Original Article

TEXTO & CONTEXTO ENFERMAGEM
TEXT & CONTEXT NURSING TEXTO & CONTEXTO ENFERMERÍA

COMPLICATIONS RELATED TO PERIPHERALLY INSERTED CENTRAL CATHETERS IN COVID-19 PATIENTS AND THE POTENTIAL OF INSERTION TECHNOLOGIES

Danielle Cortêz da Silva[1]
Carolina Scoqui Guimarães[1]
Angelita Maria Stabile[1]
Suellen Karina de Oliveira Giroti[2]
Flávia Meneguetti Pieri[2]
Carmen Silvia Gabriel[1]
Renata Cristina de Campos Pereira Silveira[1]
Amanda Salles Margatho[1]

[1]Universidade de São Paulo, Escola de Enfermagem de Ribeirão Preto. Ribeirão Preto, São Paulo, Brasil.
[2]Universidade Estadual de Londrina. Londrina, Paraná, Brasil.

ABSTRACT

Objective: to assess the incidence of complications related to peripherally inserted central catheters in hospitalized adult patients with Covid-19 and to discuss the potential benefits of employing insertion technologies to prevent complications.
Method: a descriptive, exploratory and cross-sectional study was conducted from March 2020 to December 2021 at a high-complexity hospital. The study included patients over 18 years old with a positive diagnosis for Covid-19 who made use of peripherally inserted central catheters for venous infusion. Data collection included sociodemographic and clinical information regarding catheter insertion and use. The analysis involved Chi-square and Fisher's Exact tests, with a significance level of 0.05.
Results: a total of 123 inserted catheters were analyzed. The patients' mean age was 50 years old (SD=16.37), most of them male and in the acute phase of infection (59.3%). The following significant complications related to the insertion process were identified: catheter material (p=0.01); use of Sherlock (p=0.03); need for traction (p<0.001); number of punctures (p<0.001); and difficulty in catheter progression (p<0.001).
Conclusion: the study identified the main complications related to the insertion and use of PICCs and showed that employing vascular visualization technologies such as ultrasound and Sherlock 3CG® can mitigate complications, as well as maximize patient comfort, experience and safety. The research provides support for the implementation of protocols for insertion and management of peripherally inserted central catheters, thus avoiding the occurrence of adverse events.

DESCRIPTORS: Peripheral catheterization. Technology applied to health care. Nursing care. Ultrasound. Electrocardiogram.

HOW CITED: Silva DC, Guimarães CS, Stabile AM, Giroti SKO, Pieri FM, Gabriel CS, Silveira RCCP, Margatho AS. Complications related to peripherally inserted central catheters in COVID-19 patients and the potential of insertion technologies. Texto Contexto Enferm [Internet]. 2024 [cited YEAR MONTH DAY]. Available from: https://doi.org/10.1590/1980-265X-TCE-2023-0287en

COMPLICAÇÕES RELACIONADAS AO CATETER CENTRAL DE INSERÇÃO PERIFÉRICA EM PACIENTES COM COVID-19 E O POTENCIAL DAS TECNOLOGIAS DE INSERÇÃO

RESUMO

Objetivo: avaliar a incidência de complicações relacionadas ao cateter central de inserção periferica em pacientes adultos hospitalizados com Covid-19 e discutir o potencial do uso de tecnologias de inserção na prevenção de complicações.
Método: estudo descritivo e exploratório, transversal, realizado no período de março de 2020 a dezembro de 2021, em um hospital de alta complexidade. Foram incluídos no estudo pacientes maiores de 18 anos com diagnóstico positivo para Covid-19 e que fizeram uso do cateter central de inserção periférica para infusão venosa. Fez-se coleta de dados sociodemográficos e clínicos sobre a inserção e uso do cateter. A análise envolveu os testes qui-quadrado e exato de Fischer, com nível de significância de 0,05.
Resultados: analisou-se um total de 123 cateteres inseridos. A média de idade dos pacientes foi de 50 anos (DP=16,37 anos), sendo a maioria do sexo masculino e na fase aguda da infecção (59,3%). Foram evidenciadas as seguintes complicações significativas atreladas ao processo de inserção: material do cateter (p=0,01), uso de Sherlock (p=0,03), necessidade de tração (p<0,001), número de punções (p<0,001) e dificuldade de progressão do cateter (p<0,001).
Conclusão: o estudo identificou as principais complicações relacionadas à inserção e uso do PICC e mostrou que o uso de tecnologias de visualização vascular como o ultrassom e Sherlock 3CG® pode mitigar complicações, além de maximizar conforto, experiência e segurança do paciente. A investigação apresenta subsídios para implementação de protocolos de inserção e manejo do cateter central de inserção periférica, evitando a ocorrência de eventos adversos.

DESCRITORES: Cateterismo periférico. Tecnologia aplicada à assistência à saúde. Cuidados de enfermagem. Ultrassom. Eletrocardiografia.

