

Catheter-associated bloodstream infections (CA-BSI) in wards: a prospective comparative study between subclavian and jugular access

Infecção de corrente sanguínea relacionada a cateter venoso central (ICSRC) em enfermarias: estudo prospectivo comparativo entre subclávia e jugular interna

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Abstract

Background: Positive hemoculture associated with central venous catheters has been studied in intensive care units (ICU), but is still controversial if the internal jugular vein access has a higher incidence of infection than subclavian or femoral vein access.

Objective: To compare catheter-related bloodstream infection (CABSI) rates between internal jugular and subclavian vein access in patients admitted to surgical wards.

Methods: This is a prospective, descriptive and comparative study of 114 central venous catheters placed in 96 patients admitted to the surgical wards of a tertiary-care hospital. The following parameters were studied: local of insertion of the catheter (internal jugular versus subclavian), number of lumens (single versus double) and duration of use (longer or shorter than 14 days), in order to determine their influence in CABSI rates.

Results: The CABSI rate was 9,64% (11 catheters), with no significant statistical differences regarding the number of lumens ($p=0.274$), and duration of use ($p=0.156$). The CABSI rate was higher in the subclavian vein than in the internal jugular vein access (OR 11.2, 95%CI 1.4–90.8; $p=0.023$).

Conclusions: The internal jugular vein access has a lesser incidence of CABSI than subclavian vein access in patients admitted to surgical wards.

Keywords: catheterization, central venous; cross infection; bacteremia.

Resumo

Contexto: Hemocultura positiva associada a cateter venoso central tem sido estudada em unidades de terapia intensiva (UTI), mas ainda é controverso se o acesso jugular tem maior incidência de complicações infecciosas que o acesso na veia subclávia.

Objetivo: Comparar índice de infecção entre os acessos na jugular interna e os na veia subclávia em pacientes internados nas enfermarias de cirurgia.

Métodos: Estudo prospectivo, descritivo e comparativo com 114 cateteres em 96 pacientes admitidos nas enfermarias de cirurgia de um Hospital Quaternário, tendo como variáveis o local de inserção, número de lumens, tempo de uso, comparando-os com o índice de complicações infecciosas.

Resultados: O índice de infecção foi de 9,64% (11 cateteres), sem significância estatística quando comparados o número de lumens (mono versus duplo) e infecção ($p=0,274$); também sem significância estatística a comparação entre o tempo de uso (≥ 14 dias) e infecção ($p=0,156$). Comparando os acessos jugular e subclávia, encontramos significância estatística tendo infecção em 17,2% na subclávia e 1,8% na jugular, com $p=0,005$. Índice de Hemocultura positivo associado a cateter venoso central foi maior no acesso subclávia quando comparado com jugular interna, com OR 11,2, IC95% 1,4–90,9; $p=0,023$.

Conclusões: O acesso venoso central na jugular interna tem menor risco de infecção se comparado com subclávia em enfermarias.

Palavras-chave: cateterismo venoso central; infecção hospitalar; bacteriemia.

Study carried out at Irmandade Santa Casa de Misericórdia de São Paulo – São Paulo (SP), Brazil.

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Introduction

The development of multiple techniques and the technological advances in vascular access procedures have prolonged and saved the lives of innumerable patients. However, vascular access procedures are not free of complications that can sometimes be catastrophic. For this reason, great care should be taken in the care of such patients from the moment of catheter insertion through catheter removal.

In the United States, it is estimated that about 5 million central venous catheters (CVC) are inserted in patients every year. Catheter-related bloodstream infection (CABSI) is the third most common cause of nosocomial infection (14%)¹. As a consequence, hospital length of stay is increased from 7 to 19 days, with mortality rates as high as 25%^{2,3}.

Risk factors for this complication are: a) duration of catheter use; b) type of catheter; c) the number of lumens; d) type of infusion solution; e) insertion technique; f) insertion site^{4,5}. It is well established that, for central venous catheters, the infection rate is higher when the femoral access, rather than the jugular or subclavian access is used. There is no consensus in the literature, however, when the latter two insertion sites are compared. Some papers have shown higher infection rates for the internal jugular access, but only in ICU patients^{5,6}.

