

Central Lines Infection Incidence and Risk Factors in an Intensive Care Unit, a Retrospective Cohort Study

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Abstract

Background: The central lines are fundamental for the intra-hospital management of many patients, especially critical ones, but the complications associated with those devices like infection could increase the morbidity and mortality of patients. In this study we figure the factors associated with infection in a private hospital.

Material and Methods: We conduct a retrospective study including 710 patients with central venous catheters in the period from 2014 to 2017. General data and variables like age, diagnosis, days of catheter use, site of insertion, number of puncture and others were registered and analyzed.

Results: From the total analyzed patients only 19 present central venous line associated infection (.026%), from the analyzed factors only the number of catheter lumen and the days with catheter were significantly associated with infection, the most frequent microorganism was the *Staphylococcus epidermidis* as mentioned in the literature. Factors like number of puncture during installation, site of placement, service of installation or diagnosis did not show significant results.

Conclusion: The incidence of infection in the hospital was very low compared with worldwide literature, and the risk factors associated with this are similar to previous described including multiple lumens and days with catheter, some of them have been described but not significant in our population, maybe secondary to sample size or hospital bias. A prospective study would be useful for more specific results.

Keywords: Central Venous Line, Central Catheter Infection, Hospitalary Infection, Catheter associated sepsis.

1. INTRODUCTION

The central lines are fundamental for the intra-hospital management of many patients, especially in the intensive care unit, for their use for drugs infusion, liquids, blood products; hemodialysis, blood samples or hemodynamic monitoring [1].

The central lines placement are associated with infectious, mechanic and thrombotic complications [2,3]. The associated infections represent serious consequences in morbidity,

mortality and hospitalization cost for the patients and their families [4,5].

The objective of this study was to clarify the incidence, risk factors and more frequent pathogens for bacteremia and secondary infections associated with central lines in the medical or surgical patients in the Hospital Angeles Metropolitano in México between 2014 and 2017.

2. PATIENTS AND METHODS

Study design: This was a retrospective cohort study developed in the Hospital Angeles

Metropolitano (Intensive Care Unit, Intermediate Care Unit, Hospitalization), with 160 beds, between 2014 and 2017. A total of 2723 catheters were placed, and all were included in the analysis.

The sociodemographic data like age, sex, and other variables like diagnosis, related diseases, type of catheter, number of punctures during the placement and other were registered and analyzed.

The inclusion criteria were: age between 17-90 years-old, without active infection process at another level, with SIRS and bacteremia criteria according to IDSA consensus:

2.1. BI (Bloodstream Infection) Confirmed by Laboratory by One of the Following Criteria

One or more blood culture allowing the isolation of a pathogenic microorganism not related to another site of infection. Also, with two or more of the signs, symptoms or laboratory data: fever, hypothermia, hypotension, tachycardia, tachypnea, PCO₂ <32 mmHg, leukocytes > 12.000 /ml, leukopenia <4.000 leukocytes/ml, Immature neutrophils in blood >10%.

Patient with two or more blood cultures from different puncture sites, the same day or in consecutive days, with the same microorganism; and with two or more of the next signs, symptoms or laboratory data: fever, hypothermia, hypotension, tachycardia, tachypnea, PCO₂ <32 mmHg, leukocytes > 12.000 /ml, leukopenia <4.000 leukocytes/ml, Immature neutrophils in blood >10%.

2.1.1. Commentaries

This diagnosis was determined with less than 24 hours of hospital stay if: a) background of invasive procedures b) background of intravascular therapy.

An IBI associated with health care must be considered in patients that fulfill the mentioned clinical and microbiologic criteria until 72 hours after discharge, or in who was not possible to identify another site of infection.

ITS related with catheter when the catheter was placed 48 h previous to the beginning of symptoms, and the presence of one of the next criteria: blood culture from catheter and peripheral puncture, a positivity time of 2 hours (first the central and the peripheral after), or 103 CFU in qualitative blood culture. Also, with two

or more of the next signs, symptoms or laboratory data: fever, hypothermia, hypotension, tachycardia, tachypnea, PCO₂ <32 mmHg, leukocytes >12.000 /ml, leukopenia <4.000 leukocytes/ml, Immature neutrophils in blood >10%.

