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Factors associated with difficult peripheral venipuncture in adults undergoing antineoplastic chemotherapy

Fatores associados à punção venosa periférica difícil em adultos submetidos à quimioterapia antineoplásica

Factores asociados a la venopunción periférica difícil en adultos sometidos a quimioterapia antineoplásica

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ABSTRACT

Objective: to identify factors associated with difficult peripheral venipuncture in adults undergoing antineoplastic chemotherapy. **Method:** cross-sectional, observational, analytical, and quantitative study carried out in a High Complexity Oncology Unit (UNACON) in the Brazilian Amazon region. Data were analyzed using descriptive and inferential statistics, where the odds ratio was calculated. **Results:** majority of participants were female (64.6%), self-declared as brown (51.2%). Regarding the location of the cancer, the majority had the disease in the digestive (46.4%) or reproductive (45.2%) systems. Patients who had a history of difficult venipuncture, non-visible or non-palpable veins were more likely to have difficult venipuncture (OR 1.6, 1.5 and 1.3, respectively). **Conclusion:** found predictors related to difficult peripheral venipuncture in adult patients undergoing antineoplastic chemotherapy were: history of difficult puncture and non-visible or non-palpable veins.
Descriptors: Nursing Care; Adult; Neoplasms; Drug Therapy; Catheterization, Peripheral.

RESUMO

Objetivo: identificar os fatores associados à punção venosa periférica difícil em adultos submetidos à quimioterapia antineoplásica. **Método:** estudo transversal, observacional, analítico e quantitativo realizado em uma Unidade de Alta Complexidade em Oncologia (UNACON) da região amazônica brasileira. Os dados foram analisados por meio de estatística descritiva e inferencial, onde a razão de possibilidades foi calculada. **Resultados:** a maioria dos participantes foi do sexo feminino (64,6%), autodeclarados como pardos (51,2%). Em relação à localização do câncer, a maioria possuía a doença no aparelho digestório (46,4%) ou reprodutor (45,2%). Pacientes que tinham histórico de punção venosa difícil, veias não visíveis ou não palpáveis apresentaram mais chance de apresentar a punção venosa difícil (OR 1,6, 1,5 e 1,3, respetivamente). **Conclusão:** os preditores encontrados relacionados à punção venosa periférica difícil em pacientes adultos submetidos à quimioterapia antineoplásica foram: histórico de punção difícil e veias não visíveis ou não palpáveis.
Descritores: Cuidados de Enfermagem; Adulto; Neoplasias; Quimioterapia; Cateterismo Periférico.

RESUMEN

Objetivo: identificar los factores asociados a la dificultad de la venopunción periférica en adultos sometidos a la quimioterapia antineoplásica. **Método:** estudio transversal, observacional, analítico y cuantitativo realizado en una Unidad de Oncología de Alta Complejidad (UNACON) en la Amazonía brasileña. Se analizaron los datos mediante estadística descriptiva e inferencial, donde se calculó el odds ratio. **Resultados:** la mayoría de los participantes era del sexo femenino (64,6%), se auto declaró morena (51,2%). En cuanto a la ubicación del cáncer, la mayoría tenía la enfermedad en el sistema digestivo (46,4%) o reproductivo (45,2%). Los pacientes que tenían antecedentes de venopunción difícil, venas no visibles o no palpables tenían más probabilidades de tener venopunción difícil (OR 1,6, 1,5 y 1,3, respectivamente). **Conclusión:** Los predictores encontrados relacionados con la punción venosa periférica difícil en pacientes adultos sometidos a quimioterapia antineoplásica fueron antecedente de punción difícil y venas no visibles o no palpables.
Descriptores: Atencíon de Enfermería; Adulto; Neoplasias; Quimioterapia; Cateterismo Periférico.

INTRODUCTION

Cancer poses a significant public health problem due to its high rates of morbidity and mortality. In Brazil, approximately 704 thousand new cases are expected each year during the triennium 2023-2025[1]. Despite the scientific advances achieved in the administration of oral chemotherapy, both targeted agents and cytostatics, intravenous antineoplastic chemotherapy remains the most widely used treatment in the fight against the disease[1-3].

As a result, peripheral vascular accesses play an extremely important role in all stages of oncological treatment, being present from the initial, neoadjuvant, and adjuvant phases, and extending to palliative care[3,4]. In this regard, adult oncology patients generally require long cycles of antineoplastic treatment, which may lead to the loss of vasorelaxant

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effects, suppressed anti-inflammatory and vascular repair functions, as well as endothelial dysfunction[2,4,5]. As it is an outpatient treatment, the therapeutic regimen dictates the need for intermittent peripheral venous access.