There are few published studies of patients admitted to settings other than the ICU. Marshall et al. performed a search on the National Library Medicine in 2007 using the key words "bloodstream", "infection" and "non-ICU", but were able to find only four papers. The first large observational and descriptive study on this subject was conducted in Germany and published in 2006. The authors found an infection rate of 4.3/1000 days of use, which is higher than the rate of 1.8/1000 days of use in the ICU⁸.

The first large observational study carried out in the USA in 2007, showed an infection rate in ICUs similar to that from Germany⁷ — a controversial result, for it was expected that the infection rate would be lower in patients with less severe disease outside the ICU. A cross-sectional study published by Trick et al.⁹ in 2004 showed that 83% of all questionable catheter insertions were performed in the ward (1.8% in ICU vs 8.5% in ward), which suggests that one of the factors predisposing to catheter-related infection in wards would be the large number of questionable insertions. There have been no studies in Brazil or in the international

literature addressing the issue of insertion sites as the cause of (CABSI).

Thus, due to the high frequency of CVC insertion in surgical patients, the severe complications of such procedures, the economic impact of bacteremia or sepsis in the treatment of those patients, and the dearth of studies on catheter insertion in the ward, we decided to study which venous insertion sites are most frequently associated with (CABSI).

Patients and Methods

From March 11 through June 11 2009, a prospective, descriptive and comparative study was carried out in the surgical wards of *Hospital Central da Santa Casa de São Paulo*. A total of 96 patients had 114 catheters, evaluated by filling a protocol and evaluated from the day of insertion to the day of removal.

Inclusion criteria: all patients admitted to a ward who required central venous access, had the catheter inserted through the jugular or subclavian veins and had the protocol filled correctly.

Exclusion criteria: inadequate filling of the protocol and catheter insertion by venous accesses other than the subclavian and jugular veins.

Catheter insertion was performed by anesthesiology and surgery resident physicians in operating rooms or in the surgical wards, always using aseptic technique. There was no distinction in our protocol between catheters inserted in either setting. The choice of jugular or subclavian access was random, and the conversion from one site to the other during the procedure was not reported in the protocol.

Information on the outcome and complications of each CVC was collected and reported on the protocol by two nurses of the Vascular Access Group (GAV) of the *Santa Casa de São Paulo*.

The criteria for the diagnosis of CABSI were: paired blood cultures collected from a peripheral vein and from the CVC, with the culture from the CVC turning positive earlier and with a higher number of micro-organisms than the peripheral blood; and the growth of the same micro-organism from both samples; clinical signs of infection such as fever and/or chills; and the exclusion of other causes of bloodstream infection. Our criteria were based on the CDC Guidelines 2002⁶. The time lag between the positive culture from the CVC to the peripheral blood sample was 120 minutes. According to Bouza et al., in a study¹⁰ that compared different methods of

CABSI diagnosis, this scheme presents higher sensitivity and negative predictive values. The onset of symptoms of sepsis more than 48 hours after the patient's admission to the ward was also a diagnosis criterion, according to the infection protocol described by Marschall et al.⁷

Blood culture collection was performed according to the institution's protocol: 10 mL of blood collected from the catheter after discarding the initial 10 mL and 10 mL of blood collected from a peripheral vein were immediately sent to analysis in separate test tubes.

All cases of infection received a final evaluation from an infectologist of GAV.

All catheters were evaluated by the medical team, but the patient's attending physician made the decision of removing or not the catheter. All catheters that were removed had positive blood cultures.

Regarding statistical analysis, all variables were submitted to descriptive analysis. Quantitative variables were assessed according to minimum and maximum values, calculation of mean, standard deviation and median. For qualitative variables, absolute and relative frequencies were calculated. The Student *t* test was used to compare means. The chi-square test was used to evaluate proportion homogeneity, and when expected frequencies were less than 5, the Fisher Exact test was used. To obtain predictive factors of death, the model for multivariate analysis was adjusted. Sensitivity and specificity values were determined by the Receiver Operating Characteristic (ROC) curve, while Odds Ratio was obtained by logistic regression. The software used for statistical analysis was the SPSS 15.0 software, with significance level set at 5%.

The study protocol was approved by the Ethics Committee of *Irmandade Santa Casa de Misericórdia de São Paulo* (protocol 030/10).

