Effect of Insertion Site on Risk of Central Line Associated Blood Stream Infection in Critically Ill Patients

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Abstract

**Context:** Femoral, jugular and subclavian catheterization are performed during critically ill patient care which may lead to additional morbidity, mortality, and infectious complications.

**Objectives:** To determine the Subclavian, Jugular or Femoral central venous catheters (CVC) risk of central line associated blood stream infection (CLABSI), the CVC sites related complications and patients mortality.

**Methods:** Retrospective observational study in medical-surgical ICU of a tertiary care hospital on adult patients admitted from January 2010 till December 2013. We enrolled 840 patients divided into 283 internal jugular (IJ), 270 subclavian (SC) and 287 femoral (FC) in which lines were inserted by experienced physicians, using CVC bundle checklist. Patient characteristics and catheter duration were chosen similar in all groups. CLABSI rate, Complications, and patient’s mortality were the outcomes of the study.

**Results:** Rate of CLABSI in IJ, SC, and FC groups was 5.8 vs 7.2 vs 3.45 per 1000 catheter-days respectively. Mortality in 134 (47%) cases of IJ, 108 (39%) cases of SC and 113 (39%) cases of FC with p-value 0.14, with no significant difference between the 3 groups in CLABSI rate and mortality. Pneumothorax in 6 (2.2%) cases of SC and 11 (3.8%) of IJ with no significant difference between the 2 groups as the p value was 0.3.

**Conclusion:** Site of insertion of CVC does not appear to affect the rate of CLABSI among critically ill patients with no statistical difference in mortality. Pneumothorax was recorded in SC and IJ groups with no preference to either group.

INTRODUCTION

Patients in intensive care units (ICUs) experience a disproportionately high percentage of Hospital Acquired Infection (HAI) compared with patients in non-critical areas [1-3].

The severity of underlying disease, invasive therapeutic procedures that breach normal host defenses and the prevalence of resistant microorganism are the critical factors in the high rate of infection in the ICUs [4].

Central line insertion is considered as one of the fundamental invasive procedures which are taking place in ICUs. Central line associated blood stream infection (CLABSI) remains a leading cause of morbidity and mortality in critically ill patients [5].

Femoral, jugular and subclavian venous catheterization are routinely performed during critically ill patient care. These invasive procedures contribute to additional morbidity, mortality, and costs derived from the interactions between mechanical, infectious and thrombotic complications [6,7].

Femoral venous catheterization which is rapid to perform is considered an emergency procedure to gain vascular access, but should be avoided to limit complications [8,9]. Subclavian site which often a first choice is less suitable for larger catheters such as dialysis catheter [10]. Some studies reported a higher incidence of complications associated with femoral vs jugular catheterization while others reported lower or similar incidence with femoral catheterization. Consequently, the choice between femoral, jugular or subclavian sites remains a subject of debate [11-14].

In this study we compared the three sites of central vascular insertion regarding the rate of catheter related blood stream infections.

**OBJECTIVES**

Primary objective is to determine the incidence of catheter
related blood stream infections in subclavian, jugular, femoral insertion sites.

Secondary objective is to study catheter related complications and ICU mortality.

METHODS

An observational retrospective study in a medical-surgical ICU in a tertiary hospital in KSA, including adult critically ill patients required central line insertion in ICU from Jan 2010 till Dec 2013.

Inclusion criteria: adult patients (>16 years), expected to require support with central line (dialysis, septic shock, shock, etc.).

Exclusion Criteria: local skin infection, chronic renal failure with arteriovenous fistula. Life threatening condition, PICC line, and central lines inserted outside ICU.

The study attained IRB (Institutional Review Board) approval with waived informed consent.

The study enrolled 840 patients divided into 283 Internal Jugular Catheter (IJ), 270 Subclavian Catheter (SC) and 287 Femoral Catheter (FC) in which the catheters were inserted in ICU by experienced physicians with at least 40 previously successful trials of central line insertion, using a standardized CLABSI prevention bundle checklist (Figure 1).

