



RISK FACTORS FOR THE DEVELOPMENT OF HAI IN INTRAVASCULAR LINES

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ABSTRACT

Introduction: The *Unidad de vigilancia epidemiológica* of the HCJIM (*Hospital civil Juan I. Mechaca*), registered in 2016 that the main cause of infections associated with health attention is the bacteremia with a 25% associated to catheters. In 2017, it was stated that 18% of the HAI (healthcare associated infections) were related to catheters, because of this mean the risks associated with the HAI on people with intravascular devices, installed by physician's vs catheter clinic personnel. **Methods and resources:** Transversal study, analytical, observational. 335 registered with intravascular line; 101 installed by the catheter clinic and 234 by the medical personnel of the hospital. Analysis with mean of association OR (IC95%). **Results:** The risk by installation of devices associated to the HAI was 3.4 (IC95%1.47-7.75, p=0.00) higher with the physicians than with the catheter clinic personnel. Risk also rose with the number of days, in the 82% of cases enterobacteriaceae were isolated, where lethality was associated to candida spp. **Conclusions:** This study supports the evidence to the instalment capacitation programs and to the maintainment of the intravascular lines for the prevention of the HAI; highlighting the importance of the experience of the installer. The more days with the device the more risk of infection. The rate of the HAI was higher with the physicians that do not employ a maximum barrier, neither the checklist, in contrast to the catheter clinic personnel.

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INTRODUCTION

Healthcare associated infections (HAI) previously called nosocomial or inpatient, are those that the patient acquires while he receives treatment to a medical condition or surgical condition, occurred after 48 hours to the hospitalization, taking in to consideration the incubation period of the agent that causes the issue and in whom had not manifested and was neither in incubation period at the moment the person entered the institution. It is relevant to clarify that according to the information generated by the OMS/OPS, the HAI definition will replace any other definitions previously utilized in other sub-systems such as nosocomial infection (IN), inpatient infection (II) or infections associated to healthcare (IAH).

The HAI represent a public health problem and are an indicator of the quality in the management and provision of the service, these imply a rise in the use of the antimicrobials in the hospital stays; and they are associated to a higher risk of mortality, with economic and social consequences for the patients and the institutions, and therefore, a raise in attention costs for the health system.

The HAI represent a big proportion of damages caused by the medical attention and are associated with high costs. According to Zimlichman and Henderson¹ by using the Monte Carlo simulation, on point estimations were generated with a confidence interval (CI) of 95% for the attributable costs and the duration of the hospitalization. On each case, bloodstream infections associated to the central line were the most expensive ones, to a \$ 45 814 (IC 95%, \$ 30 919- \$ 65 245), followed by pneumonia associated to mechanical ventilation to a \$ 40 144 (IC 95%, \$ 36 286- \$ 44 220), Clostridium difficile infection to a \$ 11 285 (IC 95%, \$ 9118- \$ 13 574), and infections of the urinary tract associated to a catheter in \$ 896 (IC 95%, \$ 603- \$ 1189). The annual cost of the 5 main infections was of \$ 9.8 thousand millions (IC95%, \$8.3- \$11.5 thousand millions), the infections of the surgical site were those that contributed the most to the general costs (33.7 of the total), followed by pneumonia associated to the fan (31.6%), bloodstream infections associated to the central line (18.9%), infections by C. difficile (15.4%) and infections of the urinary tract associated to the catheter (<1%).¹ According to Malagón and Álvarez, in Latin America the excessive costs generated by the HAI were, respectively, to pneumonia between 400 and

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13.000 dollars, and for bacteremia within the hospital between 600 and 20.600 dollars². In the *Hospital civil JIM*, the 80/20 of the HAI are bacteremia associated to 80% of the devices.

Ferrareze *et al.*³ expose the extrinsic values related with the insertion technique: place of insertion of the catheter within the institution, type of antiseptic before the insertion of the catheter, anatomical site of the insertion of the catheter, the indication of the insertion of the catheter making a relationship on whether is an urgency or programmed procedure.³