COMPLICACIONES RELACIONADAS CON CATÉTERES CENTRALES DE INSERCIÓN PERIFÉRICA EN PACIENTES CON COVID-19 Y EL POTENCIAL DE LAS TECNOLOGÍAS DE INSERCIÓN

RESUMEN

Objetivo: evaluar la incidencia de complicaciones relacionadas a catéteres centrales de inserción periférica en pacientes adultos hospitalizados con Covid-19 y debatir el potencial de emplear tecnologías de inserción en la prevención de complicaciones.
Método: estudio descriptivo, exploratorio y transversal, realizado entre marzo de 2020 y diciembre de 2021 en un hospital de alta complejidad. En el estudio se incluyó a pacientes mayores de 18 años con diagnóstico positivo de Covid-19 y que utilizaran catéteres centrales de inserción periférica para infusiones venosas. Se recolectaron datos sociodemográficos y clínicos sobre la inserción y el uso de los catéteres. El análisis implicó las pruebas de Chi-cuadrado y Exacta de Fischer, con 0,05 como nivel de significancia.
Resultados: se analizó un total de 123 catéteres insertados. La media de edad de los pacientes fue de 50 años (DE=16,37), con mayoría del sexo masculino y en la fase aguda de la infección (59,3%). Se hicieron evidentes las siguientes complicaciones significativas vinculadas al proceso de inserción: material del catéter (p=0,01), uso de Sherlock (p=0,03), necesidad de tracción (p<0,001), cantidad de punciones (p<0,001) y dificultad de avance del catéter (p<0,001).
Conclusión: el estudio identificó las principales complicaciones relacionadas a la inserción y el uso de catéteres PICC y demostró que utilizar tecnologías de visualización vascular como ultrasonido y Sherlock 3CG® puede mitigar las complicaciones, además de maximizar la comodidad, experiencia y seguridad del paciente. El trabajo de investigación presenta aportes para implementar protocolos de inserción y manejo de los catéteres centrales de inserción periférica, evitando así la incidencia de eventos adversos.

DESCRIPTORES: Cateterismo periférico. Tecnología aplicada a la asistencia de la salud. Atención de Enfermería. Ultrasonido. Electrocardiograma.

INTRODUCTION

The coronavirus disease 2019 (Covid-19) is a viral infection that manifests with a variable clinical presentation, ranging from asymptomatic cases to patients with different severity levels. In symptomatic patients, the majority present mild (40%) or moderate (40%) forms and progress with good prognoses. Approximately 15% develop severe forms requiring oxygen support and 5% progress to critical illness with complications such as respiratory failure, acute respiratory distress syndrome, sepsis, septic shock, thromboembolism or multiple organ failure, including acute kidney injury and cardiac injury[1–2].

Patients with severe and critical manifestations require hospitalization, oftentimes necessitating admission to intensive care units (ICUs), ventilatory support and hemodynamic support. In order to manage the Covid-19 treatment in the hospital setting, vascular access for intravenous therapy is indispensable. Peripherally Inserted Central Catheters (PICCs) have been widely used in cases requiring medium- to long-term therapy[3–4].

Among the advantages of using PICCs for patients with Covid-19, it is noteworthy that they can be inserted at the bedside, without requiring the patient to be in a dorsal decubitus position, in addition to avoiding pleuropulmonary complications. PICCs are indicated for patients with coagulopathies and respiratory syndromes, as well as for those who are on mechanical ventilation, tracheostomy and other conditions where puncture in the neck or chest increases complications. As their insertion is recommended in the upper limbs, they ease care of the insertion site for patients undergoing periodic pronation and reduce the contamination risk for health care professionals who insert and handle the devices due to respiratory secretions. This is because they keep the operator away from the patient's mouth and nose, thus reducing the risk of airborne contamination[5–6].

Despite these benefits, PICCs can result in infectious, vascular or mechanical complications[6]. Regarding the complications, patients with Covid-19 have been widely recognized as potentially prone to developing catheter-related thrombosis[7–8]. Other studies have also shown an increase in the frequency of bloodstream infections related to catheters[9–10]. Based on these assumptions, there is a recognized need to strengthen measures to reduce the incidence of complications, from insertion to management of the care related to central vascular access devices[10–11].

In this regard, it is noteworthy that infusion therapy is an irreplaceable and necessary procedure to ensure the treatment of patients with Covid-19. However, little is known about the complications resulting from the use of vascular devices in hospitalized patients with this disease. This represents a significant gap in the scientific knowledge, as such complications directly affect the patients' safety and clinical outcomes. Therefore, this study aimed at assessing the incidence of complications related to PICCs in hospitalized adult patients with Covid-19, from the time of insertion to catheter removal, as well as to discuss the potential of using insertion technologies in preventing complications.

