

# Assertiveness and peripheral intravenous catheters dwell time with ultrasonography-guided insertion in children and adolescents

ASSERTIVIDADE E TEMPO DE PERMANÊNCIA DE CATETERES INTRAVENOSOS PERIFÉRICOS COM INSERÇÃO GUIADA POR ULTRASSONOGRRAFIA EM CRIANÇAS E ADOLESCENTES

EFFECTIVIDAD Y TIEMPO DE PERMANENCIA DE CATÉTERES INTRAVENOSOS PERIFÉRICOS DE INSERCIÓN GUIADA POR ECOGRAFÍA EN NIÑOS Y ADOLESCENTES

Ariane Ferreira Machado Avelar<sup>1</sup>, Maria Angélica Sorgini Peterlini<sup>2</sup>, Mavilde da Luz Gonçalves Pedreira<sup>3</sup>

## ABSTRACT

Randomized controlled trial which aimed to verify whether the use of vascular ultrasound (VUS) increases assertiveness in the use of peripheral venous catheter in children, and the catheter dwell time, when compared to traditional puncture. Data were collected after approval of the ethical merit. Children and adolescents undergoing VUS-guided peripheral intravenous (GVUS) or puncture guided by clinical assessment of the venous conditions (CG) were included in the study. Significance level was set at  $p \leq 0.05$ . The sample was composed of 382 punctures, 188 (49.2%) in VUS and 194 (50.8%) in CG, performed in 335 children. Assertiveness was found in 73 (71.6%) GVUS catheters and in 84 (71.8%) of the CG ( $p=0.970$ ), and catheter dwell time presented a median of less than one day in both groups ( $p=0.121$ ), showing no statistically significant difference. VUS did not significantly influence the results of the dependent variables investigated. ClinicalTrials.gov NCT00930254.

## DESCRIPTORES

Pediatric nursing  
Child  
Adolescent  
Catheterization, peripheral  
Ultrasonography  
Patient safety

## RESUMO

Estudo randômico e controlado que objetivou verificar se a ultrassonografia vascular (USV) aumenta a assertividade na utilização do cateter intravenoso periférico e o tempo de permanência do cateter quando comparado ao método tradicional de punção. A coleta de dados ocorreu após aprovação do mérito ético, incluindo-se no estudo crianças e adolescentes submetidos a punção intravenosa periférica guiada pela USV, constituindo o grupo USV (GUSV), ou após avaliação clínica da rede venosa, denominado grupo controle (GC). Os valores de  $p \leq 0,05$  foram considerados significativos. A amostra foi constituída por 382 punções, 188 (49,2%) no GUSV e 194 (50,8%) no GC, realizadas em 335 crianças. Identificou-se assertividade em 73 (71,6%) cateteres do GUSV e em 84 (71,8%) do GC ( $p=0,970$ ). O tempo de permanência do cateter apresentou mediana inferior a um dia nos dois grupos ( $p=0,121$ ), não havendo diferença estatisticamente significativa. Concluindo-se que a USV não influenciou os resultados das variáveis dependentes investigadas. ClinicalTrials.gov NCT00930254.

## DESCRITORES

Enfermagem pediátrica  
Criança  
Adolescente  
Cateterismo periférico  
Ultrassonografia  
Segurança do paciente

## RESUMEN

Estudio randomizado y controlado objetivando verificar si la ecografía vascular (USV) aumenta la efectividad de utilización del catéter intravenoso periférico y su tiempo de permanencia en comparación al método tradicional de punción. Datos recolectados luego de aprobación del mérito ético, incluyéndose en el estudio a niños y adolescentes sometidos a punción intravenosa guiada por USV, constituyendo el grupo USV (GUSV), o luego de evaluación clínica de la red venosa, denominado grupo control (GC). Los valores de  $p \leq 0,05$  fueron considerados significativos. Muestra constituida por 382 punciones, 188 (49,2%) del GUSV y 194 (50,8%) del GC, realizadas en 335 niños. Se identificó efectividad en 73 (71,6%) catéteres del GUSV y en 84 (71,8%) del GC ( $p=0,970$ ). El tiempo de permanencia del catéter expresó mediana inferior a un día en ambos grupos ( $p=0,121$ ), sin diferencia estadísticamente significativa. Se concluye que la USV no influyó en los resultados de las variables dependientes investigadas. ClinicalTrials.gov NCT00930254.

