

# The Quality Improvement of Central Venous Catheter Associated Blood Stream Infection (CABSI) by New Clinical Practice Guideline in Pediatric ICU Siriraj Hospital

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## ABSTRACT

**Objective:** To evaluate the effect of a new clinical practice guideline (CPG) in central venous catheter care to prevent catheter associated bloodstream infection (CABSI) in pediatric intensive care units at Siriraj Hospital.

**Methods:** Nonrandomized pre/post observational trial. The new clinical practice guideline in central venous catheter usage was given for a 6 month period from April to October 2003. The impact of CPG was observed by measurement of CABSI rate per 1,000 catheter days, over a 6 months period of pre/post CPG in two Pediatric Intensive Care Units.

**Results:** Before the CPG implementation, the average CABSI rate of both PICUs was 15 episodes per 1,000 catheter days. After the CPG, the rates of CABSI in both units were markedly reduced. One unit was reduced to 3.8 episodes per 1,000 catheter days and another unit had a 6 month CABSI free period.

**Conclusion:** The new CPG in central venous catheter (CVC) care was excellent. It facilitated not only the medical personnel carrying out the CVC such as to make it easier to understand and reduce the variation of practice, but also it can improve the quality of care.

**Keywords:** Catheter-associated bloodstream infection; central venous catheter; clinical practice guideline

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Central venous catheter (CVC) is widely used in adult and pediatric treatment especially in intensive care units. These catheters are normally used for monitoring of central venous pressure, lack of venous access, inotrope infusion or high concentration solutions which cannot be given peripherally such as total parenteral nutrition (TPN). The infectious complications of CVC can be categorized in groups as exit-site infection, catheter colonization and catheter associated blood stream infection.<sup>1</sup> The catheter associated bloodstream infection is one of the most common nosocomial infections in the pediatric and adult intensive care units and has been estimated to occur in 3 to 7 % of all patients with CVCs.<sup>2</sup> Several studies have identified modifiable risk factors to reduce the risk of CABSI. These include employment of "maximum barrier precautions" during catheter insertion (i.e., sterile gloves, gowns, and large drapes, along with surgical masks),<sup>3,4</sup> use of subclavian vs. internal jugular or femoral

vein insertion sites,<sup>5,6</sup> use avoidance of catheter routine exchanges,<sup>7,8</sup> and removal of insertion site dressing when it becomes nonocclusive, soiled, or bloody.<sup>9</sup> Based on the findings of these and other studies, the Hospital Infection Control Practice Advisory Committee developed guidelines for prevention of intravascular device related nosocomial infections<sup>10</sup> which were updated in 2002.<sup>11</sup> Furthermore, ongoing education and training of health care workers regarding for the procedures for insertion and maintenance of CVCs and appropriate infection control had been demonstrated to prevent the CABSI.<sup>12,13</sup> Before CVC guidelines, the average incidence of CABSI in pediatric ICUs of Siriraj Hospital was as high as 15 episodes per 1,000 catheter days in 2002 to early 2003.<sup>14</sup> Because of no specific guideline for pediatric CVCs, we adapted the current guideline of how to prevent the infectious and noninfectious complications of adult CVCs<sup>9</sup> for this study.

## MATERIALS AND METHODS

The study sites were two 6-bed Pediatric ICUs of Siriraj Hospital, a tertiary and medical school hospital in

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**TABLE 1.** The Characteristics of CVC used after implementation of CPG.