METHOD

This was a cross-sectional, descriptive and exploratory study with a quantitative approach. The research was conducted from March 2020 to December 2021 at a high-complexity hospital exclusively serving the Unified Health System (*Sistema* Único *de Saúde*, SUS) and acting as a reference center for moderate and severe Covid-19 cases.

The patients included were those admitted to the hospital wards and ICU with a clinical and laboratory diagnosis of SARS-CoV-2 infection confirmed by Real-Time Polymerase Chain Reaction (RT-PCR), aged at least 18 years old, and who had a PICC for intravenous therapy. No exclusion criteria were adopted.

The patients were classified according to the viral infection phases (acute, subacute and chronic). The acute phase occurs from the first to the fourth week after exposure to the virus. It is characterized by a positive RT-PCR and symptoms such as cough, odynophagia, fever, dyspnea and, in more severe cases, acute respiratory failure. The subacute phase takes place from the fifth to the twelfth week after exposure to the virus. During this phase, symptoms from the acute phase may persist, along with sleep disturbances, fatigue, thromboembolism, renal failure (RF), palpitations, hair loss, asthenia, anxiety and depression. The last phase, known as chronic or long Covid-19, occurs from the twelfth to the twenty-sixth week after exposure to the virus and is characterized by persistence of the symptoms identified in the subacute phase[12].

The study used secondary data, and data collection took place in two stages. In the first stage, eligible participants for the study were identified through the researcher's access to the physical recording instrument of PICC insertion and maintenance used in the study institution. The standardized instrument was completed after catheter insertion and included the patients' sociodemographic data as well as information related to insertion, maintenance and removal of the devices.

In the second stage, recruited case validation was performed in the patients' electronic medical records, as the institution was undergoing the process of implementing electronic medical records during the study period. For inclusion in the study, only the first PICC inserted was considered for each patient.

In both stages, variables such as gender, age and hospitalization *locus* were collected for characterization purposes, along with clinical variables related to the insertion, maintenance and removal of the PICCs.

The PICCs in the study were inserted by nurses who were part of a catheter commission and had the necessary qualifications and training to perform this procedure. All followed the institution's PICC insertion protocol and used maximum sterile barrier precautions (hand hygiene, N-95 or PFF-2 masks, cap, sterile impermeable gown, sterile gloves, sterile drapes, sterile ultrasound cover) during the procedure; skin antisepsis was performed using alcoholic chlorhexidine. During the first 24 hours after PICC insertion, the patients received sterile gauze and sterile adhesive tape as initial dressing, given the possibility of bleeding at the insertion site.

The hospital provided an ultrasound machine for vascular visualization and a BARD Sherlock 3CG Tip Confirmation System™ device for confirming the catheter tip position. It is worth noting that these could be employed by a duly qualified nurse; however the use of an ultrasound-guided insertion technique and electrocardiographic guide for tip positioning was not mandatory, nor described in the institution's PICC insertion protocol.

Maintenance and removal of the catheters were performed by the Nursing staff in the hospital wards that were not part of the catheter commission. As coverage for the devices after the initial dressing, chlorhexidine-impregnated dressings were used for all patients.

The data were organized using Microsoft Office Excel® (version 2019). For statistical analysis, the Statistical Package for the Social Sciences® software (version 20) was used. Simple frequency descriptive analyses were conducted for the categorical variables, and central tendency (Mean) and dispersion (Standard Deviation – SD) measures were calculated for the numerical variables. To investigate possible associations between the sociodemographic and clinical variables and the presence of PICC insertion and maintenance complications, chi-square or Fisher's exact tests were used when applicable. The dependent variables considered were as follows: complications related to PICC insertion; and complications related to PICC use.

The research was approved by the Research Ethics Committee and with agreement of the participating institution. A waiver for obtaining Informed Consent Form (ICF) was requested because

many participants lived in distant municipalities and had outdated contact information, which would hinder obtaining signed ICFs.

RESULTS

According to the eligibility criteria, 123 participants with the first insertion of a PICC during hospitalization were selected. The patients' mean age was 50 years old (SD=16.37). Regarding age group, 35 (28.5%) were between 18 and 39 years old, 22 (17.9%) between 40 and 49, 28 (22.8%) between 50 and 59, and 38 (30.9%) were at least 60 years old. Seventy-three patients (59.3%) were in the acute phase of COVID-19 infection, whereas 50 (36.5%) were in the subacute and chronic phases. Most of the patients (81 [65.9%]) were male, 100 (81.3%) were admitted to the ICU, and 23 (18.7%) were admitted to the ward.