- ✓ Technique of asepsis and antisepsis for the colocation of the catheter; employment of the protection and field equipment (maximum barrier).
- ✓ Use of antiseptics: Ferrareze, De Andrade & Menis³ mention that utilized antiseptic solutions are the iodine 10%, alcohol 70 or 75%, chlorhexidine 2% and gluconate chlorhexidine 2%, confirming with the latter an infection reduction of the bloodstream associated to the use of the catheter of 11.3 by 1000 days, catheter to 3.7 by 1000 days of the central venous catheter.
- ✓ Person who develops the catheter insertion procedure, Osuna *et al.*³ specify that central vein catheter inserted by not so skilled personnel are associated to a higher incidence of infective complications, in contrast with the ones inserted by the experienced personnel. It means that they have in to consideration this variable as a predisposal factor of the infection, but this does not specify what kind of professional or with what determined education must do the insertion.
- ✓ Catheter characteristics; number of lumens of the catheter.
- ✓ They specify that the most common anatomical site used was the subclavian vein, and the less common were the jugular and femoral veins, showing a higher infection risk in the catheters inserted in the jugular vein, taking into consideration their proximity with the oropharyngeal secretions, in addition it also implies a higher difficulty to immobilize the catheter. As a specific preventive measure they recommend to not utilize the femoral vein because they consider that carries a higher risk an infectious complication, especially in adults with incontinence.
- ✓ Catheter maintenance: another aspect of big relevance, and that is taken in to consideration in multiple revision studies that are focused in the determination of the factors that influence in the presence of IADIV, is the maintenance technique. The following variables were taken:
 - Lifetime of a catheter.
 - Type of apposite utilized for the healing or covering of the catheter.
 - Healings.
 - Indication of the use of the catheter.
 - Existence of the protocol of insertion and use (checklist).
- ✓ Lifetime of a catheter. Regarding the characteristics that turn around the maintenance of the catheter, this is a relevant aspect regarding the insertion and its variables compared with the time that will last; it is of great importance within the maintenance of catheters, because depending on this will guarantee for better conditions of the device despite of its permanence in time. For Osorio, Álvarez, Pacheco, Gómez and Lozano⁴ a

central point within the maintenance of the catheter are the permanence days of the device, a time higher that 7 days predisposes as stated in their study the IADIV; besides, other contributing factors as the time in days of the hospitalization in UCI and the days of exposure to the intravascular device.

Central venous catheter (CVC) is necessary for the monitoring and the treatment of patients in critical state; nevertheless, its use raises the risks of bacteremia. In Mexico, the incidence of bacteremia related with catheter (BRC) is of 7.9 and 6.5/1000 days-catheter in 2007 and 2008 according to the *red hospitalaria de vigilancia epidemiológica* (RHOVE), while that in *unidades médicas de alta especialidad* (UMAE) from IMSS, report 3,082 episodes of BRC, from 2007 to 2011, with an incidence of 3.5 days-catheter on 2007. Costs associated to BRC are elevated, from \$10,000 to \$20,000 US dollars average per episode⁴. The most exact microbiological diagnostic method in BRC is the quantitative blood culture paired central and peripheral (sensitivity: 0.79, IC 95%, rank 0.74-0.84; specificity 0.99, rank 0.98-1.0, P=0.008). The microorganism concentration is from 3 to 5 times higher in the central blood culture in contrast with the peripheral one⁵.

In medical attention units drugs are administered intravenously to more than 20 million hospitalized patients; that is, to half of them, five million require some type of central vascular access. Almost the 60% of all bacteremia types related to catheter are originated by a vascular access, because of this, the attention procedures must be primarily to the adoption of preventive measures, independently of the identification and treatment of the BRC⁵.

Incidence of the BRC varies according to the intensive care unit (ICU) type, more frequently in medical-surgical units on 2007 (17.7/1000 days-catheter) and neonatal (14.8/1000 days-catheter), in comparison with ICU neurosurgical (7.9/1000 days-catheter) and cardiothoracic surgery (1.6/1000 days-catheter)⁵.

The microorganisms that normally colonize skin (*Staphylococcus* coagulase-negative 37% *Staphylococcus aureus* 12.6%) participate with higher frequency in the development of catheter related infections; other microorganisms that are acquired through inadequate manipulation or the administration of contaminated solutions (negative Gram bacillus, enterobacteriaceae or non-fermenters), or by another infection site. The skin organism migration in the insertion site is the most frequent mechanism in peripheral catheters of short time⁵.

The bacteremia related with the vascular catheters are within the most frequent acquired infections in the hospital⁶. Nowadays it is calculated that between the 15 and 30% of all nosocomial bacteremia are related with the use of percutaneous intravascular devices⁷. In determined hospitalizations units, like the intensive care units, this type of infection has been related with an elevated morbidity, an attributable mortality and a very relevant added sanitary cost⁸. According to Matzumura, *et al.*, 46.34% of the HAI studied cases were associated to the use of some device or procedure. Only in 29.27% of the patients microbiological findings were discovered, the following were the most recurrent; *Acetobacter baumannii*, *Pseudomonas aureginosa* and *Escherichia coli*⁹.