## DESCRIPTORES

Enfermería pediátrica  
Niño  
Adolescente  
Cateterismo periférico  
Ultrasonografía  
Seguridad del paciente

<sup>1</sup> Adjunct professor of the Pediatric Nursing Department, Escola Paulista de Enfermagem, Universidade Federal de São Paulo. São Paulo, SP, Brazil. ariane.machado@unifesp.br <sup>2</sup> Adjunct professor of the Pediatric Nursing Department, Escola Paulista de Enfermagem, Universidade Federal de São Paulo. São Paulo, SP, Brazil. maria.angelica@unifesp.br <sup>3</sup> Associate professor of the Pediatric Nursing Department, Escola Paulista de Enfermagem, Universidade Federal de São Paulo. São Paulo, SP, Brazil. mpedreira@unifesp.br

## INTRODUCTION

One of the main components needed for scientific transformation and evolution of nursing is to evidence changes in healthcare practices through nursing care. Intravenous therapy (IT) is one of the procedures that require innovations in nursing practice, based on scientific analysis that helps improve the results of care, more specifically assertiveness during the use of peripheral intravenous catheter (PIC) and longer catheter dwell time.

The term assertiveness is defined as a human characteristic or quality that determines the degree to which the individual will be competitive and directive; to make assertive statements; the quality of what is assertive<sup>(1)</sup>. In this study, the term assertiveness represents *property of successful peripheral intravenous puncture (PIP) on the first attempt and removal of the PIC due to discharge from treatment*.

Development of nursing competence is a key component to promoting higher safety, effectiveness, efficacy and efficiency in child care under intravenous therapy (IT). The main assumptions of child care should be the property of increasing success in obtaining venous access, prioritizing safety, needs and preferences of the patient and family, with reduced physical and psychological morbidity and increased satisfaction with care<sup>(2)</sup>.

Patient safety is defined as the absence of harm during healthcare and can be promoted with the incorporation of technology into professional clinical practice, in order to improve ability and assist in early detection and intervention in the presence of adverse events. It is considered an essential tool for modern healthcare<sup>(3-4)</sup>.

The introduction of the safety paradigm in healthcare has been observed in the twenty-first century. Regarding IT, studies and international standards of practice describe vascular ultrasonography (VUS) as a procedure capable of improving successful venous puncture, particularly during central vascular access puncture<sup>(5-6)</sup>.

Research results on the use of VUS to obtain peripheral vascular access are still scarce. Improvement in the results is mainly observed in patients with difficult venous access, adults or children, in the insertion of central venous catheters and PIC. Such method seems to enable improved identification of the venous network and may contribute to higher puncture success with fewer puncture attempts, less time spent in performing the procedure, and higher patient satisfaction<sup>(7-10)</sup>.

Thus, the aim was to verify whether the use of VUS could promote increased assertiveness in the use of PIC, and longer catheter dwell time, when compared to the

traditional method of PIC insertion in children in order to verify whether the use of this type of technology could assist nurses and contribute to the development of the therapy with adverse events reduction and increased patient safety.

## METHOD

This was a randomized controlled trial on the use of VUS for PIC insertion in children submitted to IT. It was hypothesized that the use of VUS for PIC insertion in children would promote higher assertiveness during catheter use and would increase catheter dwell time. The study was registered at ClinicalTrials.gov, U.S. National Institute of Health under the number NCT00930254.

The sample consisted of peripheral intravenous punctures (PIP) in children and adolescents aged one day to 18 years, hospitalized in a pediatric surgical unit, who agreed to participate in the study when applicable, as well as their parents, after being informed about objectives, risks and benefits resulting from voluntary participation in the research. Children over seven years old and adolescents signed an assent form along with their caregivers, which provides the opportunity, when appropriate, for children from this age on to participate in the decision-making process, expressing their will and individuality. The assent request is mandatory for children beginning at age 12<sup>(11-12)</sup>.