All insertions were performed by professionals duly trained in PICC insertion, with the presence of an assistant. The reasons for device insertion were antibiotic use for more than 6 days in 104 (84.6%) patients, prolonged infusion in 13 (10.6%), and vasoactive drug use in 6 (4.9%) of the patients. The basilic vein was the blood vessel used in 54 (43.9%) patients, followed by cephalic vein in 31 (25.2%), right jugular vein in 20 (16.3%), and left jugular vein in 18 (14.6%). The insertion site was the right upper limb in 44 (35.8%) patients, left upper limb in 41 (33.3%), and jugular vein in 38 (30.9%). For venous puncture, ultrasound was used in 66 (53.7%) patients and, among these, Sherlock 3CG was employed in 26 (21.1%) cases. In relation to the success of punctures, 64 (52%) were successful on the first attempt, 46 (37.4%) after two or three punctures, and 13 (10.6%) required four or more punctures. The associations between the clinical variables, catheter characteristics, insertion characteristics and complications related to insertion are described in Table 1.

Out of the 41 PICCs that had complications during insertion, 21 catheters did not progress, 15 had primary malpositioning, there was vessel rupture or hematoma in four, and there was arterial puncture in one.

Table 1 – Associations of the clinical variables, catheter characteristics and insertion characteristics with the occurrence of complications related to PICC insertion. Londrina, PR, Brazil, 2020-2021. (n=123).

Variables	Complications during insertion		p-value*
	Yes n (%)	No n (%)	
	41	82	
Clinical variables			
COVID-19 infection phase			0.52*
Acute	26 (21.2)	47 (38.2)	
Subacute	13 (10.6)	32 (26.0)	
Chronic	2 (1.6)	3 (2.4)	
Age			0.15*
18-39	15 (12.2)	20 (16.2)	
40-49	5 (4.1)	17 (13.8)	
50-59	12 (9.8)	16 (13.0)	
>60	9 (7.3)	29 (23.6)	
Hospitalization *locus*			0.19*
ICU†	36 (29.3)	64 (52.0)	
Ward	5 (4.1)	18 (14.6)	

Table 1 – Cont.

Variables	Complications during insertion		p-value*
	Yes n (%)	No n (%)	
	41	82	
Insertion variables			
Blood vessel			0.87*
Basilic vein	16 (13.1)	38 (30.8)	
Cephalic vein	11 (8.9)	20 (16.2)	
Right jugular vein	8 (6.5)	12 (9.8)	
Left jugular vein	6 (4.9)	12 (9.8)	
Insertion site			0.34*
Right upper limb	11 (8.9)	33 (26.8)	
Jugular	14 (11.4)	24 (19.5)	
Left upper limb	16 (13.1)	25 (20.3)	
Number of punctures			<0.001*
One	13 (10.5)	51 (41.5)	
Two	09 (7.3)	19 (15.4)	
Three	12 (9.8)	6 (4.9)	
Four	07 (5.7)	6 (4.9)	
Progression difficulty			<0.001*
Yes	28 (22.8)	18 (14.6)	
No	13 (10.6)	64 (52.0)	
Need for traction			<0.001‡
Yes	15 (12.2)	0 (0.0)	
No	5 (4.1)	82 (66.6)	
Not applicable§	21 (17.1)	0 (0.0)	
Use of ultrasound			0.70*
Yes	23 (18.7)	43 (35.0)	
No	18 (14.6)	39 (31.7)	
Use of Sherlock 3CG			0.03*
Yes	4 (3.2)	22 (17.9)	
No	37 (30.1)	60 (48.8)	
Catheter variables			
Catheter material			0.01‡
Silicone	23 (18.7)	23 (18.7)	
Polyurethane	15 (12.2)	50 (40.7)	
Polyethylene	3 (2.4)	9 (7.3)	
Lumens			0.25*
One	25 (20.3)	41 (33.3)	
Two	16 (13.1)	41 (33.3)	
Valved device			0.25*
Yes	16 (13.1)	41 (33.3)	
No	25 (20.3)	41 (33.3)	

*Chi-square test; †ICU: Intensive Care Unit; ‡Fisher's exact test; §Not applicable catheters, as they did not progress during insertion.

Among the 21 devices that did not progress, insertion was not completed, totaling 102 catheters inserted, of which 15 had primary malpositioning and, of these, 6 were not released for intravenous infusion and 9 were allowed for use despite their malpositioning. Thus, 96 catheters were used to receive the intravenous therapy prescribed.

Regarding the PICCs, 66 (53.7%) were non-valved devices and 57 (46.3%) were valved devices (PowerPICC®), 66 (53.7%) were single-lumen and 57 (46.3%) were double-lumen. The type of material used was polyurethane in 66 devices (53.7%), silicone in 46 (37.4%), and polyethylene in 12 (9.8%). All catheters were 5 French.

The polyurethane catheters (65 catheters) presented the following main complications during insertion: 6 (9.1%) cases of catheter non-progression, 3 (4.5%) cases of bleeding or hematoma, 1 (1.5%) case of arterial puncture, and 5 cases (7.6%) of primary malpositioning. In turn, among the polyethylene catheters (12 catheters), 2 (16.7%) did not progress and 1 (8.3%) presented bleeding or hematoma. The silicone catheters (46 catheters) were the ones that presented the most complications during insertion, with 13 (28.3%) cases of non-progression and 10 (21.7%) cases of primary malpositioning.

