



FACULDADE DE MEDICINA
UNIVERSIDADE DO PORTO

MESTRADO INTEGRADO EM MEDICINA

2013/2014

Bárbara Filipa Gomes Azevedo
Complications of the Central
Catheters in a level III Neonatal
Intensive Care Unit

março, 2014

FMUP



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Mestrado Integrado em Medicina

Área: Neonatologia

Trabalho efetuado sob a Orientação de:

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E sob a Coorientação de:

Dr. Gustavo Rocha

Baseado na revista Acta Paediatrica

março, 2014

FMUP

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Complications of the Central Catheters in a level III Neonatal Intensive Care Unit

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Abstract

Aim: To identify, during one year period, complications related to CCs in a level III NICU, to improve practices in the NICU. **Methods:** Data were collected prospectively on a level III NICU, between February 2013 and January 2014. **Results:** During the one year period, 254 CCs were placed on 131 infants, with 1.95 catheters per patient. The CC line infection rate was 6.45 per 1000 catheter-days. Length of catheter-stay superior to ten days correlated with infection outcome ($p=0.037$). Preterm infants had prolonged length of catheter-stay ($p=0.004$). Broviac was the type of catheter with highest relative incidence of infection ($p=0.302$) and complications ($p=0.879$). **Conclusions:** The length of catheters-stay appears as a risk factor for CRBI. More infection cases were found when length of catheter-stay was higher than ten days. LBW, VLBW and ELBW and preterm infants had more prolonged length of catheters-stay.

Keywords: central catheter, complication, infection, intensive neonatal care, preterm infants

Key Notes

In this study we want to identify the complications related to CCs in a level III NICU during one year.

Preterm, LBW, VLBW and ELBW infants had a more prolonged length of catheter-stay and a significant relation between the length of catheter-stay and complications was found.

Introduction

Catheters are widely used in neonatal intensive care units (NICU) (1-6). Placement of a central catheter (CC) is a medical technique that has improved medical care and has become more and more common in the last years. Vascular access can be obtained using venous access (Broviac, peripherally inserted central catheter (PICC) and venous umbilical catheter (UVC)) or arterial access (arterial umbilical catheter (AUC) and arterial periferic catheter (APC)). Each one of this has its own recommendations and specific uses (1,2).

In spite of its utility, the placement of a central catheter or an arterial access is potentially associated with complications that increase the morbidity and mortality of NICU patients. The most common complication associated with the use of vascular access is catheter-related bloodstream infection (CRBI) (7-9). Infiltration, occlusion, thrombosis, arterial hypertension, cardiac arrhythmia are other possible complications (2,3,5,10). These adverse events related to catheter use represent non-intentional lesion resulting in extended hospitalization time or even death (5).

Bloodstream infections are the most frequent nosocomial infections in a NICU (2,4,7). Their incidence is directly related to the high survival rates of infants that in the past had no chance of survival. The use of CCs is associated with a better chance of survival, but also with the risk of developing an infectious complication (4).

The aim of this study is to identify, during a period of one year, the complications related to CCs in a level III NICU, in order to improve practices in the NICU.

Methods

This is a prospective study, in a Portuguese level III NICU, with duration of one year, between February 2013 and January 2014.

Eligible patients included all neonates with at least one CC inserted in this hospital, including Broviac, PICC, AUV, VUC and APC. For patients with more than one CC, each case of catheterization was individually evaluated.

In this study the CRBI was defined as: 1) primary bloodstream infection according CDC definition: a) recognized pathogen isolated from blood cultures, b) one of following clinical signs of infection [fever ($>38^{\circ}\text{C}$), hypothermia ($<37^{\circ}\text{C}$), apnea, or bradycardia], and 2) CC present at the time the blood culture was obtained. (12) A infection was considered catheter-related if it developed 48h after CC placement up to 48h after its removal. All the cases of infection, administration of antibiotics and CRP elevation recorded outside this period were not reported in this study. Another site of infection, such as respiratory tract infection and urinary tract infection, resulting in a bloodstream infection was defined as not-catheter related.

The following data were recorded for each catheter: date and site of insertion, position of the catheter tip (confirmed by x-ray), duration of catheterization, complications during catheterization, signs of infection, CRP values, blood culture results, need of antibiotics and if the catheter was removed before or after its purposes had been reached.

The number of catheter days was calculated from day of insertion to the day of removal minus one day. Length of catheter-stay was further divided in those who were catheterized for less than or more than ten days, respectively.

For purposes of the study different categories were defined: term or preterm, according to gestational age at birth (more or less than 37 weeks, respectively); three categories for weight at birth, with those with less than 1000g defined as 'extremely low birth weight' (ELBW), between 1000 and 1500g as 'very low birth weight' (VLBW) and between 1500 and 2500g as 'low birth weight' (LBW).