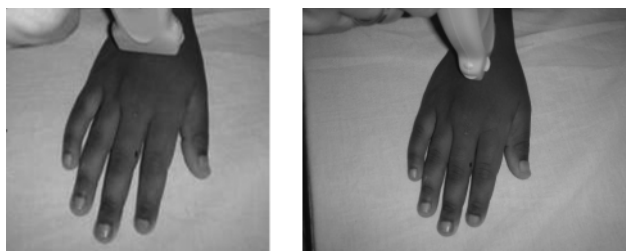
All children and adolescents who met the research inclusion criteria were studied: age from one day to 18 years old, indication of peripheral intravenous puncture for IT administration, elective surgery, signing of the assent form by children when applicable and signing of the consent form by those responsible.

For the study implementation, PIP were randomly distributed according to the program *True Epistat*<sup>®</sup> developed by Epistatic Services in Richardson, Texas, United States of America, into two groups named *VUS group* (VUSG), in which PIC insertion was performed with the use of portable vascular ultrasound equipment with a 25 mm transducer which operated at a 10 megahertz (MHz) frequency, and *control group* (CG), characterized by PIC insertion guided by clinical assessment of the site, by visualizing and palpating the vessel, called the traditional method.

Identification of the vessel ultrasound image was done transversally and longitudinally (Figure 1) by rotating the transducer 90°, by compressing it against the skin in order to confirm the compressibility of the vein.

After identification of the vessel through ultrasound image, skin antisepsis was performed and venous puncture was directed in real time by the image, which guided the catheter positioning until the confirmation of puncture success (Figure 2).

Research results on the use of vascular ultrasonography to obtain peripheral vascular access are still scarce. Improvement in the results is mainly observed in patients with difficult venous access...



**Figure 1** – Transducer positioning transversal (A) and longitudinally (B).



**Figure 2** – Vascular ultrasonography-guided peripheral intravenous puncture.

Data collection was performed after training of the nurses who would perform the proposed interventions and standardizing for the study, and after approval of the ethical merit of the research (Report #0402/06). At the end of data collection, the sample consisted of 382 PIP, performed in 335 children.

Assertiveness during PIC use, represented by successful PIP on the first attempt and removal of the catheter due to discharge from treatment and catheter dwell time were selected as outcomes variables. Successful puncture on the first attempt was considered identification of blood reflux through the catheter and infusion of 2ml of 0.9% NaCl in water without changes in inspection and palpation of the catheter insertion site, or pain complaints by the child or adolescent<sup>(13)</sup>.

Catheter removal due to discharge from treatment indicated absence of identification of signs of local IT complications which prevented an indwelling catheter until the end of the clinical indication. In this study, catheter removal due to discharge from treatment was considered the ideal indication of the end of PIC use, responding to the assumptions of patient safety and IT quality.

Catheter dwell time was assessed after data collection, according to the calculation result of the difference between

the date and time of catheter removal and the date and time of venous puncture, in hours.

An investigation of variables to characterize the children and adolescents, as well as the intravenous therapy, was also conducted. Categorical variables were assessed according to the Chi-square test, and numerical variables according to the Mann-Whitney test, because rejection of the hypothesis of normally distributed data was observed according to the Kolmogorov-Smirnov test. Descriptive levels equal to or lower than 5% ( $p < 0.05$ ) were considered statistically significant.

## RESULTS

The sample consisted of 382 punctures, 188 (49.2%) in the VUSG and 194 (50.8%) in the CG, performed in 335 children and adolescents aged between 12 days and 17 years. It is noteworthy that out of the 188 punctures in VUSG and 194 in CG, no peripheral venous access was obtained, regardless of the number of attempts in 27 (14.4%) punctures in VUSG and in 16 (8.2%) punctures in CG. Therefore, the sample consisted of 161 and 178 catheters inserted in children and adolescents in VUSG and CG respectively.