The mean dwell time of the PICCs that were released for infusion (n=96) was 11.10 days (SD=16.6). The minimum dwell time was one day, and the maximum was 126 days. Out of the 96 catheters released for infusion, 43 (44.79%) presented complications during use. It is noted that some catheters presented more than one complication, with 10 (10.41%) having two complications and 4 (4.12%) with three complications. The distribution of the catheter use complications is presented in Table 2. The mean complication-free time for the catheters was 8.7 days (SD=8.87).

Based on the data from the table above, five patients presented CRBSI, with the following microorganisms identified in three patients: one *Staphylococcus epidermidis* and two *Providencia stuartii*.

The associations of the patient and catheter clinical variables with the complications related to catheter use are described in Table 3.

In relation to the reason for catheter removal, 33 (26.8%) reached the end of the intravenous therapy prescribed and 28 (22.8%) evolved to death. However, 35 catheters were removed because the complications led to device failure, meaning that the intravenous therapy was not completed.

Table 2 – Presentation of the complications related to PICC use. Londrina, PR, Brazil, 2020-2021. (n=43).

Types of complications	N	%
Total displacement	22	22.9
Partial displacement	14	14.6
Total occlusion	5	5.2
CRBSI*	5	5.2
Partial occlusion	4	3.2
Infiltration or leak	3	3.1
Phlebitis	2	2.1
Active bleeding at the site	1	1.0
Catheter fracture	1	1.0

*CRBSI: Catheter-Related Bloodstream Infection

Table 3 – Associations of the clinical variables, catheter characteristics and insertion features with the complications related to PICC use. Londrina, PR, Brazil, 2020-2021. (n=96).

Variables	Complication		p-value*
	Yes n (%)	No n (%)	
	43	53	
Clinical variables			
COVID-19 infection phase			0.88*
Acute	25 (26.0)	30 (31.2)	
Subacute	15 (15.6)	21 (21.8)	
Chronic	3 (3.2)	2 (2.2)	
Age			0.88*
18-39	10 (10.4)	14 (14.6)	
40-49	7 (7.3)	11 (11.5)	
50-59	10 (10.4)	12 (12.5)	
>60	16 (16.7)	16 (16.7)	
Hospitalization *locus*			0.07*
Ward	12 (12.5)	7 (7.3)	
ICU†	31 (32.2)	46 (48.0)	
Insertion variables			
Use of ultrasound			0.23*
Yes	19 (19.8)	30 (31.2)	
No	24 (25.0)	23 (24.0)	
Use of Sherlock 3CG			0.72*
Yes	10 (10.4)	14 (14.6)	
No	33 (34.4)	39 (40.6)	
Progression difficulty			0.98*
Yes	9 (9.4)	11 (11.4)	
No	34 (35.4)	42 (43.8)	
Blood vessel			0.10‡
Basilic vein	20 (20.8)	22 (23.0)	
Cephalic vein	8 (8.3)	17 (17.7)	
Right jugular vein	5 (5.2)	10 (10.4)	
Left jugular vein	10 (10.4)	4 (4.2)	
Insertion site			0.53*
Right upper limb	16 (16.7)	19 (19.8)	
Left upper limb	12 (12.5)	20 (20.8)	
Left upper limb	15 (15.6)	14 (14.6)	
Number of punctures			0.32‡
One	27 (28.1)	33 (34.3)	
Two	9 (9.4)	12 (12.5)	
Three	6 (6.2)	3 (3.1)	
Four	1 (1.1)	5 (5.2)	
Catheter variables			
Catheter material			0.07‡
Polyurethane	30 (31.2)	28 (29.2)	
Polyethylene	5 (5.2)	4 (4.2)	
Silicone	8 (8.3)	21 (21.9)	

Table 3 – Cont.

Variables	Complication		p-value*
	Yes n (%)	No n (%)	
Lumens			0.40*
One	19 (19.8)	28 (29.2)	
Two	24 (25.0)	25 (26.0)	
Use of Power PICC			0.66*
Yes	23 (24.0)	26 (27.1)	
No	20 (20.8)	27 (28.1)	
Use of fixation device			0.96*
Yes	12 (12.5)	15 (15.6)	
No	31 (32.3)	38 (39.6)	

*Chi-square test; †ICU: Intensive Care Unit; ‡Fisher's exact test.

DISCUSSION

This research provides an overview of PICC complications in hospitalized Covid-19 patients, from catheter insertion to removal; in addition, it discusses the potential of using vascular visualization technologies in preventing complications. The occurrence of complications during insertion was related to catheter material, use of Sherlock, need for traction, number of punctures and difficulty in catheter progression. These findings underscore the importance of considering these factors during PICC insertion in this population of patients.

