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COSTS OF CENTRAL VENOUS CATHETER-RELATED INFECTIONS IN ADULTS: INTEGRATIVE REVIEW

CUSTOS DA INFECÇÃO RELACIONADA A CATETER VENOSO CENTRAL EM ADULTOS: REVISÃO INTEGRATIVA

COSTOS DE LA INFECCIÓN RELACIONADA AL CATÉTER VENOSO CENTRAL EM ADULTOS: REVISIÓN INTEGRADORA

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Objective: to know the financial impact of primary bloodstream infection for hospital organizations. Method: integrative review carried out in the LILACS and EMBASE databases with MEDLINE, published between June 2005 and June 2015 with the descriptors: central venous catheters, catheter-related infections and costs and cost analyses. Results: thirteen publications were included, and there was predominance of retrospective cohort studies conducted in Europe and the United States with critical patients. The cost for an episode of infection ranged from $ 24,090 to $ 34,544. European studies found values between €16,814 and €29,909. The infection increased the length of hospitalization between 1.5 and 26 days, and the mortality between 1.8% and 34%. Conclusion: catheter-related infections incur a high cost for hospital organizations, and it is necessary to assess the cost in the case of each country because of discrepant values in different nations.

Descriptors: Evidence-based nursing. Catheter-associated infections. Hospital-acquired infection. Central venous catheterization. Costs and cost analysis.

Objetivo: conhecer o impacto financeiro da infecção primária de corrente sanguínea para as organizações hospitalares. Método: revisão integrativa desenvolvida nas bases de dados LILACS e EMBASE com MEDLINE, publicadas entre jun/2005 e jun/2015 com os descritores: cateteres venosos centrais, infecções relacionadas a cateter e custos e análises de custos. Resultados: foram elencadas 13 publicações e houve predomínio de estudos de coorte retrospectiva, desenvolvidos na Europa ou Estados Unidos com pacientes críticos. O custo para um episódio de infecção variou de $24.090 até $34.544. Estudos europeus encontraram valores entre €16.814 e €29.909. A infecção aumentou os dias de internação entre 1,5 e 26 dias, e a mortalidade entre 1,8% e 34%. Conclusão: as infecções relacionadas ao

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cateter representaram um custo elevado para as organizações hospitalares e, devido à discrepância entre os valores em diferentes países, há necessidade de avaliar o custo em cada realidade.

Descritores: Enfermagem baseada em evidências. Infecções relacionadas a cateter. Infecção hospitalar. Cateterismo venoso central. Custos e análise de custos.

Objetivo: conocer el impacto financiero de la infección primaria de corriente sanguínea para las organizaciones hospitalarias. Método: revisión integradora desarrollada en las bases de datos LILACS y EMBASE con MEDLINE, publicadas entre jun/2005 y jun/2015 con los descriptores: catéteres venosos centrales, infecciones relacionadas a catéter y costos y análisis de costos. Resultados: fueron listados 13 publicaciones y hubo predominio de estudios de cohorte retrospectiva, desarrollados en la Europa o Estados Unidos con pacientes críticos. El costo para un episodio de infección varió de $24.090 a $34.544. Estudios europeos encontraron valores entre €16.814 y €29.909. La infección aumentó los días de internación entre 1,5 y 26 días, y la mortalidad entre 1,8% y 34%. Conclusión: las infecciones relacionadas al catéter representaron un costo elevado para las organizaciones hospitalarias y, debido a la discrepancia entre los valores en diferentes países, hay una necesidad de evaluar el costo en cada realidad.

Descriptores: Enfermería basada en evidencias. Infecciones relacionadas al catéter. Infección hospitalaria. Cateterismo venoso central. Costos y análisis de costos.

Introduction

Health care in institutions exposes patients to the occurrence of Health Care-Related Infections (HCRI), complications acquired during procedures in the health service environment. These have high incidence and represent a growing public health problem due to the severe effects on patients and the increase in microbial resistance to the available treatments. These complications increase the costs for hospital institutions, length of hospital stay and patient mortality[1].

The incidence of HCRI in developing countries has been observed to be three-fold higher than in developed countries such as the United States and European federations. Rates of infection associated with invasive devices in intensive care unit patients are five to eight fold higher in developing than in developed countries[2].

