

Incidence of local complications in peripheral venous catheters and associated risk factors

Incidência de complicações locais no cateterismo venoso periférico e fatores de risco associados

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Abstract

Objective: To estimate the incidence of local complications associated with peripheral catheters and identify risk factors for the development of most common complications.

Methods: This prospective cohort study included 92 adult inpatients at clinical and surgical units who had peripheral catheterization. By daily observance of the catheters we determined time of permanence and local complications due to the use of a complete safety catheter. All actions began after training of nursing teams. Statistical tests used were the Fisher exact test, G test (Williams), chi-square, Mann-Whitney U test, and relative risk.

Results: Local complications occurred in 56.2% of cases. Time of catheter permanence over 72 hours increased the risk for phlebitis development in 2.34% of cases (RR; $p=0.0483$; CI [0.91; 6.07]).

Conclusion: Incidence of local complications was high. Phlebitis was the predominant complication and the time of catheter permanence over 72 hours was a considered risk factor for this complication.

Resumo

Objetivo: Estimar a incidência de complicações locais associadas ao cateterismo periférico e identificar os fatores de risco associados ao desenvolvimento da complicação mais frequente.

Métodos: Coorte prospectiva realizada com 92 adultos internados em unidades clínicas e cirúrgicas com cateterismo periférico. Mediante observação diária do cateter, determinou-se o tempo de permanência e as complicações locais advindas do uso do Cateter de Segurança Completo, após capacitação das equipes de enfermagem. Utilizou-se os testes Exato de Fisher, G de Williams, Qui quadrado, U de Mann-Whitney e Risco Relativo.

Resultados: Observou-se 56,52% de complicações locais. O tempo de permanência superior a 72 horas aumenta o risco para desenvolvimento de flebite em 2,34 (RR; $p=0,0483$; IC [0,91; 6,07]).

Conclusão: A incidência de complicações locais foi elevada, havendo predominância de flebite; o tempo de permanência superior a 72 horas foi detectado como fator de risco para sua ocorrência.

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Introduction

Intravenous therapy is widely used in hospital care and is viable because of several technologic devices, including peripheral intravenous catheters. These devices are mainly indicated for administration of medicine, fluids, blood, and nutritional products.^(1,2)

Peripheral intravenous catheters are the most used invasive device,⁽²⁾ and the technological advances made with this device in the past decades is remarkable. In Brazil, use of health technologies is below the international average. An example is the complete safety catheter, an intravenous peripheral device indicated for medium-term treatment. The complete safety catheter has particular characteristics that aim to improve practice and improve safety of professionals performing the procedure.

This “under needle” device has two access pathways: an extensive tube that enables the practitioner to see blood reflux during puncture and to handle wings/fixation and a safety device that covers the needle in order to reduce risks for accidents with biological and hazardous waste. This device consists of polyurethane (Vialon®) and presents low thrombogenicity; this catheter is better adapted the venous network anatomy and reduces the occurrence of mechanical phlebitis caused by irritation.

Peripheral catheters, despite their wide use, can lead to local and systemic complications. In this study we focus on local complications (i.e., injuries in the area surrounding the catheter insertion site), which are rarely severe and can be observed early by objective assessment. These complications include hematoma, occlusion, phlebitis, thrombophlebitis, infiltration, leakage and local infection.⁽²⁾

To support nurses’ decision making regarding the most adequate and safe intravenous peripheral device, our study attempted to estimate the incidence of local complications associated with peripheral catheters and identify risk factors associated with the development of most common complications.

Methods

This prospective cohort study was carried out at clinical (Women’s Internal Medicine, Men’s Internal Medicine, Cardiology and Neurology) and surgical (Gastro-intestinal and General Surgery) units at a teaching hospital in Curitiba, Paraná, Brazil.

Data were collected between August and October 2014, a period during which the stipulated number of participants for sample calculation was achieved. In August, a pilot test was conducted to verify adequacy of the method and the instrument for data collection.

We included both adult inpatients of both sexes who had undergone peripheral venous puncture with a complete safety catheter during the period of data collection. This convenience sample was assemble via consecutive selection and included patients who met the eligibility criteria. Inclusion criteria were age 18 years or older, hospitalization, and need for intravenous peripheral therapy. Exclusion criteria were weakness in peripheral venous network that prohibited puncture with a peripheral catheter and allergy to any material used to produce catheters.

Data were collected by the research team after staff members received training on standards for performing the collection. Collection started after information was obtained from medical records and daily follow-up of inserted catheters in order to evaluate endpoints. We used a structured instrument with variables related to the patient (sociodemographic and clinical data), the catheter and its daily follow-up report. Sociodemographic variables included: name initials, number of medical record, sex, age, ethnic group, formal education level, occupation, family history of diseases, use of smoking products, and use of alcohol. The variable concomitant infection referred to any infectious site observed in the patient, and this finding was collected daily through the checking of therapeutic prescription of antimicrobial agents during the hospitalization.