In the context of insertion ease and adaptability of the catheters, it was identified that catheter flexibility plays a crucial role. More flexible catheters show smoother insertion, whereas stiffer ones oftentimes pose difficulties navigating vascular curves[13]. The use of silicone-made PICCs provides greater flexibility, resulting in minimized irritation to the vascular wall. On the other hand, polyurethane-made catheters confer advantages because the material is more robust and capable of withstanding intense medication flows, thereby reducing the risk of venous ruptures[14].

The complications related to catheter material have already been mentioned in previous studies, which highlighted specific issues associated with silicone catheters due to their lower mechanical stability and tendency to retain bend memory, whereas polyurethane catheters are linked to the occurrence of mechanical phlebitis[14]. Silicone catheters show higher propensity for migration and hinder achieving proper positioning.

A systematic review was conducted to compare complications following the insertion of PICCs made of polyurethane and silicone. The results indicated that the overall complication rates for both material options are similar, even in cancer and surgical patients. This finding resonates with the conclusions drawn from the Covid-19 patients addressed in the current study, where silicone catheters were related to complications at the time of insertion. Additionally, the studies evidenced that post-insertion care influences the predictive outcome of complications related to both types of PICC materials[15].

In this study, 47.9% of the PICC insertion procedures required more than one venous puncture for success. Additionally, the number of punctures was statistically related to the occurrence of complications ($p<0.001$). With the advancement of vascular visualization technologies in device insertion there has been an increase in success rates even on the first attempt, resulting in a decrease in complications associated with PICC use[16]. In line with the adoption of ultrasound, the Infusion Nurses Society's Guide to Good Practices for Intravenous Therapy recommends its use for guiding vascular

device insertion to reduce the number of punctures and, consequently, decrease complication rates, promoting a safe catheter insertion practice[7].

Although the population in this study did not show significant relevance of complications with ultrasound, 46.3% of the punctures were performed without ultrasound guidance, which may interfere with the number of punctures required for catheter insertion[17]. In addition to causing discomfort to the patient and compromising peripheral vessels, this high number increases the risk of health care-associated infections and embolisms[18].

One of the inherent risks of the multiple puncture process for PICCs in the population of this study is that SARS-CoV-2 can induce the release of pro-inflammatory cytokines and/or pro-coagulant factors. These elements can activate the coagulation cascade, leading to thrombosis and rupture of atherosclerotic plaques[19]. However, patients with Covid-19 face an additional bleeding risk, as highlighted by a multicenter retrospective study conducted with 400 hospitalized Covid-19 patients (including 144 in critical condition), in which the significant bleeding rates reached 5.6%[20]. Additionally, a retrospective study conducted in France reported 14% incidence of bleeding related to central venous catheters among the examined population[21]. Even with peripherally inserted central catheters, there remains a bleeding risk in this population[21].

Also in this regard, the puncture of a vascular access in thrombocytopenic patients with coagulopathy disorders, as in the case of Covid-19, should be performed by a well-trained professional to prevent insertion complications such as multiple puncture attempts, hematoma formation and inadvertent arterial puncture, as well as complications after insertion such as bleeding and skin injury (by the dilator). For Covid-19 patients, it is recommended to use ultrasound for PICC puncture without employing a tourniquet to reduce trauma, along with the use of electrocardiographic guidance for real-time tip confirmation[22].

Furthermore, once the catheter is punctured, bleeding from the insertion site is expected and can be controlled using direct manual pressure, hemostatic gauze, sponges or cyanoacrylate adhesive after suppressing the bleeding. Another important aspect to consider is catheter stabilization in thrombocytopenic patients to prevent catheter displacement. It is recommended to use safety devices for fixation, whether cutaneous or subcutaneous[22].

Despite the significant risk of vascular complications related to PICC use, such as deep vein thrombosis, a study conducted with 227 Covid-19 patients using PICCs and midline catheters found no results associating infection with an increased incidence of thrombotic complications related to venous devices. This fact can be linked to the recommendations for anticoagulation in Covid-19 patients, which may have mitigated the incidence of this complication[11].

Another outstanding aspect is the difficulty in catheter progression, which may have been influenced by vascular changes resulting from Covid-19, as well as by multiple prior peripheral punctures, absence of vascular visualization technology, and the patients' clinical severity[23]. It is worth noting that using ultrasound allows for the identification and detailed evaluation of the vasculature, enabling the detection of abnormalities such as occlusions or thromboses, measurement of diameter, depth and trajectory of vessels, as well as an assessment of the surrounding anatomy. This helps prevent punctures in nerves and arteries and locate the ideal site for puncture and insertion of the PICC[7].

Factors such as the health professionals' clinical competence and experience play a crucial role in successful progression of a catheter. In this pandemic scenario, the high institutional workload, the stress faced by professionals and non- standardization of catheter material may have contributed to difficulties in catheter progression[23]. Additionally, the experience level of the professionals responsible for the insertion was not controlled in this research.