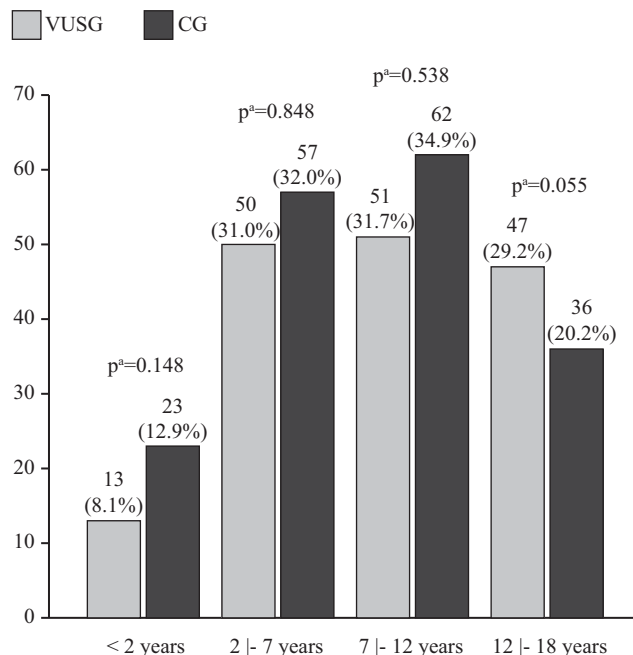
Regarding the characteristics of the children and adolescents, PIC were predominantly inserted in eutrophic white boys, with statistically similar distribution in the study groups ( $p > 0.05$ ). Regarding age, the median in the VUSG was higher (8.2 years) compared to the CG (7.2 years), with a statistically significant difference ( $p = 0.028$ ) between the groups. Figure 3 shows the age analysis of the children and adolescents who participated in the study, according to age group and successful peripheral venous access, according to the study groups.

No statistical differences in the groups were evidenced when distribution of children and adolescents by age according to successful access was assessed. A higher number of successful access was identified in VUSG in adolescents between 12 and 18 years of age, however, there was a marginally significant difference ( $p = 0.055$ ) between the groups (Figure 3).

Out of 382 punctures, 219 were successful on the first attempt, 102 (54.3%) in VUSG and 117 (60.3%) in CG. No significant difference was observed between the groups ( $p = 0.232$ ). Thus, the use of VUS did not contribute to increased success of PIP on the first attempt, when compared to the traditional puncture method.

Table 1 presents the results of the assertiveness study by associating the success variables of venous puncture on the first attempt and catheter removal due to discharge from treatment.

Regarding catheter removal due to discharge from treatment inserted on the first attempt, there was no statistically significant difference between groups ( $p = 0.970$ ).



**Figure 3** – Children’s age according to successful peripheral venous access.

**Table 1** – Assertiveness according to success of peripheral venous puncture on the first attempt and catheter removal due to discharge from treatment in groups VUS (VUSG) and control (CG)

Catheter removal due to discharge from treatment	Puncture success on the first attempt		P
	VUSG (n=102)	CG (n=117)	
	f (%)	f (%)	
Yes	73 (71.6)	84 (71.8)	0.970 <sup>a</sup>
No	29 (28.4)	33 (28.2)	

<sup>a</sup> Chi-square test.

Table 2 presents dwell time of all catheters assessed in the study, regardless of the number of puncture attempts.

**Table 2** – Peripheral intravenous catheter dwell time according to groups VUS (VUSG) and control (CG)

Catheter dwell time (hours)	VUSG (n=161)	CG (n=178)	p
Median (Q1 – Q3)	22.0 (8.2–41.7)	23.4 (10.0–46.8)	0.121 <sup>a</sup>
Minimum – Maximum	0.2–216.4	0.3–188.2	

<sup>a</sup> Mann-Whitney Test.

Regarding catheter dwell time, a median lower than 24 hours was identified in both study groups, with a maximum of 216.4 hours in the VUSG and 188.2 hours in the CG, without statistical significance according to the test applied ( $p=0.121$ ) (Table 2).

Catheter dwell time of the 73 catheters in the VUSG and of the 84 catheters in the CG inserted in the first puncture attempt and removed by discharge from treatment are described in Table 3 with the same premise of assessing effectiveness of VUS use to increase assertiveness during PIC insertion in children and adolescents, and the catheter dwell time.

**Table 3** – Dwell time of catheter inserted in the first puncture attempt and removed due to discharge from treatment, according to the VUS (VUSG) and control (CG) groups

Catheter dwell time (hours)	VUSG (n= 73)	CG (n= 84)	p
Median (Q1 – Q3)	22.5 (9.3–42.5)	22.2 (8.2–41.7)	0.725 <sup>a</sup>
Minimum – Maximum	1.5–167.2	0.9–146.5	

<sup>a</sup> Mann-Whitney Test.

According to Table 3, the two study groups were not different. Catheter dwell time in both groups had a median of less than 24 hours.