There are four known routes for the contamination of the catheters: 1) skin microorganism migration from the insertion place to the cutaneous mark of the catheter, and along the surface of the latter with the colonization of the tip of the catheter; this is the shortest most common route of infection in catheters of short duration; 2) direct catheter contamination or from its cone by hand contact, liquids or contaminated devices; 3) less frequent, the catheters can be colonized by hematogenous seeding from another infection focus; and 4) the infused contamination could rarely cause bloodstream infections related with the catheter¹⁰.

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Prevention measures and caring use of the vascular lines are fundamental to decrease this entity. Epidemiology vigilance programs, and the continuous education for the health personnel that participates on the use of the vascular lines, have achieved to decrease the incidence of these infections¹².

On the other hand, Hernández, Castañeda and González determined that the most frequent infection of the HAI was the systemic infection associated to a catheter (48%), followed by pneumonia associated to a fan (37%) and urinary lines infection associated to a urinary catheter (15%), investing this presentation to calculate the rates by 1,000 days by an invasive method, where the urinary lines infections occupy the first place with a rate of 8.19 by 1,000 days of urinary catheter, followed by pneumonia 7.15 by 1,000 days fan and, finally, the bloodstream infection of 6.03 by 1,000 days catheter¹³.

Multimodal strategies, which include educative activities for the personnel and a simple measurement package for its altogether application, applied to high risk patients have demonstrated a great efficacy for the prevention of vascular catheters related infections¹⁴.

Authors Valencia, Gutiérrez, Quinceno and Rodríguez determined the anatomical insertion site of the catheter, the jugular 58.8% and 41.2% the subclavian. The mean in days of use of the central venous catheter was of nine days (IC=6.5-17.5). The most frequent identified species related with the infection were: *S. epidermidis* (21.1%), *E. cloacae*, *K. pneumoniae* y *S. marcescens* (each one with 10.3%)¹⁵.

Good hands hygiene before the insertion or the maintainment of the catheter, along with a proper aseptic technique during the manipulation of the catheter, offer a good protection against the infection. The proper hands hygiene can be achieved with the use of alcohol products, or with water and soap and proper rinsing. The proper aseptic technique does not necessarily require sterile gloves for the insertion of peripheral catheters, a pair of new normal gloves with the technique of 'no touching'/without contact for the insertion of peripheral venous catheter. Sterile gloves must be worn to put central catheters, because the 'no touching' technique is unfeasible¹⁶.

In case of HAI related to catheters, the device must be withdrawn if the causal microorganism is *Staphylococcus aureus* *Pseudomonas sp*, any other negative Gram bacillus, *Enterococcus sp*, o *Cándidas* by the high risk of recurrences and complications; they must also be withdrawn in case of mycobacteria, *Bacillus spy* *Aspergillus sp* because they do not present healing without the withdrawn of the device¹⁷.

The *Unidad de Vigilancia Epidemiológica del Hospital Civil de Guadalajara "Dr. Juan I. Menchaca"* (HCJIM), on 2016 the bacteremia was registered as the main cause of healthcare associated infections, with a 25% associated to catheter. The related issues begin with good hand hygiene of the 20%, sub register of variables (catheter) for related issues with a bad diagnostic by the inadequate samples of blood culture, and controversies related to the effectiveness of the catheter clinic, for the prevention of nosocomial infections. With the improvement in data gathering of the risks by the service, on 2017 the 18% of the healthcare associated infections were related to the collocation of catheters. In what concerns the identification of the isolated germs by the *Unidad de vigilancia epidemiológica* for the healthcare associated infections in the period of 2016 and 2017, the main causal microorganisms were identified as the *klebsiella pneumoniae*, the *escherichia coli* and the *acinetobacter*, nevertheless, these microorganisms presented a low lethality rate in comparison to the high lethality rate shown by fungal microorganisms as the candida.

The objective of this research is to analyze the risks associated to the HAI in people with intravascular devices, installed by physician's vs catheter clinic personnel.

METHODOLOGY

An analytical, observational, transversal study was conducted, with a total of 335 persons, who had an intravascular line; from these, 101 were collocated by the catheter clinic and 234 by the rest of the hospital services.

A stratified random probabilistic sample was made in function of the different strata with simple allocation. The size of the sample was calculated for this research by the formula: $n = PQz^2 - \alpha/2/d^2$, where P= to the proportion of elements that are hoped to be found with the interest category (healthcare associated infections) = 11%. $Q = 1 - P$. The 'z' value in the normal distribution for the significance level, α , selecting = 1.96. d = accepted error on the estimation (expressed as proportion) = 5%. Resulting in a sample size of 150.