Typically, PICCs are inserted through the cephalic or basilic veins of the arm, under ultrasound guidance, and the catheter tip is positioned at the cavoatrial junction via the subclavian and brachiocephalic veins[24] A notable point in the population analyzed is PICC use in the jugular vein. This choice arises from the impossibility of inserting catheters in the upper limbs due to edema and to absence of unpunctured vessels, which may have contributed to an increase in complications during insertion in the jugular vein. Jugular vein puncture itself carries with it high risks of accidental carotid artery puncture, hematoma formation and gas embolism. In addition to that, the jugular vein region is highly mobile, which can increase the risk of catheter displacement[17].

The comparison between PICCs and centrally inserted venous catheters reveals an advantage for PICCs in reducing procedure-related complications such as pneumothorax, hemothorax and severe bleeding. However, it is important to highlight that inappropriate placement of the catheter tip emerges as the most prevalent complication during PICC insertion. This is because the procedure is conducted without fluoroscopic guidance, relying on anatomical landmarks for positioning, thus requiring chest radiographs for accurate verification. It is crucial to emphasize that this misplacement can result in serious complications such as venous thrombosis or cardiac tamponade[25].

Currently, the Sherlock 3CG® tip confirmation system (Bard Access Systems, Salt Lake City, UT, USA) is available on the market, comprising an external magnetic sensor at the catheter tip and an Intracavitary Electrocardiogram (IC-ECG) guidance system. Sherlock 3CG® allows the catheter tip to advance under the guidance of the magnetic sensor, graphically displaying its position on a monitor near the patient. As the catheter tip approaches the cavoatrial junction, the IC-ECG “P” waves gradually increase, peaking at the junction. Through this dual guidance approach, the catheter tip can be guided to the cavoatrial junction without any need for fluoroscopy[25].

A retrospective study involving 250 ICU patients undergoing PICC insertion with Sherlock 3CG® resulted in two unsuccessful procedures and one case of a catheter that was too short for proper insertion[25]. A randomized clinical trial showed that the technical success rates for IC-ECG and for methods without IC-ECG were 89.2% and 77.4%, respectively[26]. A retrospective study, aimed at evaluating the success rates and tip malposition rates of PICC insertion using Sherlock 3CG® in ward patients, found that the procedure had a high technical success rate (97.3%) and a low malposition rate (16.2%)[25].

The use of Sherlock 3CG® technology allows for precise identification of the correct catheter positioning, eliminating the need to rely on chest radiography. This avoids potential delays in catheter release or the need for later repositioning. The current study reinforces the relevance of using Sherlock 3CG® to prevent complications during insertion. Additionally, it was observed that the need for catheter traction is associated with complications. When the catheter is guided with the assistance of Sherlock 3CG®, traction becomes unnecessary, as proper positioning is ensured. In contrast, in the absence of this technology, radiography is essential, requiring multiple catheter tractions and exposing the patient to repeated radiographic exposures until the device is correctly positioned at the cavoatrial junction[25].

It is relevant to highlight that the intracavitary electrocardiogram method was introduced in July 2020 at the institution. Due to the challenges imposed by the pandemic, only a limited number of catheters equipped with this technology were available for insertion. Additionally, the allocation of human resources to critical areas exerted an impact on the sequential training of the insertion team.

When examining the catheter-related complications, the occurrence of total displacement in 22.9% is noted, characterized by the catheter being completely withdrawn from the vessel; and partial displacement in 14.6%, when the catheter tip migrates to a peripheral vein, which may result in catheter failure. As a complication that arises during catheter manipulation and dressing changes, displacement is a relevant aspect to consider[7].

The high incidence of catheter displacement can be associated with the absence of an institutional protocol that includes the use of fixation technologies, such as needleless sutures, better known as Start Lock®. In this study, it was found that less than half of the inserted catheters were secured with a fixation device as recommended by the Infusion Nurses Society, where only transparent dressings with chlorhexidine were used to stabilize the devices. This approach may have contributed to the displacements that took place during dressing changes, possibly due to material resource constraints faced by the institution in the pandemic context.

To mitigate the incidence of catheter displacements in PICCs, the Infusion Nurses Society recommends employing specially designed devices for stabilization and fixation of these catheters. These devices can reduce catheter movement, minimizing interruptions in necessary infusion therapy and reducing costs associated with failures and displacements[7].

Another complication that stood out was partial and total occlusion of the device. In large part, this is linked to inadequate catheter flushing. According to the guidelines recommended by the Infusion Nurses Society, this procedure is intended to remove fibrin deposits, precipitation of medications and other residues that may cause lumen obstruction[7].

Another concern regarding PICC complications is the rate of Catheter-Related Bloodstream Infections (CRBSIs), identified in 8.8% of the devices evaluated in this study. The CRBSI rates vary in both international and national studies in the literature. In the national context, an observational study covering 16 Brazilian hospitals, including public, private and university institutions, evaluated 12,725 applied PICCs and identified a confirmed CRBSI rate of 0.9%. However, 4.6% of the patients had suspected CRBSI, leading to catheter removal before the end of therapy[27].