The variables studied related to IT showed no statistically significant difference in the two groups related to the catheter size. A higher proportion of 24 G catheters ( $p=0.783$ ), prevalence of limb tourniquet use before puncture ( $p\geq 0.999$ ) and the indirect puncture method (insertion of the catheter into the skin at a 30° to 45° angle at the vein side and progression until venous puncture) were observed. This method was observed in the VUSG at a slightly higher proportion than in the CG, when compared to the direct method (catheter insertion directly over the vein, at a 30° to 45° angle), but without statistical significance ( $p=0.625$ ).

## DISCUSSION

Successful peripheral vascular access in the first puncture attempt and catheter dwell time until the end of IT indication should be considered the gold standard for IT implementation. However, they are challenges for nurses, especially in pediatrics, due to physiological, anatomical and developmental characteristics of each child or adolescent.

In order to reduce the number of puncture attempts and increase the frequency of successful peripheral venous access, some authors report the advantage of VUS in increasing the puncture success. However, those studies had diverse populations of small samples and different methodologies, which did not describe successful access in the first puncture attempt with catheter removal due to the end of treatment<sup>(7-10,13-16)</sup>.

In the present study, contrary to what was expected, assertiveness was similar between the two study groups; VUS did not increase success in the first puncture attempt, nor did it influence catheter removal due to discharge from treatment, which indicates the need for



further study in order to identify improvement in the results of IT.

It is emphasized that the survey was conducted with new technology for the professionals who participated in data collection, all children and adolescents who met the inclusion criteria were assessed, regardless of the characteristic of the venous network, not taking into account those with difficult venous access, as identified in the studies on the subject, which limit the use of VUS to this population.

A study conducted with 35 adults with difficult venous access submitted to PIP guided or unguided by VUS evidenced that puncture success on the first attempt was higher in the group with punctures by the traditional method when compared to the group using VUS<sup>(14)</sup>, similar to the present study, though not statistically significant when compared to VUS-guided PIP ( $p=0.232$ ).

Higher success on the first attempt was reported in another study with adults, with 46.0% success rate on the first attempt with VUS and 23.8% with the traditional method<sup>(15)</sup>. The frequency of successful first attempts with the use of VUS was higher in our study than in the study mentioned. However, that occurred in only about half of the sample, which suggests the need for development of this nursing intervention in order to achieve better results.

Other studies have been performed with adults with a history of unsuccessful puncture attempts, but they were not experimental studies, since they did not compare the use of the traditional method to VUS use. Therefore, it is not possible to compare them with the present investigation. They identified a frequency ranging from 73.0% to 84.0% of successful VUS-guided puncture on the first attempt<sup>(13,16)</sup>.

By analyzing the results of the studies<sup>(13,16)</sup> developed, higher success in adult puncture on the first attempt using VUS was evidenced (73.0% and 84.0%, respectively) compared to results of the present study with children and adolescents.

For identification of the ultrasound image it is necessary to obtain patient cooperation regarding immobilization of the limb to be punctured, because its movement interferes with the proper conduct of the procedure, making it difficult to maintain the transducer in an ideal position, which compromises identification of the venous network and the capture of the peripheral venous ultrasound image, a condition relatively common when it comes to children or adolescents.

The analysis of children and adolescents by age groups evidenced a marginally significant difference in obtaining peripheral venous access in adolescents 12 to 18 years old, with higher successful number in the VUSG, possibly due to their collaboration during the ultrasound image acquisition.

A randomized study conducted in an emergency department with children with a history of difficult venous access

submitted to unsuccessful puncture attempts identified no benefit with the use of VUS for insertion of peripheral venous catheters<sup>(10)</sup>.

A randomized study was developed with children who had experienced two unsuccessful puncture attempts using the conventional method. The use of VUS did not significantly improve the frequency of successful puncture ( $p=0.208$ ), but it decreased the time needed to perform the procedure ( $p=0.001$ ), the number of attempts ( $p=0.004$ ) and the need for repositioning the catheter ( $p<0.0001$ ) when compared to conventional puncture<sup>(9)</sup>.