SPSS Statistics was the program used in the statistical analysis. Descriptive statistics for the categorical and continuous variables were calculated. Comparisons between groups were made using the χ^2 test for categorical variables and the Mann-Whitney U test for continuous variables. p value <0.05 was considered to indicate statistical significance.

The study was approved by the Ethics Department of the hospital.

Results

During the study period, 131 infants admitted to the NICU needed at least one CC in some phase of their hospitalization, giving a total of 254 CCs, with 1.95 catheters per patient (minimum one and maximum six). The 131 infants had a mean gestational age of 34 weeks, with 52 (39.7%) of the patients term and 79 (60.3%) preterm. Out of 131, 22 (16.8%) patients were ELBW, 18 (13.7%) VLBW and 47 (35.9%) LBW. Out of the 254 CCs, 88 (34.6%) were PICC, 43 (16.9%) Broviac, 41 (16.1%) AUC, 65 (25.6%) VUC and 17 (6.7%) APCs. (figure1)

Twenty five (9.85%) complications from direct use of CCs (e.g. infiltrations) and 14 (5.51%) infections were related. The total of events by type of catheter are described in table1 and figure2.

One hundred eighty four CCs (72.44%) were removed after their purpose had been achieved and the others were removed for several reasons, including death not related with catheter complications (table2).

The CC line infection rate in the 131 neonates was 6.45 per 1000 catheter-days. Out of the total of 14 infection episodes developed in context of a CC, six (42.86%) occurred in preterm infants and eight (57.14%) in term infants ($p=0.972$). There were six (42.86%) cases of infection in LBW patients and four (28.57%) in ELBW patients ($p=0.442$). Also, 12 (85.71%) cases of infection were related to venous catheters and two (14.29%) to arterial catheters ($p=0.433$).

Concerning the length of catheter-stay, 70 (27.6%) cases had a duration of more than ten days, 50 (71.43%) in preterm infants ($p=0.004$). Of the total 184 CCs with less than ten days of catheter-stay, six (3.26%) had infection, and of the 70 with more than ten days of catheter-stay, eight (11.43%) had infection ($p=0.011$). Twenty one (11.41%) cases of complications occurred in CCs placed for less than ten days, and four (5.71%) in those placed for more than ten days ($p=0.610$).

Discussion

CCs are essential for the treatment of sick neonates in NICU, however its use leads to an increased risk for iatrogenic complications (9). Identification of these complications, as well as their risk factors, is of great importance to help to avoid them and improve the outcome of high risk infants in a NICU.

The incidence of CC line infection incidence rate was 6.45 episodes per 1000 catheter-days, with 2.67 episodes per 1000 catheter-days in LBW and 1.84 episodes per 1000 catheter-days in ELBW. Similar to other studies, the higher incidence occurred in LBW and ELBW infants (1,2,8). National Portuguese Data shows an incidence of 16 per 1000 catheter-days of CC-associated sepsis, with 22.5 per 1000 catheter-days in ELBW (data not published). The disparity in the infection rates may be explained by the different characteristics of NICUs.

CCs placed for more than ten days had a highest incidence of infections, with 11.43% of them having infection compared with only 3.26% of those with less than ten days ($p=0.011$). This correlates with other studies where length of catheter-stay was a predictor of catheter line sepsis (1). Our results also show that 80.0% of infants with more than ten days of catheter-stay were LBW (44.29%), VLBW (11.43%) and ELBW (24.29%) infants ($p=0.004$) and that 71.43% of the infants with more than ten days of catheter-stay were preterm ($p=0.004$). Both this results have statistical significance and are similar to those found in literature (1,3,4). On the other side, complications directly related to the catheter use were more frequent (11.41%) within first ten days of catheter-stay, compared with 5.71% in CCs with more than ten days ($p=0.610$).

Although most of infections occurred in LBW (42.86%) and ELBW (28.57%) infants, no statically significant correlation was found ($p=0.442$), probably due to small sample. The same reason can explain why no statistic significance was found between infection prevalence and gestational age, with both term and preterm having similar results (57.14% vs. 42.86%, $p=0.972$). Although lacking statistical significance in this

study, evidence that LBW and ELBW infants with CCs have higher risk of developing bloodstream infection is corroborated by other studies (9).

Complications directly related to the presence of a catheter were described more frequently in infants with VLBW and ELBW compared with infants LBW (34.3% vs. 27.4%, $p=0.671$). These results lack statistical significance but, the finding that incidence of infection is increased in infants with decreased weight corroborates the National Nosocomial Surveillance study of the CDC, as well other studies (7,8,9,13).