Despite its ubiquity and frequency, the access can often be difficult or impossible to perform in these patients, a situation referred to as Difficult Intravenous Access (DIVA), occurring when there are multiple access attempts, with the minimum number of unsuccessful attempts varying according to the literature[7,8]. The occurrence of this event is associated with the patient's clinical conditions and the procedure itself, performed by the nursing care providers, where DIVA can cause psychological and physical harm to the patient, treatment delays, loss of dose, frustration in the care provider, or even the need for a central venous catheter. Additionally, studies indicate that antineoplastic chemotherapy is an independent risk factor for DIVA[9,10].

In this context, it is understood that the early identification of DIVA is an emerging research field worldwide, where various conditions and variables have been proposed as potential risk factors for this condition[7]. However, there is still a lack of studies addressing this condition in Brazilian oncology patients, especially in the Amazon region. Therefore, recognizing potential risk factors for DIVA in this population could be a useful ally to the nursing clinical practice, aiming to identify potential difficulties and prevent the consequences of multiple punctures, considering that infusion therapy is one of the most common nursing procedures.

Accordingly, the present study aimed to identify the factors associated with DIVA in adults undergoing antineoplastic chemotherapy.

METHOD

This cross-sectional, observational, analytical, and quantitative study was conducted between September 2020 and June 2022 in the chemotherapy administration rooms of a High Complexity Oncology Unit (UNACON) located within a public university hospital in the Amazon region, renowned for cancer treatment in the northern region of Brazil. The methodological procedures were reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist[11].

The study included adults (18 years and older) diagnosed with cancer who underwent intermittent antineoplastic chemotherapy through a peripheral catheter and presented with Difficult Intravenous Access (DIVA). Individuals with a peripherally inserted central catheter (PICC) for daily chemotherapy administration, pre-existing skin lesions at insertion sites (rashes, lacerations, burns, trauma, or radiodermatitis), and other types of catheters for medication administration were excluded. Each patient was included in the study only once and approached on the first day of chemotherapy. For the sample calculation, a finite population of 1,700 patients treated at the chemotherapy outpatient clinic in 2019 was considered, with a DIVA prevalence of 59.3% in adults[12], a margin of error of 5%, and a 95% confidence interval, resulting in 279 patients with DIVA.

The study was conducted in the university hospital's chemotherapy service, which has five nurses and seven nursing technicians attending to an average of 50 patients per day. Peripheral venous puncture followed an institutional Standard Operating Procedure (SOP), where the doctor prescribed chemotherapy, the nursing technician or nurse performed the venous puncture, and in case of failure, the procedure was repeated by other team members.

In this service, catheter types comprise two models available to nursing based on institutional stock availability, with model 1 having a retractable device (active needle protection technique) and the second having a needle protection device (passive needle protection technique).

Initially, prior contact with the nursing team was made for authorization to accompany and observe the venous puncture by the nursing care provider. Subsequently, a pilot test was conducted with five patient evaluations, which did not contribute to the final sample.

Difficult intravenous access was considered in situations where there were two or more unsuccessful puncture attempts and/or the decision not to implement vascular access (when intravenous access was not achieved, and the procedure was abandoned)[7]. Success was considered when the peripheral venous catheter was authorized for use.

Data collection took place from Monday to Friday on alternate mornings, in the morning hours (7:30 AM to 12:00 PM) between September 2020 and June 2022. An instrument based on a previous study[13] was used for data collection by the researcher during the observation of the patient's venous puncture by the nursing care provider. Data were collected for all punctures performed, considering both the first and the last (if successful).

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Variables considered included sociodemographic (gender, race, age group, marital status, education, family income), clinicopathological data (cancer location, previous chemotherapy, previous surgeries, and comorbidities), and data related to the observation of the venous access (topography, cannula size, palpability, and visibility, number of attempts, catheter type, and history of difficult access).

The main aim was to analyze the association of sociodemographic, clinicopathological, and puncture-related variables with DIVA presented by patients undergoing chemotherapy. The independent variable was the manifestation of DIVA. Data were double-checked and entered into a Microsoft Office Excel® spreadsheet, then subjected to descriptive and inferential statistics using the IBM SPSS version 20 software. To achieve the objectives, the analysis of categorical variables employed distributions of absolute and percentage frequencies. For quantitative variables, measures of central tendency (mean and median) and variability measures (ranges and standard deviation) were used. The Chi-Square test was applied to compare two independent categorical variables.