Catheter-related Primary Bloodstream Infections (PBIs) represent one of the most incident HCRI, especially among patients admitted to Intensive Care Units (ICU)[3], because most of them use short-term central catheters[4]. Catheter-related PBI is defined as the first infection of the bloodstream in patients using central venous catheter for more than 48 hours without any other infectious area identified[5].

Study indicates that developing countries have central venous catheter-related PBI indices in adults of up to 44.6/1000 catheters-day, while in developed countries the indices reach a maximum of 5.0/1000 catheters-day[2]. This considerable high in PBI rates in developing countries happens due to poor infrastructure, lack of professionals and adequate skills, and lack of awareness of preventive measures[1].

With regard to the microorganisms commonly involved in the etiology of PBIs in Brazilian adult ICUs, coagulase negative *Staphylococcus* (19.9%), *Staphylococcus aureus* (16.5%), *Klebsiella pneumoniae* (12.4%), *Acinetobacter* Spp. (11.4%) and *Pseudomonas aeruginosa* (8.9%) stand out. A notable bacterial resistance to antimicrobials has increased in recent years, indicated by the large number of resistant microorganisms isolated in blood cultures of patients with PBI[6].

This increase in the number of multiresistant microorganisms in the genesis of PBI contributes to rise the mortality attributed to this health grievance[3]. Bacterial resistance increases the costs of drug treatment, as it requires the combination of two or more antimicrobials and the use of broad-spectrum and last generation drugs.

Studies show that, besides expenses with antimicrobial treatment, PBI increases lenght of hospitalization and in the intensive care unit, hospital expenses and mortality rate[7-8].

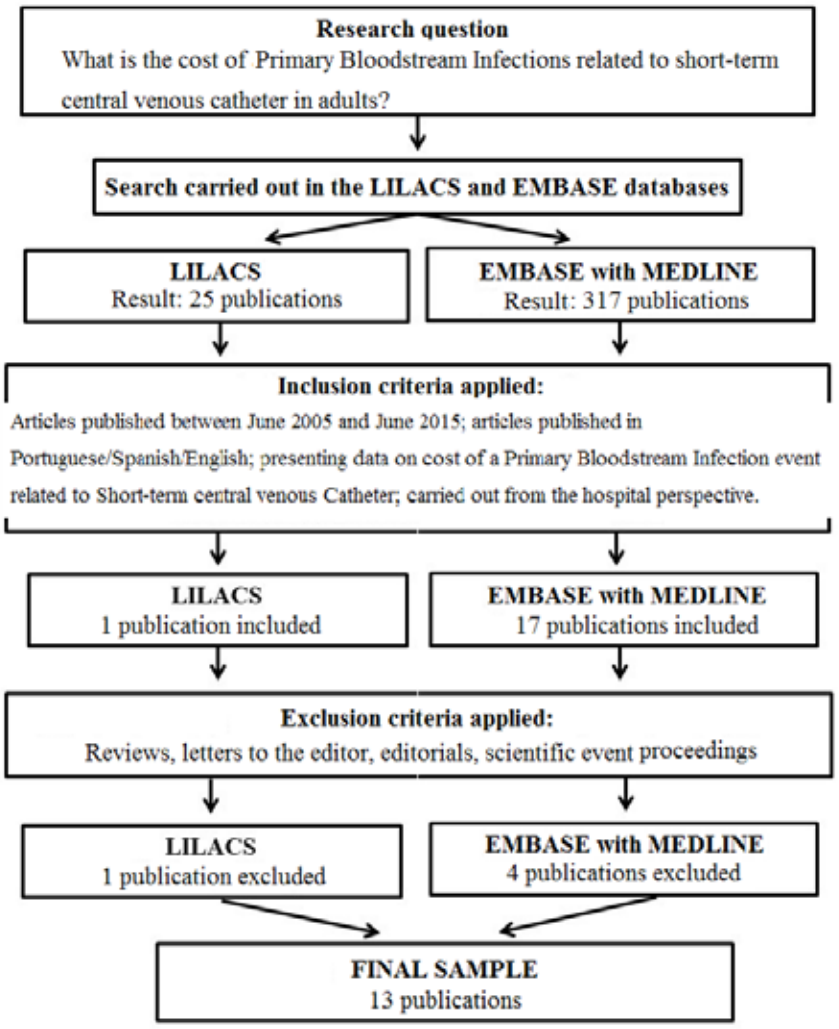
Before the growing expense related to the treatment of this problem, health organizations have sought to implement strategies, such as lectures, *bundles*, audits, among others to update professionals on the guidelines and recommendations to avoid HCRI[9]. It is also necessary to know the financial impact of the HCRI for health organizations, since this is a concern of managers in the search for more efficient health services. Therefore, this study aimed to know the financial impact of primary bloodstream infections in hospital organizations.