Decisions to remove catheters were made independently by the attending intensivist when the catheters were no longer needed or new access was required (suspicion of catheter-related infection, catheter dysfunction). Patients were followed up until death or ICU discharge.

Incidence of catheter complications and APACHE II score adjusted severity and mortality were calculated for each group.

Definitions

Catheter-related bloodstream infection was defined as catheter-tip colonization plus 2 sets of peripheral blood culture yielding the same species with the same antimicrobial susceptibility as the catheter tip within 48 hours of catheter removal, with no other apparent source of sepsis.

Catheter duration was defined as the time of catheter insertion till the removal from the patient in days.

Statistical analysis

All critically ill patients with central line inserted in ICU were included in the study. SPSS version 21 was used for data analysis. The mean of each group was calculated along with its percentage then the three groups' data were compared and analyzed using kruskal-wall test.

RESULTS

Table 1 shows the critically ill patients characteristics and the mean duration of catheterization which were similar in the three groups.

The rate of CLABSI in IJ, SC and FC groups was 5.8 vs 7.2 vs 3.45 per 1000 catheter-days respectively with p-value of 0.35. ICU Mortality were 134 (47%) cases of IJ group, 108 (39%) cases of SC group and 113 (39%) cases of FC group. There was no significant difference between the 3 groups of CVC in the incidence of CLABSI Rate in the critically ill patients, slight increase in ICU mortality in the IJ group comparing to the other two groups. Pneumothorax occurred in 6 cases (2.2%) cases of SC and 11 cases (3.8%) of IJ with no significant difference between the two groups as the p value was 0.3 (Table 2).

DISCUSSION

In our study we enrolled 840 patients and divided them into 3 groups according to site of central line insertion. We found that CLABSI rate in IJ, SC, FC was not significant in the three groups of the included patients, with p value of 0.35.

These findings could be attributed to the use of standardized CLABSI prevention bundle with regular auditing in our ICU which most probably contributed to both low and insignificant incidence of blood stream infection between different insertion sites of CVC.

This result goes with Deshpande et al., who concluded that the incidence of infectious complications of central venous catheters at the subclavian, internal jugular, and femoral sites clinically and statistically, is not different at all with experienced operators and trained intensive care unit nursing staff care [13].

In Cathedia Study which compared between femoral and jugular venous catheterization, Parieti J et al., concluded that jugular venous catheterization did not reduce the risk of infection compared with the femoral line.

In addition, they suggested that decision for the best insertion site to prevent complications might be more complex to depend solely on the anatomical location [14,15]. Conversely, Merrer J et al., in their RCT stated that femoral venous catheterization is associated with greater risk of infections than subclavian catheterization [16].

However Marik PE et al., showed in a systemic review and meta-analysis that there is no difference in the rate of CLABSI infections between the three sites [17].

Ge X et al., in their systematic review suggested that subclavian and internal jugular, femoral routes have similar risks for catheter related complications in long term catheterization while subclavian CVC is preferable to femoral CVC in short term catheterization, due to higher colonization rather than infection rate which was statistically insignificant [18].
The incidence of CLABSI was reported by Randolph AG et al., to be higher in IJ group than SC grouping unless catheter tunneling was performed; such result is not supported by our findings [19].

High femoral CLABSI rate which was attributed to high body weight as found in several studies [17,18]. This conclusion couldn’t be appreciated in our analysis where we found insignificant effect of the body weight on the infection rate.

In our study APACHE II score and the catheter days in each group were similar.

While APACHE II score was found to have positive correlation with CLABSI incidence according to Cheung et al., and Gunst et al., our data analysis did not find such correlation [20,21].

In addition, the catheter-days in each group were not associated with increased infection rate in contrary with Gunst et al., and Pawar et al., as they detect such strong risk association [22]. This conclusion can be explained by the short catheter-days in our study with a range of 4.2-4.4 days in contrast to the long periods of catheter-days up to 19 days in the aforementioned studies.