Results

During the study, 114 catheters from 96 patients were analyzed, with results depicted in Table 1. The group of patients was comprised of 35 females (36.4%) and 61 males (63.5%), with mean age of 59 years, and mean hospital stay of 18 days. Catheter-related infection was identified in 9.64% of the cases (11 catheters).

Mean catheter duration of use was 12.3 days (1 to 69 days), and 31.3% of all catheters were used for more than 15 days. No protocol of catheter removal or exchange (CDC guidelines) was necessary⁶. The statistical analysis on days of use and infection did not show significant correlations ($p=0.156$), although 19.4% of catheters (7 out of 36) used for more than 14 days had to be removed for infection.

Regarding the number of lumens, one case had to be excluded from the sample because the number of catheter lumens was not informed. Out of the total, 54.8% (62) were double-lumen catheters and 45.1% (51) were single-lumen catheters. In the comparative analysis, 4 out of the 51 single-lumen catheters (7.84%) and 7 out of the 62 double-lumen catheters (11.9%) presented infection, without statistically significant differences ($p=0.274$).

The micro-organisms found in blood cultures were similar to those reported in literature, that is, polymicrobial in 2 cases (18.1%) and monomicrobial in 9 cases (81.8%). Negative-coagulase *staphylococcus* was the most common finding, with 5 positive cultures, followed by *Pseudomonas aeruginosa*, identified in 4 cultures.

The subclavian vein was the access in 58 cases (50.9%) and the jugular vein in 56 cases (49.1%). Regarding the catheter insertion site, statistical analysis showed infection rates of 17.2% in the subclavian vein and 1.8% in

Table 1. Characteristics comparison between infected and non-infected catheters.

Characteristics	Positive blood culture	Negative blood culture	Total
Male patients	9 (24.30%)	28 (76.70%)	37 (36.60%)
Female patients	4 (6.35%)	60 (93.65%)	64 (63.40%)
Age	59 years (35-74)	52.9 years (19-83)	Mean: 53.46 years
Time of use ^a <14 days	6 (7.20%)	77 (96.80%)	83 (69.70%)
Time of use ^a ≥14 days	7 (19.40%)	29 (80.60%)	36 (30.30%)
Double-lumen tube ^b	8 (11.90%)	59 (88.00%)	67 (56.30%)
Mono-lumen tube ^b	5 (9.60%)	47 (90.00%)	52 (43.70%)
Subclavian access ^c	10 (17.24%)	48 (82.76%)	58 (48.70%)
Jugular access ^c	1 (1.79%)	55 (98.20%)	56 (47.10%)
Femoral access ^c	1 (25.00%)	3 (75.00%)	4 (3.40%)

CA-BSI- Catheter-related bloodstream infections; ^aNon significant p value ($p=0.18$); ^bNon significant p value ($p=0.246$); ^c $p=0.008$; One of the 13 medical reports did not specify what the site of catheter insertion was; hence it was excluded from the analysis on this subject.

the jugular vein ($p=0.005$) (Figure 1). The Relative Risk (Odds Ratio) of infection in subclavian vein compared to jugular vein was 11.2 times higher (95%CI 1.4–92.8; $p=0,023$).

Discussion

Central venous catheter-related infections have been extensively studied in the literature. Most studies, however, have been carried out at ICUs, with severely ill patients, who are difficult to manage and often in ventilatory support. Climo et al.¹¹ published a study of 2,459 patients in 2003. Central venous access was used in 29% of the patients; 55% of the ICU patients and 24% of the ward patients had central venous catheters. However, the absolute number of patients in the ward was higher than in the ICU (506 vs 212), which reflects on the importance of care and preparation for catheter insertion. The objective of our study was to evaluate patients from the surgical wards, not comparing them to those from the ICU.

Studies have shown a 1 to 13% prevalence rate of positive blood cultures related to CVCs¹²⁻¹⁵; In our patients we have found a rate of 9.64% (11 catheters). This is a value in the upper normal range high and concerning value, but we should be taken into account that most CVCs were inserted by inexperienced first-year residents. According to Bernard and Stahl¹³, the risk of mechanical and infectious complications of CVC insertions depend on the operator's experience (cutoff number: 50 procedures). A significant difference has been observed in the infectious complication rate of procedures performed by experienced (25%) compared to inexperienced operators (56%)¹⁶.