Information gathering was done in the HCJIM from August to November of 2017, through the revision of the registered cases by the catheter clinic during the year 2016 and 2017.

The relation analysis between the healthcare associated infections and the collocation of the intravascular line, was made with help of the software Epi Info 7.2 and SPSS 21, through the statistics of frequencies, percentages and as associated measure the *odds ratio* (OR) comparing the collocation service, infections presence associated to the health attention and exposure days.

To guarantee the integrity and validity of the paper, the researchers declare that they do not exist interest conflicts, this work does not pretend to evidence neither the institution nor the personnel, with no economic interest either, because it will not be financed by no organization.

RESULTS

335 persons were studied in this study to determine the association in the collocation of intravascular lines with the healthcare associated infections. With the sociodemographic characteristics presented in this paper, people from the ages 0-16 presented the higher prevalence for the development of healthcare associated infections in people with intravascular lines, representing the 53% of cases, followed by the group of people with 60 or more years old with the 22% of cases.

On the analysis of the association of the HAI with the collocation of the intravascular lines by the hospital service, of the made interventions by the catheter clinic; the 93% of these do not presented infections, and from the interventions made by other hospital services the 80% did nor presented infections. On the association of the collocation of the intravascular lines by the other services of the hospital as a risk factor for the development of the HAI, the collocation of the intravascular lines by other hospital services were identified as a risk factor, with a OR of 3.4 and a value of $p=0.00$ being this significant refusing the null hypotheses. See table 1.

With regard of the collocation of intravascular lines by the specific services of the hospital, it was identified that the services with a higher association to the HAI were the *Unidad de Cuidados Intensivos Neonatales* with 30% of the HAI in collocated intravascular devices, the *Unidad de cuidado smaterno infantiles* with the 24% of the HAI, and the surgical service with 21% of the HAI; in comparison with the pediatrics service with the 15% of the HAI and the made interventions by the catheter clinic with the 7% of the HAI.

Regarding the other insertion sites of the intravascular lines, it was determined that the anatomical site most commonly utilized was the brachial with 139 procedures representing the 41% of cases, followed by subclavian with 131 (40%), the umbilical with 28 (9%), the jugular with 22 (7%) and the femoral with 9 (3%). It was analyzed its association with the HAI identifying that the insertion sites with a higher presence of the HAI were the brachial with the 43% of cases, the subclavian with the 41% of cases, the jugular with the 13% of cases, the umbilical with the 4% of cases and the femoral with the 0%.

Regarding the catheter days as a risk factor for the development of the HAI, it was determined that people with an intravascular line for more than 3 days, present a rick for the development of an infection with an OR of 3.1 ($p=0.01$) and the people with an intravascular line for more than 10 days presented an OR of 4.1 ($p=0.00$). Seetable 2.

Regarding the isolated germs with the identification in the detected HAI, it was determined as the main causal agents of infection to the klebsiellawith an incidence of 15 for 100 persons, the candida with an incidence of 13 for 100 persons and the Acinetobacter with an incidence of 9 for 100 persons. With a lethality relation presented by the isolated germ it was determined that the candida was the causal agent with the highest lethality rate with 33 for 100 persons. See figure 1.

As infection indicator of the central venous catheter of the bloodstream, it was determined that the hospital presents an incidence rate of bacteremia associated to CVC of 17 events by 1,000 catheter days.

Table 1 Association of the collocation of intravascular lines with the healthcare associated infections.

Colocación de la línea intravascular	IAAS		Sin Infección		OR	IC 95%	Valor de p
	n	%	n	%			
Otros servicios	47	87	187	67	3.38	1.47-7.75	0.00
Clinica de catéter	7	13	94	33			

Source: proper elaboration.

Table 2 Association of the days catheter with the healthcare associated infections.

Díascatéter	IAAS		Sin infección		OR	IC 95%	Valor de p
	n	%	n	%			
1-2	49	91	230	82	2.0887	0.79-5.51	0.13
3-51	5	9	49	18			
1-3	48	89	202	72	3.1	1.3-7.4	0.01
4-51	6	11	77	28			
1-5	44	82	162	58	3.2	1.5-6.6	0.00
6-51	10	18	117	42			
1-7	39	72	123	44	3.3	1.7-6.3	0.00
8-51	15	28	156	56			
1-10	33	61	77	28	4.1	2.2-7.6	0.00
11-51	21	39	202	72			

Source: proper elaboration.