In our study, we included all children and adolescents who needed intravenous access, regardless of the venous condition and medical history. There was a higher frequency of successful puncture on the first attempt in our study when compared to data from a prospective, non-randomized study conducted in Nebraska, United States, on the number of puncture attempts in children and adolescents aged between three days and 20 years, using only the traditional method of puncture. The author evidenced an average of 2.35 attempts to obtain peripheral venous access in 249 punctures, with 47.0% success on the first attempt, 15.0% on the second attempt, and 28.0% on the fourth<sup>(17)</sup>.

Regarding the reason for catheter removal, a study comparing three types of PIC dressings in children identified removal of the devices due to discharge from treatment in only 37 (24.7%) of 150 catheters inserted, the majority (75.3%) removed due to adverse events<sup>(18)</sup>. In another research on the reasons for IT interruption in adults, it was observed that 52% of PIC were removed due to discharge from treatment<sup>(19)</sup>.

Comparing the results of this investigation with the research presented, it appears that the majority of catheters was removed at the end of IT, that is, free from occurrence of complications. Even though the majority of catheters were removed due to discharge from treatment, over 30% were removed because of complications, accidental loss or complaints of children, indicating the need to promote advances in nursing care provided to children.

Maintaining the PIC for as long as possible, complication free and for as long as necessary, is an important factor to minimize the discomfort of the child and the need for new punctures. Progressive venous sclerosis and thrombosis due to multiple punctures cause physical and psychological trauma in children, and catheter removal due to discharge from treatment is considered one of the best indicators of quality in IT implementation<sup>(20)</sup>.

Catheter dwell time was not identified in the literature search that related this variable to the use of VUS for device insertion. In this study, there was similarity between the groups, and a higher dwell time was not evidenced in the GUSV, a fact that would be hypothetically

possible, because when there is visualization of the catheter insertion by ultrasound image, the tip of the device would not cause damage to the vessel wall, with proper positioning and prevention of possible factors predisposing to complications which would lead to shorter catheter dwell time.

It is noteworthy that the catheter dwell time cannot be analyzed in isolation, using only the puncture method as a basis, but must also consider the type of device and dressing used, type and method of infusion of solutions and medications, and the occurrence of IT complications.

A prospective randomized trial about the factors that affect PIC dwell time, performed in a pediatric hospital in Northern India with children from one day to 12 years of age, evidenced longer time in the group that received infusion of heparin after drug administration associated with the use of 22 G catheters and limb immobilization. The shortest dwell times occurred with younger children using 24G catheters, inserted in the wrist and cephalic region. The authors also evidenced a higher incidence of complications, such as phlebitis and infiltration, as the catheter dwell time lengthened<sup>(20)</sup>.

In our study, according to the primary data, the catheters used were predominantly 24G, had a transparent dressing covering the insertion site, and infusion of heparin solution when maintained intermittently, with no difference observed in catheter dwell time. Regarding the occurrence of IT complications, it is possible to infer that their occurrence was directly related to catheter dwell time; that is, due to the high rate of complications in children, dwell time of peripheral devices would be proportionally lower.

A descriptive study on catheter dwell time and on the reason for discontinuation of therapy through PIC in adults undergoing surgical procedures showed that, out of 40 patients, 43.0% stayed with the catheter for less than 24 hours, 47.0% between 24 and 72 hours, and only 10.0% maintained catheters for over 72 hours<sup>(19)</sup>.

A randomized study on PIC dwell time in children according to the type of dressing verified influence of transparent dressing (29.53 hours) on the dwell time of 150 catheters inserted in 68 children compared to a dressing with sterile gauze (46.12 hours) and adhesive tape (38.18 hours)<sup>(21)</sup>.

In the present study, the median catheter dwell time, regardless of the study group, was less than 24 hours, with maximum time above 200 hours in the VUSG and approximately 190 hours in the CG, though without statistical significance as shown in Table 2.

Thus, both in this and other research on the subject, it is observed that there is fertile ground for the development

of numerous studies that describe the factors that may influence catheter dwell time.

## CONCLUSION

Given the results obtained, there was success in over half of the punctures on the first attempt and removal of catheters due to discharge from treatment in both study groups. Regarding the catheter dwell time a median lower than one day was identified in both groups, with no statistically significant difference between groups. It is concluded that VUS did not influence the results of the dependent variables investigated.