It is important to highlight that CRBSIs are among the main Healthcare-Associated Infections (HAIs) and exert a significant impact on health care, representing one of the leading causes of death and increased hospital costs. The Covid-19 pandemic has exacerbated the number of prolonged hospitalizations, as there was no treatment or vaccine to mitigate severity of the disease at the beginning. This scenario likely contributed to the increased incidence of HAIs, including the high CRBSI rate found in this study.

Additionally, with Covid-19, there are reports of indiscriminate prescription of antimicrobials and use of immunosuppressive therapies, further increasing the risk for the proliferation of unwanted microorganisms[28]. A study conducted by Fakin *et al.* (2021) evaluated the incidence of central line CRBSIs before and during the Covid-19 pandemic and found a 51.0% increase in CRBSIs in the wards and a 71.0% increase in the ICU during the pandemic period. Additionally, the study found that patients diagnosed with Covid-19 had a 5-fold higher incidence of CRBSIs than non-Covid-19 patients[10].

Followed by enterobacteria, Coagulase-negative *staphylococci* was the main agent responsible for the infections identified in this study, which is in line with the profile described in the literature. Various surveys, both national and international, have identified *Staphylococcus epidermidis* as the most prevalent microorganism associated with CRBSIs, corroborating the results of this research[27].

In addition to that, the population at risk for developing severe Covid-19 cases consists of aged patients who tend to have multiple pre-existing comorbidities. Due to intrinsic factors related to aging, they are prone to developing more infectious complications when compared to the young population. Obese patients, who also represent a risk group for Covid-19 infection, have about 4 times more chances of developing infectious complications when compared to other population segments. In other words, patients hospitalized with Covid-19 are individuals at high risk of complications[23].

Other less common complications identified in this study were presence of infiltration and leak, catheter fracture and active bleeding at the insertion site.

Given the above, it is not possible to ignore some of the study limitations. The bias resulting from the single-center study design cannot be dismissed from consideration. In addition to that, the lack of uniform material and unequal availability of technology for all patients due to the pandemic context also represent relevant limitations. We did not assess the comorbidities in the Covid-19 population, which may have contributed to a different incidence of infectious and non-infectious complications. Blood tests related to coagulation factors were also not collected because these data were not uniformly available in the medical records for all patients.

The findings of this study do not confirm whether the incidence of complications is solely related to the repercussions of the Covid-19 pandemic and the specific characteristics of this population group, as the data were not compared to those of patients from this institution before and after the pandemic scenario.

CONCLUSION

The study identified the main complications related to PICC insertion and use lines and showed that employing vascular visualization technologies such as ultrasound and the electrocardiographic guide for tip visualization can mitigate complications, as well as maximize patient comfort, experience and safety. We provided support for the implementation of protocols for PICC insertion and management to prevent adverse events.

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NOTES

ORIGIN OF THE ARTICLE
Extracted from the dissertation – Failures of Peripherally Inserted Central Catheters in hospitalized patients diagnosed with COVID-19, presented to the Graduate Program in Nursing Technology and Innovation at the Ribeirão Preto Nursing School, *Universidade de São Paulo*, in 2023.

CONTRIBUTION OF AUTHORITY
Study design: Silva DC, Renata – Silveira RCCP, Gabriel CS, Margatho AS.
Data collection: Silva DC, Giroti SKO.
Data analysis and interpretation: Silva DC, Stabile AM, Pieri FM, Silveira RCCP, Gabriel CS, Margatho AS.
Discussion of the results: Silva DC, Guimarães CS, Silveira RCCP, Gabriel CS, Margatho AS.
Writing and/or critical review of the content: Silva DC, Guimarães CS, Stabile AM, Pieri FM, Silveira RCCP, Gabriel CS, Margatho AS.
Review and final approval of the final version: Guimarães CS, Stabile AM, Pieri FM, Silveira RCCP, Gabriel CS, Margatho AS.

FUNDING INFORMATION
This work was carried out with the support of the Professional Master's Degree Program in Nursing Technology and Innovation at the Ribeirão Preto School of Nursing and the Dean of Postgraduate Studies at the *Universidade de São Paulo*.

APPROVAL OF ETHICS COMMITTEE IN RESEARCH
Approved by the Ethics Committee in Research of the *Universidade Estadual de Londrina* under opinion No.3,027,165 and Certificate of Presentation for Ethical Appraisal No. 16451019.80000.5393, with the agreement of the co-participating institution.

CONFLICT OF INTEREST
There is no conflict of interest.

EDITORS
Associated Editors: Glilciane Morceli, Ana Izabel Jatobá de Souza.
Editor-in-chief: Elisiane Lorenzini.

TRANSLATED BY
Leonardo Parachú.

HISTORICAL
Received: September 29, 2023.
Approved: February 28, 2024.

CORRESPONDING AUTHOR
Amanda Salles Margatho.
amandamargatho@usp.br