Character of catheters	CVCs (% of total 38 CVCs)
<b>Site of insertion</b>	
Femoral	31 (81.6)
Internal jugular	6 (15.8)
Subclavian	1 (2.6)
<b>Number of lumen</b>	
2-lumen	34 (89.4)
3-lumen	4 (10.53)
<b>Size</b>	
4 FR	16 (42.1)
7 FR	18 (47.4)
9 FR	4 (10.5)

Bangkok, Thailand, where around 400-500 of pediatric critical care patients are admitted per year. The CVCs were used approximately 800 catheter days per year in each ICU. No medical students participate in patient care in the ICU. The certified ICU nurses provide the nursing care of the CVCs. All CVCs were inserted percutaneously by ICU consultants and pediatric residents. Only in busy times or emergency situations, blood samples or CVC manipulations were done via CVCs by pediatric residents. The incidence of the nosocomial catheter associated bloodstream infection was monitored and reported by the Hospital Infectious Control Department. The data records were decided and filled in by the ICU care team which included ICU doctor and nurses. The data were included of the incidence of the nosocomial catheter-associated bloodstream infection, exit site infection, catheter colonization, problems and non-infectious complications such as catheter obstruction, catheter malposition and patient demographics.

#### Definitions:<sup>9</sup>

Exit-site infection: Erythema, tenderness, induration, or purulence within 2 cm of the exit site of the catheter.

Catheter colonization: Growth of organisms from a catheter segment by either semi quantitative or quantitative culture.

Catheter associated blood stream infection (CABSI): An isolation of the same organism from the blood culture of a catheter segment, accompanied by clinical symptoms of blood stream infection without any other apparent source of infection. A CABSI was considered if it had occurred > 24 hrs after admission to the ICU or 48 hrs after discharge from the ICU. For low virulence organisms such as *Staphylococcus coagulase negative*, two or more positive blood cultures obtained on separate occasions had to be noted for the isolate to be considered a true pathogen and at least one blood culture had to be peripheral venipuncture.<sup>15</sup>

Even with the categorized definitions we had defined, sometimes it was difficult to give the certain diagnosis of

**TABLE 2.** The indication of CVC usage.

Indication of CVC	CVCs (% of total 38 CVCs)
Monitoring of CVP	4 (10.5)
Lack of venous access	14 (36.8)
Inotrope infusion	8 (21.1)
Total parenteral nutrition	4 (10.5)
Chemotherapy	1 (2.6)
Others	7 (18.4)

**TABLE 3.** The complication which indicated removal of catheter.

Complication when stopped using	CVCs (% of total 38 CVCs)
Accidental removal	3 (7.8)
Exit site infection	3 (7.8)
Colonization	3 (7.8)
Blocked	3 (7.8)
Leak or broken lines	3 (7.8)
Marked swelling of soft tissue	1 (2.6)

CABSI and exit site infection.<sup>16</sup> Practically, because of the difficulty of taking blood samples in pediatrics, sometimes the specimen was only able to be taken either via a central line or via a peripheral, some blood cultures were grown from 2 or more bacteria; and these may require the correlation of clinical symptoms to diagnose as CABSI or just contaminated specimens. For the instances of uncertain-diagnosis cases, to give the diagnosis whether or not CABSI, we discussed with the Hospital Infection Control Team to make the conclusive diagnosis.

#### Guidelines:

The guidelines included the criteria of CVC insertion, the type of CVC (surgical implantation or percutaneous insertion) which should be considered, the care map of how to do with the lines (such as blood culture, line needs to be out, etc.) in suspicious cases (such as fever, redness around the catheter) and the CABSI control policy (such as the dressing of the wound, the frequency of connector or fluid line change, etc).

## RESULTS

38 CVCs in 25 patients in the 6 month period were included the study during May to October 2003. All catheters were the product of Arrow Company USA, and were percutaneously inserted. The femoral vein was the most common site (81.6%), followed by the internal jugular (15.8%) and the subclavian vein (2.6%), respectively. Most CVCs (34 of 38) were double lumen catheters and the rest were triple lumen catheters. The size of CVC's were 4 Fr (42.1%), 7 Fr (47.4%) and 9 Fr. (10.5%). (Table 1) The time of CVCs use ranged from 1 to 50 (10.6 ± 9.3) days.

