American Journal of Infection Control 41 (2013) e81-e84

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major article

Incidence of infectious complications associated with central venous catheters in pediatric population

Viviane Rosado MSc[a], Paulo Augusto Moreira Camargos PhD[b], Wanessa Trindade Clemente PhD[a,c], Roberta Maia de Castro Romanelli PhD[a,d,*]

[a] Infection Control Committee of Clinics Hospital, Federal University of Minas, Gerais (UFMG), Belo Horizonte, Minas Gerais, Brazil
[b] Health Sciences Post-graduate Program, Health Sciences Center, Federal University of São João del-Rei (UFSJ), Divinópolis, Minas Gerais, Brazil
[c] Complementary Propedeutics Department, Faculty of Medicine of Federal University of Minas Gerais (UFMG), Belo Horizonte, Minas Gerais, Brazil
[d] Pediatrics Department, Faculty of Medicine of Federal University of Minas Gerais (UFMG), Belo Horizonte, Minas Gerais, Brazil

Key Words:
Catheter-related infections
Precaution
Infection control

Background: Central venous catheters (CVC) are essential in intensive pediatric care units (PICU). Preventive measures during insertion and maintenance reduce infection risks.
Methods: A prospective cohort study was conducted from January 2010 to December 2011 in a Brazilian university hospital PICU. Patients were followed throughout hospital stay to verify the occurrence of catheter-associated infection (CAI). An active search was performed of the daily prospective data related to the practice of CVC insertion.
Results: There was a total of 255 catheter insertions with a CAI incidence density of 13.55/1,000 CVC-days. No association was found between an increased risk for infection and surgical hand antisepsis, the use of maximum barrier precautions, or the use of chlorhexidine for skin antisepsis, which were recommended for the prevention of CAIs. A multivariate analysis showed that catheter use for less than 7 days was protective ($P < .01$; odds ratio, 0.29; 95% confidence interval: 0.12-0.72).
Conclusion: Health care teams responsible for CVC insertion should rigorously assess the need for CVC and remove them within 7 days when possible. For patients who have no indication for CVC removal, monitoring with clinical evaluation and requests for additional blood cultures should be scrutinized rigorously.

The rate of catheter-associated infections (CAIs) is an important indicator of quality of care in pediatric intensive care units (PICUs). Few studies regarding CAIs have focused specifically on this population, and the existing publications show that the adoption of interventions to prevent infection during central venous catheter (CVC) insertion and maintenance leads to a reduction of infection rates.[1,2]

In countries such as the United States and Spain, the incidence of catheter-associated bloodstream infections (CA-BSIs) is between 2.5 and 6.7/1,000 CVC-days.[2,3] Brazilian and Latin American hospitals, which have similar characteristics of technologic resources, population, techniques used, and materials acquired by the health care facilities, show much higher rates of CA-BSIs (between 1.6 and 44.6 cases per 1,000 CVC-days).[3]

The incidence density (ID) of sepsis associated with CVC (that is, the sum of the new cases of CA-BSIs in the period divided by the total number of patients with central catheter-days in the examined period, multiplied by 1,000) at the PICU of Brazilian university hospital in which this study was conducted was 15 episodes per 1,000 CVC-days in 2010 and 13 episodes per 1,000 CVC-days in 2011.[4]

To reduce both the rate of infection and the ID of sepsis, the Healthcare Infection Control Practices Advisory Committee and the Institute for Healthcare Improvement of the United States of America recommend the adoption of bundles or "Intervention Packages," which are combinations of practices and behavior for the prevention of microbial contamination, the migration and adhesion of microorganisms, and catheter colonization. These practices include handwashing, use of maximum barrier precautions, use of chlorhexidine for skin antisepsis, selection of the best site for CVC insertion, and daily catheter assessment in addition to its removal as soon as it is no longer necessary.[5,6] This study aimed to verify the

* Address correspondence to Roberta Maia de Castro Romanelli, PhD, Avenue Professor Alfredo Balena, 110, 1° andar-sala CCIH-Santa Efigênia, 30130-100 Belo Horizonte-MG, Brazil.
E-mail address: rmcromanelli@medicina.ufmg.br (R.M.de.C. Romanelli).

Supported by the Brazilian research agencies National Council of Technological and Scientific Development (CNPq; grant 303827/2009-2; to P.A.M.C.) and Foundation for Research Support of the State of Minas Gerais (FAPEMIG; grant PPM-00230-10; to P.A.M.C.) and by Pro-Rector for Research of the Federal University of Minas Gerais (PRPQ) for translation.

Conflicts of interest: None to report.

0196-6553/$36.00 - Copyright © 2013 by the Association for Professionals in Infection Control and Epidemiology, Inc. Published by Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.ajic.2012.10.024

rates of CAIs in hospitalized patients in the PICU of a public hospital and to identify the main risk factors related to CAIs.

METHODS

This was a prospective cohort study conducted in the PICU of a university hospital between January 2010 and December 2011.

Selection and description of the participants

The target population consisted of patients undergoing central venous catheterization in the PICU or the surgical ward of the same hospital. We included patients younger than 18 years who underwent a central venous puncture or dissection for a peripherally inserted central catheter (PICC). The standardized surveillance form for insertion must have been completed. The design and data collection instrument were approved by the Ethics and Human Research Committee: COEP/UFMG (ETIC417/07).