Variables related with catheter were: gauge, anatomical localization, duty hour when the catheter was inserted, duration of catheter permanence, intravenous drugs used, and reason for the catheter

removal (elective because of end of intravenous therapy, discharge, death, transference from the unit, or development of complications).

Direct and daily follow-up of the device enabled to determine the frequency of fixation change and its material, presence of concomitant venous access (central and/or peripheral) and complications associated with the catheter (phlebitis, thrombophlebitis, obstruction, infiltration, leakage and local infection). For the variation local infection we standardized the following: presence of purulent discharge at the catheter exit site, hyperemia and edema in the surrounding skin.⁽²⁾ These information were collected daily, along with information about drugs administered through catheter, concomitant infection and surgical procedures. Endpoint variables evaluated were infiltration, leakage, obstruction, phlebitis, thrombophlebitis, local infection and accidental catheter traction.

Puncture and handling of devices were done by the nursing teams in the units. The study institution did not use this technology; thus, before we began data collection we offered training to all employees on how to handle the device.

We analyzed the following themes: technological advances of intravenous devices, general specification of complete safety catheter, puncture technology – handing of short flexible catheter (conventional) complete safety catheter; risks and benefits of each technology, methods of fixation; frequency of catheter change, research protocol, inclusions in medical records, local complications. The correct and complete register of data in the patient's medical record was emphasized, particularly because medical records were the single source where researches could obtain all information concerning insertion and removal of the catheter, occurrence of local complications and their severity degree.

Healthcare personnel were trained with the last recommendations of the Infusion Nurses Society - INS concerning the frequency of catheter change. Therefore, catheters were removal according to clinical indication or in case of contamination, complication, inefficient therapy or discontinuation of the therapy.⁽²⁾

The guidelines of Centers for Disease Control and Prevention - CDC was followed for steriliza-

tion, puncture, fixation, and stabilization of catheters - skin preparation with 2% chlorhexidine or 70% alcohol for antiseptis and use of sterile, transparent, semipermeable dressings. However, because the institution where this study was conducted did not have this material available, we used sterile gauze with dressing tape, which was changed every 24 hours or in case of appearance of residues, humidity, and adhesive tape detachment.

Data were entered into a spreadsheet using Microsoft Excel® and were analyzed using the Bioestat® program by a descriptive statistical approach. To analyze occurrence of local complications we used chi-square tests, Fisher exact test, and G test (Williams) for categorical explanatory variables and a Mann-Whitney U test for quantitative explanatory variables. A significance level of 5% was used for all tests. To evaluate risk factors we calculated the relative risk (RR) and confidence interval (CI).

Development of this study followed national and international ethical and legal aspects of research on human subjects.

Results

The sample consisted of 92 patients. One complete safety catheter was analyzed per patient. Most punctures were done at a men's clinic (27.17%). The majority of individuals were women (53.26%), and the mean age was 54.8±18.03 years. Most patients were white (89.13%). In general, participants were non-smokers and did not consume alcohol (85.87% and 73.91%, respectively).

Most of patients had no comorbidities (73.91%), and the reason for hospital admission was related to bowel (31.52%) and cardiovascular (22.83%) disease. Mean duration of hospitalization was 11.6±8.56 days. Most patients were discharged (93.48%). We did not analyze mean duration of hospitalization of patients who remained hospitalized after the end of data collection (4.35%); the same occurred with one patient who remained hospitalized for 442 days (outlier).

Most punctures were achieved with a 20-gauge catheter (72.83%), in the left upper limb (68.48%),

and in the forearm region (64.13%). In most cases the nurse successfully achieved the puncture procedure at first attempt (83.7%). Most catheters were used to administer sedatives or analgesics (66.3%).

Mean duration of catheter permanence was 3.73±2.23 days (minimum, 1 day; maximum, 10 days). In most patients catheter permanence was ≥72 hours (60.87%). However, for 14 catheters (15.2%) permanence was greater than 120 hours. Of these, nine (9.8%) were removed electively (at discharge or at the end of intravenous therapy).

Reasons for catheter removal were occurrence of a complication in 52 patients (56.52%) and elective removal due to discharge or end of intravenous therapy in 35 (38.04%). Other reasons included injury in one of the extensor routes (3.27%) and local pain reported by patients without evidence of complication (1.09%). Phlebitis was the most frequent complication (36.54%), followed by infiltration (23.08%), accidental catheter traction (17.31%), obstruction (15.38%), local infection (3.85%), leakage (1.92%), and thrombophlebitis (1.92%).