Patient with one or more blood cultures that allow isolation of a pathogenic microorganism not related with another site of infection; and the same microorganism isolated in the catheter tip (Maki technique) with 15 CFU by plate in case of semi quantitative cultures or 102 CFU in quantitative cultures and with one or more of the next signs, symptoms or laboratory data: fever, hypothermia, hypotension, tachycardia, tachypnea, PCO₂ <32 mmHg, leukocytes > 12.000 /ml, leukopenia <4.000 leukocytes/ml, Immature neutrophils in blood >10%.

2.2. Exclusion Criteria: Files with Incomplete Data

2.2.1. Statistics

Descriptive statistics and analysis with SPSS® v.14., using one variable analysis and determining incidences and frequencies. Finally, with the obtained results a proposal of actions to diminish these problems would be suggested.

The presented study was a retrospective research work, descriptive and longitudinal, developed by files review of clinical data, in surgical and medical patients, of the Hospital Angeles Metropolitano in Mexico City, from 2014 to 2017.

Initially, a recollection data instrument was designed, with sociodemographic data like age, sex, other variables like diagnosis and related diseases are registered. The objective is to identify the incidence of central lines associated infections and the associated microorganism, with posterior analysis of risk factors.

2.3. Statistical Analysis

The database was performed, and the statistical program SPSS version 23.0 for Mac IOS 10.6 was used to perform statistical data analysis. Complications, risk factors, and general characteristics were registered and compared between the groups using X² test, with p < .05 indicating a significant correlation. A multivariate analysis was performed for the independent variables and the possible association with complications, all of this with a 95 % interval confidence.

3. RESULTS

An analysis of the clinical files of the infection control department was realized, from the catheter management division, from 2014 to 2017, and 2723 files were reviewed. A total of 710 patients were included.

3.1. Catheter Characteristics

The medicated catheter (chlorhexidine) 7 Fr, placed without ultrasonographic guidance: 288 male patients (40.6%), and 422 female patients (59.4%). The global average age was 48.78 years old, with ages from 0 to 95 years.

3.1.1. Type of Patient

Surgical patients: 221 patients in total (31.22%); Non-surgical patients: 489 (68.93%).

3.1.2. Reason for Installation

Necessity of a central access for solutions and intravenous drugs: 409 (57.6%); Chemotherapy administration: 177 (24.9%); Total parenteral nutrition: 5 (0.7%); solutions, intravenous drugs and NPT: 78 (11%); hemodialysis 9 (1.3%) other: Difficulty to obtain a peripheral Access in critic patient: 32(4.5%).

Table1. Reason for central venous line installation

Reason for installation	Frequency	Percentage
Critical patients	32	4.5
Solutions and drugs	409	57.6
Total parenteral nutrition	5	.7
Solutions and drugs, total parenteral nutrition.	78	11.0
Hemodialysis	9	1.3
Chemotherapy	177	24.9
Total	710	100.0

3.1.3. Site of Insertion

Right subclavian in 426 (65.84%); left subclavian 109(16.84%); Total: 535 (82.68%), right yugular 91(14.06%), left yugular 18 (2.78%); Total: 109 (16.84%)and other (braquial, femoral, umbilical) 0.46%.

3.1.4. Number of Punctures During Installation

One punction (548) 84.69%; two (51) 7.88%, three (3) 0.46%, more than three (26) 4.01 %.

3.2. Service Performing Installation

Operating Room; 328(43.4%), Critical areas (Intensive care unit and coronary unit):193 (27.2%), Emergency room: 40 (5.6%), others (Hospitalization, catheters clinic: 169(23.8%).