Additionally, the odds ratio (OR), confidence interval (CI = 95%), and a score > 1.5 were considered as a risk factor. A significance level (*p*-value) of $p \leq .05$ was considered for all statistical tests.

RESULTS

Due to the suspension of secondary services and research activities within the study's setting due to the "lockdowns" caused by the COVID-19 pandemic, it was feasible to assess 82 patients during the study period.

The sociodemographic characteristics of the study participants are detailed in Table 1.

Table 1: Sociodemographic characterization (n=82). Belém, PA, Brazil, 2022.

Variable	*n*	%
Sex		
Female	53	64.6
Male	29	35.4
Race		
Asian	01	1.2
White	18	22.0
Black	21	25.6
Mixed	42	51.2
Age group		
21 to 30	01	1.2
31 to 40	12	14.6
41 to 50	21	25.6
51 to 60	17	20.7
61 to 70	23	28.0
≥ 71	07	8.5
Education		
Illiterate	03	3.7
Complete High School	09	11.0
Incomplete High School	04	4.9
Complete College	05	6.1
Incomplete College	02	2.4
Complete Elementary School	06	7.3
Incomplete Elementary School	34	41.5
Complete Middle School	15	18.3
Incomplete Middle School	04	4.9
Income*		
01	53	64.6
02	22	26.8
03	02	2.4
> 03	05	6.1

Note: * Minimum wages

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Among the participants, the majority were female (64.6%), of mixed race (51.2%), with incomplete elementary school education (41.5%), and income up to one minimum wage (64.6%). The age ranged from 27 to 82 years, with a mean of 54.51 years (*SD*= 12.67).

Of the participants, 47.4% reported some form of comorbidity, with Systemic Hypertension (SH) being the most prevalent (31.7%). Regarding the current cancer location of the participants, the vast majority reported having the disease in the digestive system (46.4%) or reproductive system (45.2%), while those located in the respiratory system, head and neck, skin, appendages, and unidentified represented only 8.4% (*n*=7). In addition, 69.5% (*n*=57) of the participants were undergoing the first cycle of chemotherapy for the first time.

During the access procedure, the majority of participants reported being calm (69.5%), while only 16.1% were fearful. Regarding the history of DIVA, 45.10% reported experiencing difficult access. Table 2 presents the data related to the catheter used in the DIVA.

Table 2: Type and material of the catheter used (n=82). Belém, PA, Brazil, 2022.

Variable	n	%
Type of peripheral venous catheter on the first attempt		
Model 1*	28	34.1
Model 2**	54	65.9
Type of peripheral venous catheter on the last attempt		
Model 1	27	32.9
Model 2	55	67.1
Vein		
Dorsal metacarpals	42	51.2
Cephalic	18	22.0
Accessory cephalic	06	7.3
Intermediate forearm	05	6.1
Median cubital	05	6.1
Basilic	03	3.7
Mid-antebrachial	01	1.2
Median cubital	01	1.2
Intermediate forearm vein	01	1.2
Catheter reuse		
No	47	57.3
Yes	35	42.7
Number of access attempts		
02	39	47.6
0	27	32.9
≥ 04	16	19.4

Notes: *PVC with retractable device (active needle protection technique)
**PVC with needle protection device (passive needle protection technique)

The most used model of PIC catheter in the first (65.9%) and last attempt (67.1%) was the PVC type with a needle protection device (passive needle protection technique) made of polyurethane (74.3%), as available in the institution. The most accessed region was the back of the hand, specifically the dorsal metacarpal veins (51.2%).

During the procedure, there were no observed attempts to puncture areas near infected, ruptured, or inflamed skin, or in bony or flexion areas. All catheter insertions were performed in an upper extremity. In addition, in all punctures, the attempt to locate the vein with the catheter already inserted was made, and the success of the punctures was evaluated based on the return of blood and infusion of saline solution through a syringe.

Regarding the number of attempts, 47.6% of participants were punctured twice, 32.9% three times, and 19.4% were punctured more than four times until access for chemotherapy administration was achieved. Additionally, the catheter was reused to attempt to access the same person in 42.7% of cases. Concerning chemotherapy administration, only 6.1% experienced some form of complication, with 3.7% experiencing chemotherapy extravasation and 2.4% accidental catheter loss.

