดำส่วนกลางในผู้ป่วยเด็กที่เข้ารับการรักษาในหออภิบาลผู้ป่วยเด็กภาวะวิกฤต โรงพยาบาลพระมงกุฎเกล้า หลังการใช้แนวทางป้องกันการติดเชื้อในกระแสเลือดจากการใส่สายสวนหลอดเลือดดำส่วนกลางแบบใหม่*

วัสดุและวิธีการ: *ศึกษาในผู้ป่วยอายุ 0-18 ปี ทุกรายที่เข้ารับการรักษาในหออภิบาลผู้ป่วยเด็กภาวะวิกฤต โรงพยาบาลพระมงกุฎเกล้า ระหว่างวันที่ 1 มกราคม 2549 ถึง 31 ธันวาคม 2549 ที่ได้รับการใส่สายสวนหลอดเลือดดำส่วนกลางจากห้องผ่าตัดหรือหออภิบาลผู้ป่วยเด็กภาวะวิกฤต โดยเก็บข้อมูลเกี่ยวกับอายุ เพศ โรคที่ได้รับการวินิจฉัย ตำแหน่งที่ทำการใส่สายสวน และภาวะแทรกซ้อนที่เกิดขึ้น ผู้ป่วยทุกรายได้รับการดูแลตามแนวทางป้องกันการติดเชื้อในกระแสเลือด จากการใส่สายสวนหลอดเลือดดำแบบใหม่ที่เรียกว่าThe central line bundle*

ผลการศึกษา: *มีผู้ป่วยเข้าร่วมการศึกษา จำนวน 61 คน จำนวนวันที่ใส่สายสวนคิดเป็นค่าเฉลี่ยเท่ากับ 8.7 วัน พบภาวะแทรกซ้อนจากการใส่สายสวน จำนวน 8 ราย คิดเป็นร้อยละ 13.1 ได้แก่ ก้อนเลือดที่ตำแหน่งเข็มแทงและการติดเชื้อ คิดเป็นร้อยละ 6.6 และ 3.3 ตามลำดับ ในช่วงเวลาที่ศึกษาพบการติดเชื้อในกระแสเลือดที่เกี่ยวเนื่องกับสายสวนหลอดเลือดดำส่วนกลาง (CRBSI) เพียง 1 ราย คิดเป็น 2.4 ต่อ 1,000 วันที่ใส่สายสวน เปรียบเทียบกับ 2.6 ต่อ 1,000 วันที่ใส่สายสวนในปี 2548*

สรุป: *อุบัติการณ์ของการติดเชื้อในกระแสเลือดที่เกี่ยวเนื่องกับสายสวนหลอดเลือดดำส่วนกลางหลังการใช้แนวทางป้องกันการติดเชื้อในกระแสเลือดจากการใส่สายสวนหลอดเลือดดำที่เรียกว่าthe central line bundle ลดลง คิดเป็น 0.92 เท่า เมื่อเทียบกับก่อนการนำแนวทางป้องกันแบบใหม่มาใช้*