Method

This is an integrative review of literature developed in the following steps: identification of the theme and selection of the research question; establishment of inclusion and exclusion criteria; categorization of studies; evaluation of included studies; interpretation of results; and presentation of the review/synthesis of knowledge[10].

The research question, the inclusion and exclusion criteria and the sample composition are described in the Diagram 1. The search for the studies was performed in the LILACS and EMBASE interfaces, including MEDLINE. The descriptors were used In LILACS were as follows: [("catheter-related infections") and "infection" or

Diagram 1 – Sample composition, research question and criteria for inclusion and exclusion of publications.



Source: Created by the authors.

"hospital infection"] or "Central venous catheters" or "Central venous catheterization" [Subject descriptor] or "catheter-related infections" [Subject descriptor] and "COST" or "COST analysis in health" or "COST-benefit analysis" or "analysis of COST-benefit" or "COST-benefit data" or "COST-effectiveness" or "COST-effectiveness evaluation" or "COST-efficiency analysis" or "COSTs" or "COSTs analysis" or "COSTs of health care" or "COSTs of medical care" or "COSTs of Treatment" or "COSTS of direct services" or "COSTs and COST analysis" or "Hospital COSTs" [Subject descriptor].

In the EMBASE interface, several searches were carried out, among which it was decided to select the articles of the strategy that associated the searches #3 AND #4 AND #20: #3: "catheter infection"/exp OR "catheter infection"; #4: "central venous catheter"/exp OR "central venous catheter"; # 20: "cost'/exp OR "cost" OR "cost benefit analysis"/exp OR "cost benefit analysis" OR "cost effectiveness analysis"/exp OR "cost effectiveness analysis" OR "cost minimization analysis"/exp OR "cost minimization analysis" OR "cost of illness"/exp OR "cost of illness" OR "cost utility analysis"/exp OR "cost utility analysis" OR "hospital cost"/exp OR "hospital cost" OR "hospitalization cost"/exp OR "hospitalization cost" OR "health care cost"/exp OR "health care cost" OR "nursing cost"/exp OR "nursing cost".

The results of the searches had their titles and abstracts read, to verify if they addressed the researched topic. The pre-selected articles were read in full length to apply the inclusion and exclusion criteria. Repeated articles were included only once. Ethical aspects of copyright were respected.

Results

Thirteen publications were included. As for the methodological design of the selected studies, there were five retrospective cohorts, two prospective cohorts, one randomized clinical trial, one quasi-experimental study, one cost-utility study, one cross-sectional study, one intervention study, and one observational study.

As for the frequency of publications, the year 2014 concentrated the largest number, with a total of 5, two of them by the same author. The other years had between 1 and 3 publications. A total of 11 studies were conducted in Europe and 2 in North America. No studies on costs incurred by PBIs were found in the Brazilian reality.

Regarding the population of the studies, 10 of them included intensive care unit patients, 1 included chronic renal patients, 1 included oncology patients, and 1 did not specify the sample (Chart 1).

Chart 1 – Methodological aspects of the studies included in the present review (to be continued)

Study	Year	Country	Type of Study	Place of hospitalization	Sample size	Analysis perspective
A[11]	2015	Spain	Retrospective cohort	ICU	Impregnated catheter (n = 353) and conventional (n = 518)	Not informed
B[12]	2014a	Spain	Prospective cohort	ICU	Impregnated catheter (n = 245) and conventional (n = 391)	Not informed
C[13]	2014	United States of America	Quasi experimental	-	Not informed	Not informed
D[14]	2014	United Kingdom	Utility cost	ICU	Not applicable	National health service

Chart 1 – Methodological aspects of the studies included in the present review (conclusion)