Risk factors were analyzed for the most frequent complication. We found no significant associations between phlebitis occurrence and several sociodemographic and clinical variables. The p-value* was greater than 0.05 for all variables. Mean time between catheter permanence and phlebitis development (4.36 days) was significantly different compared with the time between catheter permanence and other complications (3.18 days) (p=0.0430**). No statistical significance was found for the other variables.

Considering data presented, phlebitis was most frequent in men (52.63%), who had bowel diseases (36.84%), used a 20-gauge catheter (78.95%) in the left limb (57.89%), in the forearm (68.42%), and with time of catheter permanence over 72 hours (79%) and who received sedative/analgesic intravenous (73.68%).

To verify the existence of risk factors for phlebitis development, we conducted an analysis after excluding all patients who did not develop any complications (n=40). This analysis included 52

patients. In this analysis we considered two groups: patients who had phlebitis (n=19) and patients who did not present other complications (n=33).

It is important to highlight that phlebitis was detected in patients who used a catheter for more than 72 hours (79%). This finding indicates that longer permanence increases the risk of phlebitis development (Table 1).

Table 1. Analysis of duration of permanence associated with phlebitis caused by the use of complete safety catheter

Time of permanence	Phlebitis		p-value	RR	CI [95%]
	Yes (n=19) n(%)	No (n=33) n(%)			
< 72 hours	4(21.0)	16(48.5)	0.0483	1	[0.91;6.07]
> 72 hours	15(79.0)	17(51.5)			

n=52

RR – Relative Risk ; CI [95%] – 95% Confidence Interval

Discussion

The small numbers of significant associations among variables and occurrence of phlebitis in our sample limited our ability to identify other risk factors for complications related to the use of catheters.

The complete safety catheter appears to be an innovation for intravenous therapy, considering the benefits pointed out in the research. These include the high rate of successful placement with the first puncture attempt; longer permanence until appearance of local complications; low incidence of local infection due to components of the closed system; and protection offered to the professional against accidental exposure to biological and hazardous waste. In addition, our results can be used to help prevent local complications because of the use of peripheral intravenous catheter by the nursing team once they are responsible for choosing the technology to be used, as well as catheter insertion and maintenance until removal.

Most patients were women (53.26%); the mean age was 54.8±18.03 years. Most were white (89.13%) and non-smokers (73.91%) and did not consume alcohol (85.87%). Our results corroborate those of similar studies; an earlier study population

*Tests: Chi-square, Fisher's exact, G Williams and Mann-Whitney.
**Mann-Whitney U test

also had a majority of women (55%), age older than 50 years and non-smokers (56.1%).⁽³⁾

Most patients in our study had no comorbidities (73.91%). The majority of the patients were admitted for treatment of disease related with gastrointestinal system and cardiovascular diseases, especially because these are specialties investigated where the study was conducted. A randomized clinical study also reported the predominance of hospitalized patients for gastrointestinal related-problems (27.07%), however most patients (59.3%) had more than two comorbidities.⁽⁴⁾

Mean duration of hospitalization was 11.6 ± 8.56 days, a result similar to that of an earlier study (mean duration of hospitalization, 12 days).⁽⁵⁾ Of note is the high incidence of discharge (93.48%), especially because in the units studied inpatients are at lower risk of death. However, the lack of comorbidities also contributes to satisfactory patient recovery.

Most of the complete safety catheters used in our analysis were 20 gauge (72.83%) and were inserted in the left upper limb and in the forearm region to administer sedatives or analgesics. Another study in the literature also reported the prevalent use of 20-gauge catheters (53%); in that study, however, punctures were mainly made at the dorsum of the hand (47%).⁽⁶⁾ Another study found more frequent use of catheter to administer antibiotic drugs (68.9%).⁽⁷⁾

It is important to highlight the rate of success in the first attempt at puncture by the professional; this is notable because until the beginning of the study the employees were unfamiliar with the technology. Such success is due to the professionals' lengthy experience with venous puncture; it also suggests the positive effect of the training provided.

Mean duration of catheter permanence was similar to that reported in an earlier study (mean duration, 3.5 days).⁽⁸⁾ We highlight that the majority of patients had the catheter in place for 72 hours or more, and in many patients catheter permanence was over 96 hours. A prospective study reported that permanence of most peripherally inserted central catheters was 72 hours or less (93%); 5.8% were in place for 73 to 96 hours, and the others (1.2%), more than 96 hours.⁽⁹⁾ These results are different from those reported in our study.

Most studies in the literature report that catheter permanence for more than 120 hours is unusual; in a prospective cohort study, this occurred in only 7.8% of cases.⁽¹⁰⁾ However, our study found a high proportion of permanence over 120 hours, and the majority was due to elective removal.