Technical information

The variables included in the standardized form reflect the recommendations contained in the guidelines of the Centers for Disease Control and Prevention (CDC).[7] Thus, catheter insertion was considered appropriate when the following were performed: (1) surgical antisepsis for hand hygiene with the aid of a brush, (2) appropriate adornment of the professionals who participated in the procedure (eg, use of a mask, cap, sterile gown, sterile gloves), (3) use of a large sterile drape, and (4) use of 2% chlorhexidine followed by 0.5 % alcohol chlorhexidine as an antiseptic. In addition, data regarding the duration of CVC insertion and variables not included in the *bundle*, ie, the number of puncture attempts, type of catheter (mono lumen or double lumen), and type of dressing performed immediately after the insertion of the CVC were evaluated.[8]

The data were collected on a standardized documentation form to monitor the processes of insertion, maintenance, and removal of the catheter. They were subsequently checked and entered into the database.

Patients were followed throughout their hospital stay to record the occurrence of CAIs, which were defined using the criteria of the National Healthcare Safety Network 2010 of the CDC[7] in Atlanta, in patients who had a CVC or who have had a CVC until 48 hours before the diagnosis of an infection.

Culture samples were routinely sent to the microbiology laboratory. Microorganisms were isolated using an automated method (Vitek 2; Biomerieux, Marcy l'Étoile, France), and susceptibility testing was performed using an agar disk diffusion method[9] for confirmation of the resistance profile. The bacteriologist was unaware that the patient had a CVC or of how long the device had been implanted. The sensitivity profile of the microorganisms considered the Commission's definition of Hospital Infection Control Program, based on the Clinical and Laboratory Standards Institute.[1]

CA-BSIs were defined in patients with CVCs by the following: the isolation of a pathogenic microorganism from at least 1 blood culture that was not related to the infectious process in another site, clinical signs or symptoms (fever (>37.8°C), chills, hypotension), isolation of the same contaminating microorganism in 2 or more cultures collected on separate occasions that were not related to an infection at another site.

Statistical analysis

Assuming (1) that 255 CVC insertions are carried out every 2 years with an approximate CAI prevalence of 10%, (2) a margin of error of 5%, and (3) an α error of 5%, a minimum of 90 patients would be required to assess the rate of infection associated with CVCs during the study period. The variables were collected, entered into a database, and analyzed using SPSS 17.0 (IBM, New York, NY). The mean, median, mode, and standard deviations were used to describe the quantitative variables. The categorical variables were presented as frequencies and percentages. The differences between categorical variables were analyzed using the nonparametric χ^2 test or Fisher exact test. Differences were considered significant at $P < .05$. We also calculated the odds ratio (OR) and the 95% confidence interval (CI) for the factors associated with catheter-related infections. The multivariate analysis included variables with a P value less than or equal to .20 in the univariate analyses.

Table 1
Characteristics of the population studied in the PICU from 2010 to 2011

Population characteristics	n (%)
Sex	
Female	127 (49.80)
Male	128 (50.20)
Clinical diagnoses	
Congenital malformations	89 (16.33)
Infectious diseases	64 (11.74)
Cancer	55 (10.09)
Respiratory diseases	50 (9.17)
Circulatory diseases	49 (8.99)
Other diagnoses	238 (43.67)
Hospital location of insertion	
Pediatric ICU	67 (26.28)
Surgical room	188 (73.72)
Incidence	
Laboratory-confirmed bloodstream infections	24 (82.75)
Cardiovascular system or arterial infection	5 (17.25)
Distribution of isolated microorganisms*	
Gram-negative bacteria	17 (58.60)
Gram-positive bacteria	8 (27.60)
Fungi	4 (13.80)

*Isolated microorganisms: Gram-negative bacteria: *Acinetobacter baumannii*, *Escherichia coli*, *Enterobacter cloacae*, *Flavobacterium meningoseptic*, *Pseudomonas aeruginosa*, *Serratia marcescens*, *Burkholderia* ssp, *Klebsiella penumoniae*. Gram-positive bacteria: *Corynebacterium* sp, *Staphylococcus coagulase negativos*, *Enterococcus faecalis*, *Staphylococcus aureus*. Fungi: *Candida* SSP.

RESULTS

A total of 255 patients was eligible for inclusion in the study, which was 183% greater than the minimum sample size required. Table 1 shows the characteristics of the population evaluated in the study.

Most patients were younger than 6 years of age, and the most prevalent diagnoses were congenital malformations, infectious diseases, and cancer. The majority of CVC insertions was performed in the surgical ward, and 58.6% of the identified infections were caused by gram-negative bacteria (Table 1, footnote).

The ID was 13.55 per 1,000/CVC-days. Gram-negative bacteria were the most commonly isolated, reflecting the profile of microorganisms associated with CAIs in the PICU of the hospital. Table 2 presents the univariate analysis of the procedure used during CVC insertion and its association with the occurrence of CAI.

Maximum Barrier Precautions were not fulfilled in 3.9% of the cases. Hand antisepsis was performed for all of the procedures. In 81.4% of the insertions, the antiseptic chlorhexidine was not used as recommended (meaning that the procedures have not been made with chlorhexidine gluconate [CHG] but PVP-I or aqueous CHG was used, not followed by an alcohol-CHG).

Maintaining the CVC for less than 7 days was protective against infection (OR, 0.32; 95% CI: 0.1-0.7); patients with CVCs inserted for less than 7 days had a 0.32-fold lower chance of infection (Table 2). Only the variables with a P value less than or equal to .20 in the