Study	Year	Country	Type of Study	Place of hospitalization	Sample size	Analysis perspective
E[15]	2014b	Spain	Retrospective cohort	ICU	Impregnated catheter (n = 64) and conventional (n = 190)	Not informed
F[16]	2014	Germany	Prospective cohort	ICU	Patients with (n = 40) and without (n = 40) PBI	Not informed
I[17]	2012	Spain	Retrospective cohort	ICU	n = 147	Not informed
L[18]	2012	Romania	Cross-sectional study	Chronic renal patients	n = 75	Not informed
M[19]	2011	Spain	Retrospective cohort	ICU	Impregnated catheter (n = 184) and conventional (n = 190)	Not informed
N[20]	2011	United States of America	Intervention research	ICU	Not applicable	Not informed
P[21]	2010	France	Randomized clinical trial	ICU	1,636 patients	Not informed
R[22]	2007	Italy	Observational prospective	Cancer patients	n = 44	Not informed
S[23]	2005	Belgium	Retrospective cohort	ICU	n = 176	Not informed

Source: Created by the authors.

The increase in the length of hospitalization of the patients diagnosed with PBI in relation to the others ranged from 1.5 to 26 days, with an increase in mortality ranging from 1.8% to 34%. The cost per episode of infection ranged from $24,090 to $34,544, and for studies conducted in Europe, the cost was between €16,814 and €29,909 (Chart 2).

Chart 2 - Costs, increase in length of hospitalization and mortality related to episodes of Primary Bloodstream Infection (PBIs) (to be continued)

Study	Costs related to a PBI episode	Increased length of hospitalization	Increased mortality	Other results
A[11]	Daily cost * €736 ± 283	Not informed	Not informed	Patients who used silver chlorhexidine-sulfadoxine-treated catheters had lower daily cost compared to those using conventional catheters (€3,35 ± 3,75 x €3,94 ± 9,95).
B[12]	Daily cost * €7.28 ± 16.71	Not informed	Not informed	
C[13]	$25,000 per episode	Not informed	Not informed	The total annual cost to the hospital was $1,050,000, considering the increase in days of hospitalization, mortality and treatment.

Chart 2 - Costs, increase in length of hospitalization and mortality related to episodes of Primary Bloodstream Infection (PBIs) (conclusion)

Study	Costs related to a PBI episode	Increased length of hospitalization	Increased mortality	Other results
D[14]	£3,940 per episode	1.5 fold	RR 3.25	
E[15]	Daily cost * €18.22 ± 53.13	Not informed	Not informed	
F[16]	Average of €29,909 per episode	Average of 7 days	Not informed	The average hospital cost was significantly higher in patients with PBI (€60,445 x €35,730) and the length of hospital stay (44 x 30 days) as well.
I[17]	Daily cost * €1,772 ± 480	Not informed	17%	Higher cost in patients who used rifampicin-miconazole-impregnated catheters than those using conventional catheters (€38.11 ± 77.25 x €11.46 ± 6.25).
L[18]	Not informed	Not informed	Not informed	Increase of 47% in the expenses with patients diagnosed with PBI in relation to those without such diagnosis.
M[19]	Daily cost * €1,661 ± 480	Not informed	34%	Lower cost in patients who used rifampicin-miconazole-impregnated catheters compared to those using conventional catheters (€12.61 ± 8.38 x €18.22 ± 53.13).
N[20]	Between $30,607 and $34,544 per episode Average cost of $32,254	Not informed	Not informed	
P[21]	$24,090 per episode	2 to 26 days, with an average of 11 days	Not informed	
R[22]	€383.44 per episode *	Not informed	Not informed	Catheter-related adverse events increased costs from 27.2% (€1,092) to 32.5% (€1,179).
S[23]	€16,814 ± 3,594 per episode	12 days	1.8%	Mortality was 27.8% in the cases against 26% in the controls, but the cases required more time in mechanical ventilation (23 x 16), longer ICU time (28 x 20 days). Total cost was higher in patients with PBI.

Source: Created by the authors.

* Expenses included: cost of the catheter, costs with the diagnosis of the PBI and antimicrobial treatment, without considering the increase in the days of hospitalization.

Legend: € - euro; £ - pound; $ - dollar; RR - Relative Risk

Discussion

The methodology used in the studies was quite diverse, however there was a predominance of observational cohort studies. This is a relevant methodology to identify the dynamics of events in a population and the incidence of an injury, and thus know the risks. Furthermore, cohort studies are indicated for diseases of high incidence and with a short period of development[24], as it is the case of PBI.