Table2. Service performing installation

Service of installation		
Service of installation	Frequency	Percentage
Operating room	283	39.9
External operating room	25	3.5
ICU	108	15.2
NICU	44	6.2
Coronary unit	41	5.8
Hospitalization	39	5.5
Infections clinic	123	17.3
Emergency service	40	5.6
Intermediate therapy	7	1.0
Total	710	100.0

Number of lumens: One lumen: 261 (36.8%); two lumens: 98 (13.8%); three lumens :(351) 49.4%.4.8%.

Table3. The number of catheter lumens and percentage

#	Frequency	Percentage
1	261	36.8
2	98	13.8
3	351	49.4
Total	710	100.0

3.3. Catheter Permanency

One day: 134(18.85%); 2-5 days: 182 (25.65%); 5-10 days: 153 (21.63%) +10 days:240 (33.84%).

From the total of included catheters, only 19 of the 710 (2.7%) develop symptoms of infection; the others were asymptomatic.

From the isolated microorganisms in the studied catheters and with infectious characteristics, the *Staphylococcus epidermidis* was the more frequent of the Gram (+), and the next was *Klebsiella pneumoniae* and *Serratia marscesces*.

In the analysis of risk factors for infection, the sex did not have any significant relation, with a $p=0.277$. The use of parenteral nutrition did not present relation with catheter infection, with a $p=0.486$. The sex was not related to the incidence of infection, with a $p= 0.567$. The presence of infection was not influenced by the performance of any surgery, with a $p=0.695$. The other analyzed risk factors like diagnosis attempts for placement, co morbidities, number of lumens, service of placement,

A factor that presents a significant relation with the incidence of infection was the age of the patients, with a median age of 34.88 years in the infected cases vs. 49.26 years in the not infected cases, with a difference of 14.34 years, and a $p=.007$. This risk factor could be explained by the newborns' cases in the study, with critical

health and immature immune system, favoring the infection.

The number of lumens presented a significant correlation with the incidence of infection, with the catheters of three lumens developing more infections with a $p=0.027$ (Table 4).

Table4. The significance of the number of lumens in central lines vs. infection

Pearson chi-square test number of central line lumen vs infection.			
	Value	gl	Asymptotic Significance (bilateral)
Pearson Chi square test	7.246 ^a	2	.027
Reason for credibility	8.150	2	.017
Lineal association	7.162	1	.007
N	710		

Other risk factors associated in a significant manner with infection were the days of the catheter, with a $p=0.000$ after Mann-Whitney U test (and 6).

Table5. The number of days with catheter range

	Infection	N	Range	Sum of ranges
Days of catheter	Non-infected	691	348.70	240953.50
	Infected	19	602.71	11451.50
	Total	710		

Table6. Mann-Whitney U test of days with catheter vs. infection

	Days with catheter
Mann-Whitney U test	1867.500
W of Wilcoxon	240953.500
Z	-5.444
Asymptotic Sig. (bilateral)	.000

4. DISCUSSION

The infections of the central venous catheter increase the morbidity, hospital stay and total cost of health care. Some risk factors for infections have been identified, like male sex, emergency surgery, and catheter use for more than 15 days. The frequently reported microorganism include staphylococcus negative coagulase, with the *Staphylococcus aureus* as the most frequent, and in our study, a Staphylococcus was the more frequent too [4]. Concerning days of catheter placement, the incidence of infection increases significantly according to the days since placement like the literature refers. The other factor identified in our study that increases the incidence of infection is the number of lumens.

We can see the infection-related catheter infection symptoms and signs in the insertion site or the catheter path. Alternatively, the clinical picture could be systemic and manifested with complications secondary to bacteremia like fever, the more frequent symptom in our study [1]. The catheter-associated sepsis is a critical point to the patient prognosis and considered as a marker for the health care quality [6]. The extra luminal microorganism influences the risk of blood infection related to the catheter in the insertion site [7].

In the United States of America, the annual cases of catheter-associated sepsis are 11 000 in 2010 and 14 400 in 4 Europe countries (France, Germany, Italy and United Kingdom) with associated annual health care cost between 35,9 and € 163,9 millions [9-11]. (11) The catheter-associated sepsis continues as an essential problem for the patients of low, medium and high income [12].