The guidelines created to prevent complications of intravenous therapy recommend the scheduled replacement of peripheral catheters in adults every 72-96 hours. For newborns, children and patients with weak peripheral venous network, the recommendation is to replace the catheter only when clinically indicated.⁽¹¹⁾

There is no consensus about catheter permanence in adults. However, a systematic review did not find conclusive results concerning benefits in scheduled change of catheters. Clinical trials, which were included in the review, reported that scheduled removal every 72-96 hours was associated with complication rates similar to those seen with required removal.⁽¹²⁾ Since 2011, INS has recommended changing intravenous peripheral catheters according to clinical indication. For this reason, the catheter insertion site should be regularly inspected in order to identify clinical signs of complications, of inefficient therapy, or discontinuation of therapy.⁽²⁾

The main reason for catheter removal was the occurrence of complications with predominance of phlebitis, followed by infiltration, and accidental catheter traction. In addition, we observed a low occurrence of local infection, leakage and thrombophlebitis. A multicenter study presented the following rates of complications related to catheters: obstruction (20.95%), infiltration (15.65%), accidental catheter traction (9.89%), phlebitis (6.94%) and local infection (0%).⁽¹³⁾ This study differs from ours in that regard. The phlebitis rate exceeds the accepted standard by Infusion Nurses Society, which established an acceptable frequency of 5% in one population.⁽²⁾

The low occurrence of leakage is because of the little amount of catheter used for infusion of irritant and/ or vesicant agents, due to preference of central venous access for administration this type of medication.

In our study the phlebitis was not significantly associated with a number of sociodemographic and clinical variables. In catheters variables we observed that devices that developed complications had greater mean duration of permanence than those that were associated with several complications. The permanence greater than 72 hours was a risk factor for complication. A national prospective cohort study including 100 patients, reported that phlebitis was statistically associated with catheters with permanence greater than 72 hours.⁽¹⁴⁾

A study including 171 adult patients identified that permanence greater than 48 hours and catheter insertion in the antecubital fossa were significant factors for development of phlebitis, as well as 18-gauge catheter size, pre-existing diabetes mellitus and smoking.⁽³⁾ Another study identified four risk factors: female sex, insertion of catheter in emergencies, insertion in the forearm and administration of antibiotic drugs (which normally are irritants to blood vessels).⁽¹⁰⁾

Such data were validated in a multivariate analysis showing that catheter insertion in an emergency department and female sex were risk factors for phlebitis.⁽¹⁵⁾ International guidelines recommend that catheters inserted in emergency situations and with compromises in aseptic technique should be changed as soon as possible in order to prevent infectious complications.^(2,7)

Although other variables statistically associated with the occurrence of phlebitis were no identified in our study, a higher frequency of complications was seen among male patients who were admitted for gastrointestinal related problems and used 20-gauge catheter size on the upper left limb, inserted in the forearm region to administer sedatives or analgesics. These facts might explain the irritant characteristics to the vascular endothelium of most of these medicines.

A study identified that women with neurologic manifestations and hospitalized for eight and 20 days had higher occurrence of phlebitis, but this result was not associated with any statistically significant variable. The same study identified, concerning aspects related with catheter, higher frequency of complication in patients who received analge-

sics and antipyretic intravenously, used 22- and 24-gauge catheter size inserted in the forearm, received intermittent infusion and had catheter with permanence lower than 72 hours, this latter result does not corroborate with our findings.⁽¹⁶⁾

Another study with 76 adult patients using peripherally inserted catheter showed results similar to our study findings, their identified higher occurrence of phlebitis in those who used 18- and 20-gauge catheter size in the upper left limb and forearm. However, their study identified more complications in catheter with permanence equal or lower than 72 hours, a similar result identified by the other study mentioned above.⁽¹⁷⁾

The use of a complete safety catheter can provide more comfort for patients and safety for professionals; however, actions taken to prevent complications of peripheral intravenous therapy do not depend exclusively on the adoption of new devices. Rather, it is important to help people become more aware and to foster an attitude that encourages prevention.

Conclusion

A high incidence of complications associated with use of a complete safety catheter was seen. Phlebitis was the predominant complication and duration of catheter permanence was over 72 hours. This long period was considered a risk factor for this complication.

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Collaborations

Danski MTR contributed to the conception of the project, data collection, critical review relevant for intellectual content and approval of proofs. Olivei-

ra GLR and Johann DA contributed to the conception of the project, data collection, analysis and interpretation of data, drafting the manuscript and approval of proofs. Vayego SA contributed to the analysis and interpretation of data, critical review relevant for intellectual content. Pedrolo E contributed to the conception of the project, drafting the manuscript and approval of proofs.

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