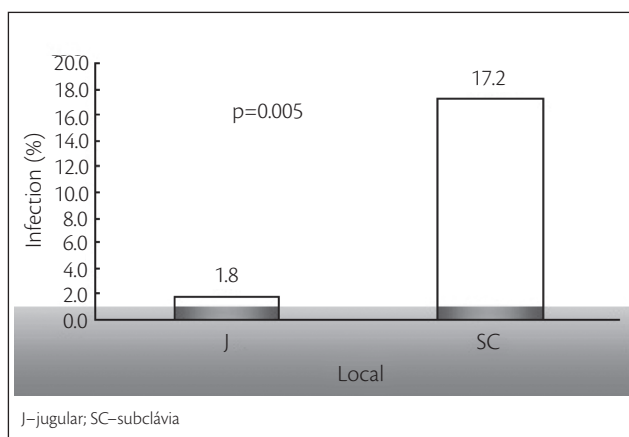


Figure 1. Jugular vein versus subclavian vein infection.

There is a scant number of studies in the literature on catheter-related infections in settings other than the ICU. The first study conducted in the USA, published by Marschall in 2007⁷, showed an infection rate similar to that found in ICUs, leading to believe that in settings other than the ICU the risk of catheter-related infection is higher, probably because more unnecessary procedures are performed and the level of care is lower than in the ICU. .

Regarding the mean duration of catheter use of 12.3 days, even though most literature reports recommend removing the catheter after 14 days of use¹⁷⁻¹⁹, we decided to follow CDC guidelines and remove only the catheters with clear evidence of infection. The wide variation of duration of catheter use on our series (from 1 to 69 days), with 30% used for longer than 14 days, should not change the recommendation of removing or exchanging the catheter after 14 days of use, for, after that period of time, the catheter becomes more susceptible to infection^{18,19}. Despite the fact that the infection rate was 19.4% for the catheters used longer than 14 days and only 5.1% for catheters used for less time, no statistical significance was observed.

The insertion site that carries the lowest risk of infection has long been a subject of controversy in the literature. Until the controversy is resolved, each hospital has to establish its own protocol. According to CDC Guideline 2002⁶, the preferred insertion site regarding the risk of infection is the subclavian vein, but no definitive clinical trial has been conducted to clarify this issue.

Deshpande et al.²⁰ did not find statistically significant differences on the rates of catheter colonization or infection between three different insertion sites (jugular, subclavian and femoral) in ICU patients. Merrer et al.⁵ conducted a more specific trial and showed that the femoral catheters had a higher risk of infection than subclavian catheters (19.8% vs 4.5%, $p<0.001$), but a comparison between the jugular and subclavian veins was not made. In a study published in 2005, Lorente et al.²¹ evaluated 2,595 catheters and found a statistically significant difference of infection rate between three sites: femoral access was associated with higher incidence of infection compared to the other accesses, and the jugular access was associated with a significantly higher incidence of infection, compared to the subclavian access (RR: 3.1; $p=0,005$).

The femoral access tends to have a higher infection rate, probably from the fact that the groin skin has a dense bacterial flora. The higher prevalence of

infection in the jugular access compared to the subclavian access remains under investigation. It is probably due to two factors: (1) proximity to the oral cavity; (2) higher density of the local bacterial flora due to the high local temperature and difficulty of keeping occlusive bandages²¹. The limitation of all studies is that they were carried out in the ICU setting, with sicker patients with fever, some of them on ventilatory support with endotracheal tube or tracheostomy and difficulty to clear oral secretions.

The present study found a lower incidence of jugular access infection compared to the subclavian access. This finding, which differs from the literature, is probably explained by the fact that ward patients do not present the difficult clinical problems seen in ICU patients. One cannot state however that the jugular access has less risk of infection, for further studies with larger samples would be necessary to prove such statement. Our patients were not randomized according to the admission diagnosis, and even though it has been published that critical patients present lower rates of infection²², several yet unidentified factors may be responsible for catheter-related infections.

Conclusion

Our results show superiority of the jugular access over the subclavian access regarding the incidence of CABSIs in settings other than the ICU.

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