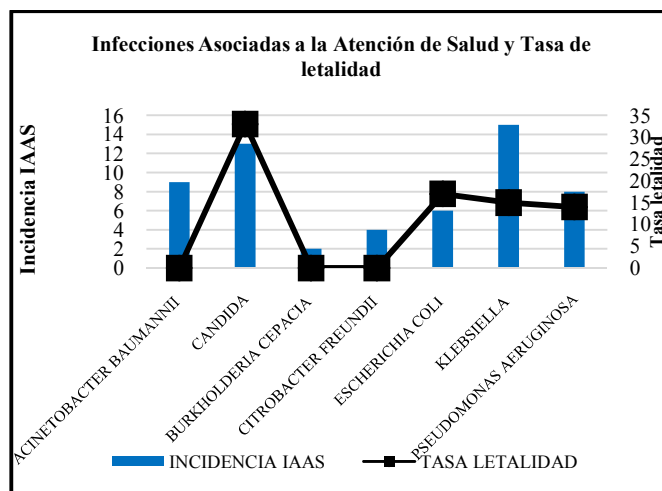


Figure 1 Incidence of the healthcare associated infections by isolated germ and lethality rate.

Source: proper elaboration.

DISCUSSION

Regarding the microbiological insulation related to the HAI they were determined as the main causal agents to the klebsiella, acetinobacter baumannii, and pseudomona aurogynose, being related to the words of Matzumura, *et al.*, identifying a higher predisposition of acetinobacter baumannii, pseudomona aurogynose and Escherichia coli with the HAI,⁹ likewise in other studies the most frequent identified species related with the healthcare associated infection were: *S. epidermidis* (21.1%), *E. cloacae*, *K. pneumoniae* y *S. marcescens* (cadauno con 10.3%)¹⁵.

Other strains that can generate healthcare associated infections are the yeasts, where there are actually more than 150 *candida spp.*, of the onew approximately 15 are considered as pathogens for men, and from the previous the genre *C. albicansis* the most common, because in countries such as the US, this species represents 62% of the infection cases, while that in Latin American countries they represent approximately 50%¹⁸,

these numbers are superior to the ones found in this research, with the relation to the presence of yeasts the *Candida* spp was identified with an incidence of 13 for 100 persons, representing the 23% of cases and with a lethality rate of 33 for 100 persons.

The time of use of the catheter is a risk factor for the development of the HAI, the people with an intravascular line for more than 3 days presented a risk for the development of an infection 3 times higher, and the persons with an intravascular line for more than 10 days represented a risk 4 times higher, which corresponds with the words by Valencia in his study where the risk was presented with 9 days with an intravascular line¹⁵.

The literature suggests that to a higher number of days of the use of the catheters, the risk of infection is higher, but there is no clear data about the number of days that would be safe to use.

As main risk factors associated to the development of the HAI in intravascular lines it was found that: medical personnel not trained for the collocation of the catheter, low percentage of the attachment of the checklist of catheter installation and low percentage of attachment of hand hygiene in the hospital. The dab attachment to the list of security packages raised the risk of the HAY. The rate of the HAI was higher with the physicians that do not employ the maximum barrier, and attachment to the checklist, in contrast with the catheter clinic personnel. There is even cost-benefit in favor.

This study supports the evidence to the installation capacitation program and maintainment of the intravascular lines for the prevention of the HAI; highlighting the importance of the experience of the installer (catheter clinic personnel). As mentioned in the study of Sherertz, where a quasi experimental study was made of educational intervention with pretest+posttest for the correct utilization of sterile collocation techniques of catheters, being the rate of infection related with the catheter decreased from 4.51 infections for 1000 days-patient before of the first intervention cycle, to a 2.92 infections for 1000 days-patient 18 months after the first cycle (average decrease, 3.23 infections for 1000 days-patient; $p < 0,01$)¹⁹.

The precautions of the maximum sterile barrier during the insertion of the catheters reduce the risk of infection of the catheter. This practice is cost-effective and is consistent with the practice of universal precautions during an invasive procedure²⁰.

CONCLUSION

Catheter clinic of the HCJIM is attached to the alinements for cleaning and use of the intravascular lines, it also maintains a high attachment to the checklist of installation of catheters, which is reflected in the low percentage of infections in the catheters collocated by the clinic, nevertheless, it is only responsible of the installation of 30% of the catheters.

To achieve a higher impact on the decreasing of the nosocomial infections it is indispensable that the procedures made by the catheter clinic are to be implemented in all the institution through a continuous capacitation program and permanent about the safe and hygienically procedure, the handling and tracking (checklist) in the collocation of the intravascular lines.

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