The catheter line access bloodstream infection (CLABSI) is a substantial threat for the hospitalized patients, with an incidence of about 4.4 CLABSI for each 100 inserted devices [13].

The incidence of bacteremia associated with an intravascular catheter has diminished in the last decades, in the United States from 3.64 to 1.53 for every 1000 days of use between 2001 to 2009 [14]. However, the incidence in Latin America is significantly superior, with 6.8 cases for every 1000 days/catheter [15].

The relative risk of bacteremia associated with the intravascular catheter and total parenteral nutrition is 2.6 times higher than the one not associated with parenteral nutrition [16], and the associated mortality is variable from 13.9 to 18.6% [17].

The central venous catheters can produce an infection by three routes, intraluminal, extraluminal and bloodstream. The incidence in patients submitted to gastrointestinal surgical procedures is 5.6 for every 1000 days/catheter [18,1].

In our study, we observed that the *Staphylococcus epidermidis* was the most frequent Gram (+) microorganism isolated, followed by *Serratia* and *Klebsiella*.

The subclavian vein catheterization has less risk of infection but higher risk of pneumothorax compared with the jugular or femoral locations,

in our study may be secondary to our sample size the incidence of infection in the subclavian site or other sites were not significantly higher [3].

In a systematic review and meta-analysis comparing the risk of CLABSI between peripherally inserted central catheters infection and central venous catheter, the risk was ten times higher of CLABSI in the hospitalized patients (5,2%) compared with the ambulatory patients that receive a peripheral catheter (0,5%). Although, the hospitalized patients that underwent a peripherally inserted central catheter had similar CLABSI incidence compared with the CVC [20].

Some measures to prevent CLABSI are sterile barriers, site of insertion disinfection, and avoidance of femoral insertion site [21-23]. Since 1980, the impregnation of the catheter with antiseptics and antibiotics have been performed [24]; some of them include chlorhexidine-silver sulfadiazine (CSS) and minocycline-rifampicin (MNR), both the more studied to the date. We used other compounds like silver, platinum, carbon or heparin as impregnated materials for CVC [25]. Other manuscripts mention that the antibiotic impregnation in the CVC inhibit the bacteria colonization in the catheter surface and avoid their diffusion in the blood stream. Of those techniques, the most effective is the impregnation with minocycline-rifampicin [26].

The biofilm generation by the bacteria's produces the late infection of the bloodstream. This biofilm confers to the bacteria's the capacity to avoid the effect of antibiotics and the immune system, with the subsequent travel in the bloodstream [27].

We can see the symptoms and signs of infection in the site of insertion or the path of a dispositive with tunnels. Alternatively, the signs could be systemic or complicated by bacteremia [6].

The infection, thrombosis and mechanic complications are related to the site of the catheter insertion site. The extra luminal bacteria colonization is responsible for the risk of infection in the bloodstream, and the location with less risk of infection is the subclavian [28].

The use of a covered antibiotic catheter reduces the bloodstream infections in a significant way [3,18]. The catheter covered with chlorine and silver sulfadiazine only diminish the risk of

infection in the first 48 hours after installation [29]. In the procedures of placement, there is an element frequently using, the heparin that according to some studies promote the formation of biofilm by *Staphylococcus aureus* [18].

The beginning of antibiotic therapy in patients with central venous catheter-related infection must be only in the ones with symptoms of colonization, severe disease or APACHE >5. There exist better results when the diagnosis is early diagnosis and treatment is associated with better results.

5. CONCLUSIONS

The presented study analyses risk factors for central venous lines infection in a private hospital in Mexico City, with all the international guidelines recommendations for catheter placement and management, with a low incidence of infection and by the more frequent bacteria species as reported in the international literature, with some of the previously reported factors increasing the incidence of infection. Some of the classical risk factors for infection were not significant in our study may be for the type of pathologies treated, and the number of patients included that could increase the risk of bias. More prospective studies are needed to determine the real differences in risk factors for infection of central venous lines in our hospital compared to the literature.

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