Although SC site is anatomically more susceptible for pneumothorax, more cases were recorded in IJC group than SC group which could be related to mild increase in co morbidities.
Table 1: Critically ill patient’s characteristics and the mean duration of catheterization.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Femoral</th>
<th>Jugular</th>
<th>Subclavian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Patients</td>
<td>287</td>
<td>283</td>
<td>270</td>
</tr>
<tr>
<td>Age, mean (SD) y</td>
<td>47 ± 20</td>
<td>51 ± 18</td>
<td>48 ± 18</td>
</tr>
<tr>
<td>Body mass index (mean, SD)</td>
<td>27 ± 6</td>
<td>32 ± 5</td>
<td>31 ± 4</td>
</tr>
<tr>
<td>APACHE II, mean (SD)</td>
<td>19.7 ± 10</td>
<td>22.2 ± 14</td>
<td>21.3 ± 10</td>
</tr>
<tr>
<td>Diagnosis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Septic shock</td>
<td>97(34%)</td>
<td>108 (38%)</td>
<td>94(35%)</td>
</tr>
<tr>
<td>Hypoxic respiratory failure</td>
<td>81(28%)</td>
<td>61(22%)</td>
<td>68 (25%)</td>
</tr>
<tr>
<td>CNS catastrophe</td>
<td>23(8%)</td>
<td>25(9%)</td>
<td>36(13%)</td>
</tr>
<tr>
<td>Postoperative</td>
<td>13(5%)</td>
<td>21(7%)</td>
<td>16(6%)</td>
</tr>
<tr>
<td>Others</td>
<td>73(24%)</td>
<td>68(24%)</td>
<td>56(21%)</td>
</tr>
<tr>
<td>Catheter duration mean, SD</td>
<td>4.2 ± 1</td>
<td>4.4 ± 2</td>
<td>4.5 ± 1</td>
</tr>
</tbody>
</table>

Table 2: Significant difference between the two groups.

<table>
<thead>
<tr>
<th>Patients group</th>
<th>Femoral</th>
<th>Jugular</th>
<th>Subclavian</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micro-organism isolated</td>
<td>Serratia</td>
<td>Staphylococcus</td>
<td>Staph aureus</td>
<td></td>
</tr>
<tr>
<td>E. marcescens</td>
<td>E. marcescens</td>
<td>E. marcescens</td>
<td>E. marcescens</td>
<td>ESBL-Klebselsa</td>
</tr>
<tr>
<td>Ecoli-ESBL</td>
<td>Candida</td>
<td>Pneumonae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ecoli-MDR</td>
<td>parpsilosis</td>
<td>Pseudomonas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enterobacter</td>
<td>Serratia</td>
<td>Acintobacter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ecoli-ESBL</td>
<td>marcescens</td>
<td>Staphylococcus</td>
<td>epidermidis</td>
<td></td>
</tr>
<tr>
<td>Ecoli-MDR</td>
<td>Ecoli-ESBL</td>
<td>Acintobacter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incidence per 1000</td>
<td>3.45</td>
<td>5.8</td>
<td>7.2</td>
<td>0.35</td>
</tr>
<tr>
<td>catheter-days</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complications</td>
<td>0(0%)</td>
<td>6 (2.2%)</td>
<td>11 (3.8%)</td>
<td>0.3</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mortality #, %</td>
<td>113(39%)</td>
<td>134(47%)</td>
<td>108(46%)</td>
<td>0.14</td>
</tr>
</tbody>
</table>

in the jugular group; however there was insignificant difference between the two groups with P value 0.3.

The difference between ICU mortality in the three groups was insignificant with P value 0.1, which could be due to comparable APACHE II score, and the use of standardized protocols to manage critically ill patients in our unit.

**CONCLUSION**

Site of CVC insertion does not seemingly affect the rate of CLABSI among critically ill patients provided the strict adherence to CVC care bundle by experienced physicians and proper nursing care. Similarly, pneumothorax and mortality were statistically insignificant between the studied groups.

**AUTHOR CONTRIBUTION**

Individualized contribution including writing and reviewing the manuscript were carried out by primary author Dr. Naglaa and coauthor Dr. Hammadi. A multitude of general revision sessions by were held by Dr. Hammadi, Dr. Rasheed while data validation and revision were done by Ms. Nadia (an infection control specialist).

**REFERENCES**