Table 3 presents data related to the analysis of the association and increased risk between the occurrence of DIVA in adults undergoing antineoplastic chemotherapy according to variables related to the catheter.

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Table 3: Association of difficult intravenous access in adults undergoing chemotherapy (n=82) according to clinical and catheter-related variables. Belém, PA, Brazil, 2022.

Variable	DIVA		*p**	Odds Ratio**	RR
	Yes *n* (%)	No *n* (%)			
Sex					
Male	04 (14.8)	23 (85.2)	1.00	1.278 (0.361 – 4.521)	0.815 (0.281- 2.362)
Female	10 (18.2)	45 (81.8)			
Skin color					
White	05 (27.8)	13 (72.2)	.177	0.425 (0.122 – 1.484)	1.975 (0.756 - 5.159)
Others	55 (85.9)	09 (14.1)			
Morbidities					
Yes	06 (15.8)	32 (84.2)	.099	0.844 (0.264 – 2.693)	1.152 (0.439 -3.024)
No	36 (81.8)	08 (18.2)			
Previous chemotherapy					
Yes	07 (22.6)	07 (13.7)	.369	1.833 (0.575 – 5.847)	0.608 (0.236 - 1.568)
No	24 (77.4)	44 (86.3)			
History of difficult venous access					
Yes	14 (37.8)	23 (62.2)	.000	1.609 (1.251 – 2.068)	-
No	-	45 (100)			
Visible venous network					
Yes	14 (33.3)	28 (66.7)	.000	1.500 (1.211 – 1.858)	-
No	-	40 (100)			
Palpable venous network					
Yes	14 (25.5)	41 (74.5)	.003	1.341 (1.150 – 1.565)	-
No	-	27 (100)			
Emotional state					
Calm	07 (13.0)	47 (87.0)	.219	2.238 (0.697 – 7.191)	0.519 (0.202 - 1.331)
Others	07 (25.0)	21 (75.0)			
Catheter gauge					
24	08 (17.4)	38 (82.6)	1.000	0.950 (297- 3.036)	1.043 (0.398 - 2.737)
≥ 22	06 (16.7)	30 (83.3)			
Catheter reused in the same puncture attempt					
Yes	04 (11.4)	31 (88.6)	.374	0.477 (0.136 – 1.673)	
No	10 (21.3)	37 (78.7)			

Note: *Chi-Square Test; ** >1.5

An association was observed with the history of difficult intravenous access (p = .000 and OR: 1.609), visible venous network (p = .000 and OR: 1.500), and palpable venous network (p = .003 and OR: 1.341). There was no association between sociodemographic or clinicopathological data and DIVA. In the binomial logistic regression model, no risk factors associated with demographic characteristics were identified. Only the history of DIVA (p* < .001) and the non-visible (p* = .003) and palpable (p* < .001) venous network variables were correlated with DIVA.

DISCUSSION

The prevalence of DIVA can vary according to the hospital setting, care complexity, and the profile of the evaluated population[13].

The majority of participants in this study were female. Although there is no consensus in the literature regarding gender as a statistically significant risk factor, the result is consistent with other studies showing that women are more prone to DIVA[3,9,12,14].

Regarding age, which ranged from 27 to 82 years, with a mean of 54.51 years, it should be emphasized that the Northern Region of the country has the lowest concentration of people aged 60 and over (9.9%)[15]. In this study, age range was not analyzed as a significant factor associated with the occurrence of DIVA. However, older adult patients present greater venous fragility due to physiological changes, leading to an average of one complication every five punctures[4,16-18]. On the other hand, other studies indicate that patient age is not a significant predictor for DIVA[9,13,16].

The most frequent comorbidity in the study was Hypertension (31.7%). According to data from the Brazilian Guidelines for Arterial Hypertension of 2020[16], risk factors related to non-communicable chronic diseases can cause complications for individuals. In these cases, the patient's venous network can be easily compromised due to the

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progressive stiffening and loss of compliance of the large arteries. Although morbidities were not statistically significant in this study (p = .099), 47.4% of participants reported some type of comorbidity.

In terms of skin color, 51.2% identified as mixed race. According to data from the National Household Sample Survey (PNAD), 47% of the Brazilian population is composed of people of mixed race, with the Northern region having the highest concentration (73.4%) in the country[15]. The authors suggested that skin pigmentation, Asian or African descent, could influence the decreased visibility of veins; however, this factor was not statistically significant (p = .177) in the population studied. This was consistent with another Brazilian study that found no statistical significance (p = .997) regarding skin color and the occurrence of DIVA[13].