The characteristics of patients were hematology and oncology 42.1%, cardiac 18.4%, pulmonary 47.4%. Nineteen of 38 lines (50%) were inserted in patients who had infection at any sites before the CVC insertion which were bacterial sepsis, UTI or pneumonia. Seven cases (14.9%) had a previous history of CVC line insertion. For the indication for CVCs usage, they were lack of venous access, inotrope infusion, TPN and for monitoring of central venous pressure. (Table 2)

Most CVCs (33 of 38) were inserted in the ICU and the rest were put in in the operating room or general ward. For the skills of CVC placement, the most (22 of 38 or 57.9 %) were done by a pediatric resident and the rest were done by ICU consultants and anesthesiologists in the OR.

The immediate complications were found in 10.5% (4 of 38) of total CVCs which were minor complications such as arterial puncture and catheter malposition which required adjustment post-insertion.

The problems found while using the lines were suspected new nosocomial infection, new fever, inflammation of the wound around the catheter and a positive blood culture. For the fever during use of CVCs, most were infections in



**Fig 1.** The monthly plot chart of CABSI per 1,000 catheter day of ICU1, ICU2 and Siriraj Hospital (average of 12 ICUs of adult and pediatric ICUs). The chart demonstrated the rate of CABSI after CPG compared to the average of hospital.

(the red arrow show the time of CPG implementation)

(Modified from the reference No.14)

other specific organs such as pneumonia, peritonitis. The blood cultures were positive for 5 cases in suspected cases which were bacterial sepsis secondary from bowel perforation (1 case), CABSI (1 case) and 3 contaminated specimens. The only CABSI case was a 13 year-old girl with severe aplastic anemia who required the CVC for lack of access for anti-thymoglobulin infusion. The line was inserted electively at the internal jugular vein in the operating room. She had fever on day 3 after insertion of CVC and positive *E. coli* in her blood specimen from the central venous catheter. The details of contaminated specimens were growth of *Staphylococcus coagulase negative* for 1 case, *Candida spp.* 1 case and 2 cases of > 1 organisms grown in the same blood samples each of which were contaminated by *Streptococcus viridans* or *Bacillus spp.* The contaminated specimens were repeated before treatment and all results became negative.

Apart from CABSI, we found 3 cases of exit-site infection and 3 cases of catheter colonization which were documented by post removal culture.

The non-infectious complications or problems were accidental removal 3 cases, blocked lines 3 cases, leaking or broken lines 3 cases and marked swelling of the soft tissue around due to partial removal of catheter 1 case. Because of the complications, 8 lines needed reinsertion. (Table 3)

During the 6 month of CPG, the rate of CABSI were markedly reduced in both ICUs : one unit was reduced to 3.8 episodes per 1,000 catheter days (calculated by the average over a 6 month period) and another unit had a 6 months disease free period. The rates of CABSI by time, pre and post guideline period were plotted in a graph to demonstrate the efficacy. (Fig 1)

## DISCUSSION

The decision making what to do about the line problems and the correct diagnoses were difficult and complex to understand. The use of CPG had demonstrated the quality improvement in patient care. Although there were many risk factors which affected the CABSI such as patient factors (immune function, positive blood culture pre-insertion, difficult access), catheter factors (type, site, size, number of lumens, antibiotic coated) and processes of care (dressing, care of connectors and fluid lines), the CPG summarized these problems in groups and made them easier to understand and practice. The main key

points were: use CVC only whenever indicated, off as soon as possible, act properly on suspicious lines and reinsert whenever indicated. This study had demonstrated that in a short term period of this, CPG could dramatically reduce the CABSI.

Apart from infectious complications, the noninfectious complications of CVC usage were observed in this study, but the CPG could not demonstrate the quality improvement in this point of view because the pre-CPG information was not available.

## CONCLUSION

The CPG on CVC care was very helpful on the reduction of CABSI. It also helped the physician and ICU nurse to make a decision when the problems occurred such as what they had to do with the culture, can they keep the line or is the line needed to be out etc. In the unit of the teaching center, there were many medical personnel rotated in and out such as pediatric residents, and in training ICU nurses. These were the factors on which we had to focus and explain to them that how important they have to strictly follow the CVC guidelines. Anyway, the efficiency of the CPG depended on the adherence of the users which were likely to require a booster intervention to improve the adherence after use.

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