Descriptive cost-of-health studies are the basis for comprehensive economic evaluations and allow the assessment of different interventions related to PBI prophylaxis, with a view to reducing the financial and social impact of this complication. There was a greater occurrence of studies focusing on the cost of PBIs from 2010 onwards. Despite the concern with health costs dating back to 1970, economic health assessments focused on distributing resources only in order to achieve the proposed results, until the 1990s. After this period, this concept was expanded, and the costs started to provide tools to assist in the decision-making process in a broader way[25]. This fact contributed to increase the realization and dissemination of studies assessing the economic consequences of the diseases, especially in developed countries.

It should be noted that all papers included here were published in developed countries, pioneering the structuring of technology assessment and health economics agencies in the world, with the United States as the cradle[26]. The most frequently studied population was intensive care unit patients, justified by the large-scale use of central venous catheters, both for treatment and for monitoring, and also because ICUs are the hospital sector where PBIs most frequently occur[4].

The results revealed a mortality rate due to PBI ranging from 1.8%[23] to 34%[19]. Although mortality does not generate a direct cost for the hospital, it entails social costs due to the individual's early death and loss of productivity.

Regarding the type of cost analyzed, seven studies considered the following factors to calculate the cost of an PBI: increased length of hospital stay, expenses with the puncture of a new central venous catheter, antimicrobial treatment, and diagnosis of the infection. In these studies, the cost of a PBI episode, calculated in dollars, ranged from $24,090[21] to $34,544[20]. When the currency used was the euro, the values ranged from €16,814[23] to €29,909[16].

It is noticed that there are discrepancies between the values found in different countries. This may be due to the difference in the epidemiology of the disease (micro-organism involved) and the technology available for diagnosis and treatment[27]. Furthermore, the diversity between developed and developing countries[27], the health reality of each country and the methods of data collection employed must be taken into account. However, the data collected confirmed the major epidemiological and financial relevance of PBI, both for developed and developing countries.

In six studies[11-12,15,17,19,22], the average cost per PBI episode was lower than the others, ranging from €7.28[12] to €1772[17]. However, all studies considered only the replacement of the catheter, the diagnosis of the infection and the antimicrobial treatment as PBI-associated costs, overlooking the cost due to the increased length of stay.

It should be noted that these studies did not address the financial impact of PBIs in its full extent, because there was an increase in the hospitalization time of patients with diagnosis of infection that varied from 1.5[14] to 26 days[21], and this involver higher cost due to infection from the perspective of the health system or hospital. No study was developed from the perspective of community; thus, the days of productivity lost as a result of the disease are not considered.

A study developed with the purpose of evaluating the quality of the hospital infection control program pointed out the need for better structuring of infection control services related to health care, focusing on the prevention of infections[28]. Knowing the real financial impact of an infection to the hospital can contribute to

the search for preventive actions that are cost-effective for each organization.

The results of this review reinforce the need to expand the research on PBI-related costs in developing countries in order to know their financial impact, including in the Brazilian reality.

As limitations of this review, it was not possible to compare costs in different countries, as they have different clinical behaviors and epidemiology of the disease; and also the studies were developed with different methodologies and perspectives.

Conclusion

Primary bloodstream infections related to short-term central venous catheters in adults represent a high cost for hospital organizations. Scientific evidence revealed a discrepancy in relation to the cost of central venous catheter-related PBI, considering that they are studies with different methodologies and represent diverse epidemiological realities. Moreover, it was not possible to compare the costs between the countries, because different currencies were used in the studies and because they did not consider the same aspects in the analyses.

This study reinforces the need to develop economic cost-effectiveness studies of central venous catheter-related PBIs in each reality, taking into account the epidemiology of the disease and the availability of technologies for its treatment, which directly impacts on the final cost related to each episode of infection.

Collaborations:

1. conception, design, analysis and interpretation of data: Mitzy Tannia Reichembach Danski, Edivane Pedrolo, Astrid Wiens Souza and Radamés Boostel;

2. writing and relevant critical review of intellectual content of the article: Mitzy Tannia Reichembach Danski, Edivane Pedrolo, Astrid Wiens Souza, Radamés Boostel and Jorge Vinícius Cestari Felix;

3. final approval of the version to be published: Mitzy Tannia Reichembach Danski, Edivane Pedrolo, Astrid Wiens Souza, Radamés Boostel and Jorge Vinícius Cestari Felix.

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