Another result found was the reuse of the catheter to attempt to access the same person in 42.7% of cases. This practice goes against the recommendations of the National Health Surveillance Agency (ANVISA) found in Technical Note No. 04/201219, which advises that a new peripheral intravenous catheter should be used for each access attempt in the same patient. It is understood that this practice results in the loss of lubrication, alteration in the needle tip (bevel), clogging of the cannula, and the risk of needle breakage, all of which can further complicate the venous puncture and cause complications[20,21].

Regarding the history of patients with DIVA, 45.1% of participants reported having veins that were difficult to access, and the results of the linear regression analysis showed that this factor was a predictor for DIVA (p < .001), with adults with a history of DIVA being 1.60 times more likely to present this clinical condition. This result is consistent with other studies that indicate that a history of multiple punctures and reports of previous difficulty in establishing access are predictors for DIVA[9,12,13,16].

Despite the frequency of patient reports about previous punctures during clinical practice, a mixed-methods study conducted in Portugal showed that only 25% of nurses inquire about patients' experiences with previous venous access[22]. Additionally, during the data collection, it was observed that no instrument was used by the nursing team to assess the potential difficulty level of the access.

Regarding the visibility and palpability of the venous network, both factors were indicated as predictors for DIVA according to the linear regression (p < .001). This result has been found to be statistically significant in other similar studies, constituting a network of relevant variables that can be easily identified in the clinical practice to detect at-risk patients even before the first puncture[9,13].

Several previous studies show that the most reliable predictors for DIVA are non-visible or non-palpable veins and a history of difficult access. However, these studies vary in how they define DIVA (i.e., >1 attempt, >2 attempts, or whether ultrasound was used), with three or more attempts being the concept most commonly used[7,16,23-25]. One study identified statistically significant risk rates that were up to five times higher for each of these three predictors[7].

Regarding the choice of access site, the provider must take into account clinical factors, the provider's skill, patient preference, and institutional norms adopted by the facility[13]. In this study, a preference for dorsal metacarpal veins (51.2%) was observed. Similar to what was observed in two other studies, where the main insertion sites for the catheter were on the dorsum of the hand[6,13].

Concerning the catheter model used, the providers preferred model 2 in the first attempt (65.9%) and the last attempt (67.1%), which is a peripheral venous catheter with a needle protection device (passive needle protection technique). It is important to note that the care providers chose the catheter and its size according to availability in the unit's stock, which may influence venous access.

The diagnosis of cancer can be a predictor of DIVA (p < .001/OR = 1.97)[9]; therefore, it is crucial to identify risk factors associated with DIVA early in oncology patients, as this can facilitate the use of advanced techniques for peripheral intravenous catheterization when necessary[26,27]. The creation of working groups composed of infusion therapy specialists is important, considering that patients with DIVA in oncology should undergo a careful assessment by the healthcare team to ensure the best technique is applied.

Study limitations

Not considering the drugs used in the chemotherapy treatment regimens as a variable for analysis, due to the variability related to the histological type and oncological staging of the patients was considered to be a limitation. Furthermore, the classification of vascular toxicity for each drug was beyond the scope of this study.

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Additionally, being a cross-sectional study that did not reach the intended sample size due to the COVID-19 pandemic, it was not possible to determine causality or generalize the data.

CONCLUSION

Patients with a history of difficult intravenous access, and those with non-visible or non-palpable veins had a higher likelihood of experiencing DIVA, with these factors being predictors for the clinical condition (OR 1.6, 1.5, and 1.3, respectively). Contrary to expectations, there was no association between demographic variables, likely due to the limited number of participants in the study.

Therefore, similar research should be conducted in other oncological institutions to contribute to the early identification of this condition and its risk factors in oncology patients, reducing pain and minimizing the risks associated with this procedure. Early identification of these factors could guide the nursing team to adopt new practices, tools, and technologies in their service routine.

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Authors' contributions

Conceptualization, AMPCR and TPS; methodology, ALCM and SEMT; formal analysis, AMPCR and ALCM; resources, AMPCR; tools/software, MSCRC; investigation, ALCM and KBCB; data curation: ALCM; manuscript writing, ALCM and AMPCR; manuscript review and editing, ALCM, AMPCR, KBCB and LNFT; visualization, SEMT and ACN; supervision, AMPCR; project administration, AMPCR and ALCM; financial aquisition, AMPCR. All authors have read and agreed to the published version of the manuscript.