Our results show that 72.05% of the CCs placed in this NICU were removed after their aim had been accomplished (table2). The most frequent reason to remove a CC before aim had been reached was infiltration (5.12%), although in only two (0.79%) catheters the catheter position had been considered abnormal. This is a complication that cannot be predicted and correlates with catheters management, which can explain this result. As expected, vasospasm (0.79%) only occurred in arterial catheters (figure2). Blockage had a similar incidence among all CCs and was probably related to catheter management and not to catheter type (figure2).

In our study, Broviac was the type of catheter with highest relative incidence of infection (11.63%, $p=0.302$) compared with other catheter types (table1), which is in accordance to the National Portuguese Data (data not published). More Broviacs (16.28%) developed complications compared with PICCs (11.4%); PICC had the highest number of infiltrations (eight out a total of 13 (61.54%)). Comparing Broviac and PICC catheters, the last one reported a smallest relative incidence of both complications (11.4%, $p=0.879$) and infection (5.68%, $p=0.302$) (table1), showing that its use should be preferred when possible.

There were two limitations in this study: 1) the small sample; 2) the criteria of infections and other potential iatrogenic complications aren't universally defined, which difficults the comparison with other studies.

Conclusions

The length of catheters-stay appears as a risk factor for CRBI. More infection cases were found when catheter-stay was longer than ten days. LBW, VLBW and ELBW and preterm infants had more prolonged catheters-stay. Although not statistically significant a higher incidence of infection was found in these groups. Since CC associated infection occurred mainly in patients who were smaller, younger and sicker, we hypothesize that they are also related to the degree of host illness and immaturity of the host defense system.

In summary, as the iatrogenic complications related with the presence of one or more CCs can be life threatening, an adequate monitoring should be provide, in order to improve the results obtained. More studies should be done, to improve specific techniques of care and monitoring and obtain a low onset of complications, as infections. CRBI, as one of the most concerning complications, should be carefully prevented, assessed and treated. We must weight the benefits of catheter removal before aim has been accomplished and the antibiotherapy must be correctly used to avoid antibiotic resistances.

A protocol of better practices to prevent catheter complications is mandatory in all units.

List of Abbreviations

- CC – central catheter
- NICU – neonatal intensive care units
- CRBI – catheter-related bloodstream infection
- ELBW – extremely low birth weight
- VLBW – very low birth weight
- LBW – low birth weight
- PICC- peripherally inserted central catheter
- AUC – arterial umbilical catheter
- VUC – venous umbilical catheter
- APC – arterial periferic catheter
- CRP – C reactive protein

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Tables

Table1. Type of catheters and associated events.

Event Catheter Type	Complications ($p=0.879$)		Infection ($p=0.302$)	
	No	Yes	No	Yes
PICC (n=88)	78 (88.6%)	10 (11.4%)	83 (94.32%)	5 (5.68%)
Broviac (n=43)	37 (83.72%)	7 (16.28%)	38 (88.37%)	5 (11.63%)
AUC (n=41)	37 (95.12%)	2 (4.88%)	39 (95.12%)	2 (4.88%)
VUC (n=65)	63 (96.92%)	2 (3.08%)	63 (96.92%)	2 (3.08%)
APC (n=17)	15 (88.2%)	2 (11.8%)	17 (100%)	0 (0.0%)

(PICC-peripherally inserted central catheter; AUC-arterial umbilical catheter; VUC-venous umbilical catheter; APC-arterial periferic catheter)

Table 2. Reason for catheter removal.

<u>After purpose reached</u>	184 (72.44%)
<u>Before purpose reached</u>	
1. Infiltration	13 (5.12%)
2. Blocked	5 (1.97%)
3. Vasospasm	2 (0.79%)
4. Possible infection of insertion place	3 (1.18%)
5. Abnormal position	2 (0.79%)

(CC-central catheter)

Legend

Figure. 1. Frequency of each type of catheter used during the length of the study.

Figure. 2. Number of complications per catheter type. (PICC-peripherally inserted central catheter; AUC-arterial umbilical catheter; UVC-umbilical venous catheter; APC-arterial periferic catheter; CRBI-catheter related bloodstream infection)

Figures

Figure1.

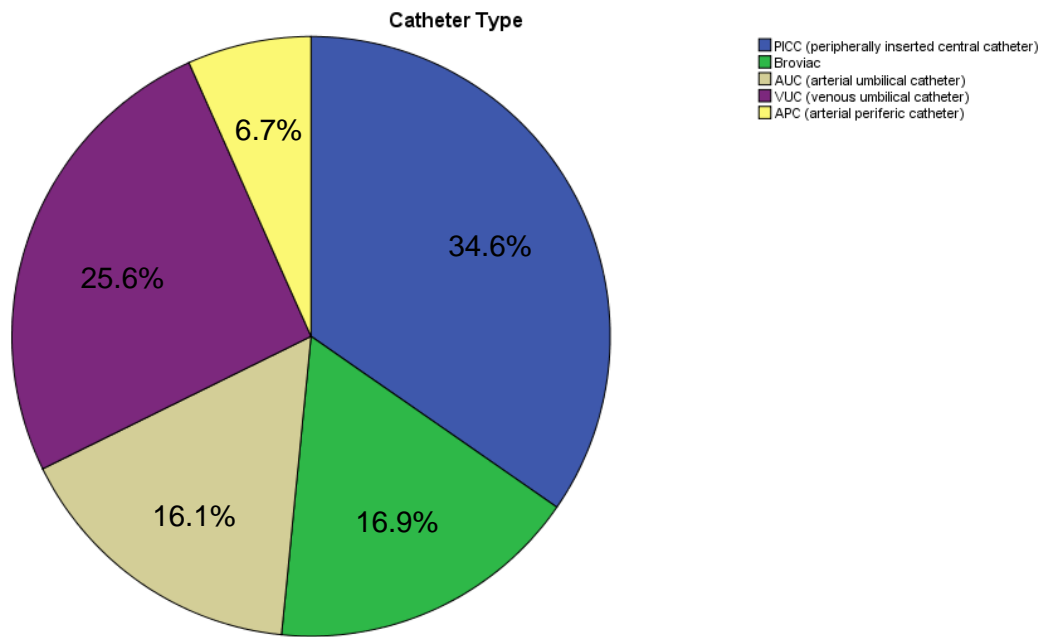
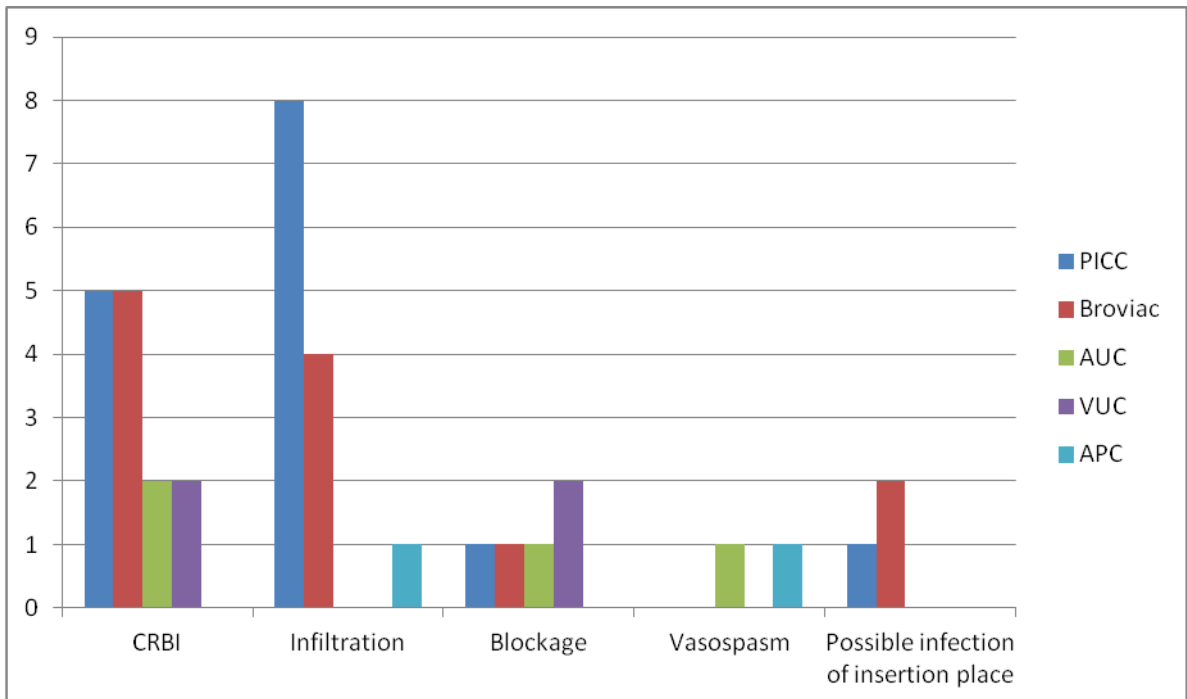


Figure 2.



Agradecimentos

Um muito obrigada a todos aqueles que colaboraram comigo e me ajudaram a tornar este trabalho possível, principalmente à minha orientadora, a Doutora Hercília Guimarães, que foi incansável.

Quero agradecer a toda a minha família, em especial à minha mãe, por todo o amor, apoio e paciência ao longo deste trabalho.

Um especial agradecimento ao Joe, por me fazer ver para além da primeira página.

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