As limitations of the study, we cite the impossibility of sample size calculation and delimitation of the power of study prior to data collection, due to the unprecedented nature of the research; the wide age range studied, which may compromise the analysis due to the peculiar characteristics of each group of children and adolescents, as well as the assessment of all children and adolescents who met the inclusion criteria, regardless of the condition and previous history of unsuccessful venous punctures, which could interfere with the results of PIP and applicability of VUS. No research was identified in the literature on the topic in children with methodology and inclusion criteria similar to those used in this investigation.

Since nursing took this assignment in the practice of healthcare, many advances in IT have resulted in the production of nursing knowledge, such as the manufacturing of catheters increasingly compatible with the patient's needs, dressings with better performance in the prevention of complications and in the preservation of the patient's self-image, as well as the development of studies relating to the preparation and patient satisfaction during the use of IT. However, few studies are directed to improve the results of the effectiveness of PIP and in that sense, this study contributes to innovation in this area of research for nursing, which can generate new knowledge capable of transforming praxis.

It is noteworthy that the group of nurses who performed the VUS probably characterize one of the first Brazilian teams to implement this practice in a systematic way. This may have led to low levels of correct interpretation of ultrasound images, especially at the beginning of data collection, due to the introduction of new technology for the practice of nursing, and the recent acquisition of skills and competencies.

Added to this is the use of one of the earliest forms of the VUS equipment manufactured for the purpose of intervention; there are already similar ones with several technological advances. In addition, there is the difficulty of limb immobilization during VUS-guided venous puncture, a condition observed in most children and adolescents who participated in the study, which may contribute to failure of the procedure.

## REFERENCES

1. Michaelis moderno dicionário inglês português. São Paulo: Melhoramentos; 2000.
2. Institute of Medicine, Committee on Quality Health Care in America. Crossing the quality chasm: a new health system for the 21st Century. Washington; 2001.
3. Bates DW, Gawande AA. Patient safety: improving safety with information technology. *N Engl J Med*. 2003;348(25):2526-34.
4. Van de Castle B, Kim J, Pedreira ML, Paiva A, Goossen W, Bates DW. Information technology and patient safety in nursing practice: an international perspective. *Int J Med Inform*. 2004;73(7-8):607-14.
5. Tibbles CD, Porcaro W. Procedural applications of ultrasound. *Emerg Med Clin North Am*. 2004;22(3):797-815.
6. Murphy PC, Arnold P. Ultrasound-assisted vascular access in children. *Contin Educ Anaesth Crit Care Pain J [Internet]*. 2011 [cited 2011 Nov 17];11(2):44-9. Available from: <http://ceaccp.oxfordjournals.org/content/11/2/44.extract>
7. Abboud PA, Kendall JL. Ultrasound guidance for vascular access. *Emerg Med Clin North Am*. 2004;22(3):749-73.
8. Samoya SW. Real-time ultrasound-guided peripheral vascular access in pediatric patients. *Anesth Analg*. 2010;111(3): 823-5.
9. Doniger SJ, Ishimine P, Fox JC, Kanegaye JT. Randomized controlled trial of ultrasound-guided peripheral intravenous catheter placement versus traditional techniques in difficult-access pediatric patients. *Pediatr Emerg Care*. 2009;25(3):154-9.
10. Bair AE, Rose JS, Vance CW, Andrada-Brown E, Kuppermann N. Ultrasound-assisted peripheral venous access in young children: a randomized controlled trial and pilot feasibility study. *West J Emerg Med*. 2008;9(4):219-24.
11. World Health Organization; Research Ethics Review Committee. The Process of Seeking Informed Consent [Internet]. Geneva; 2009 [cited 2011 Nov 17]. Available from: [http://www.who.int/rpc/research\\_ethics/Process\\_seeking\\_IF\\_printing.pdf](http://www.who.int/rpc/research_ethics/Process_seeking_IF_printing.pdf)
12. Sigaud CHS, Rezende MA, Veríssimo MDLOR, Ribeiro MO, Montes DC, Piccolo J, et al. Ethical issues and strategies for the voluntary participation of children in research. *Rev Esc Enferm USP [Internet]* 2009 [cited 2011 Nov 17];43(spe 2):1342-6. Available from: [http://www.scielo.br/pdf/reeusp/v43nspe2/en\\_a34v43s2.pdf](http://www.scielo.br/pdf/reeusp/v43nspe2/en_a34v43s2.pdf)
13. Costantino TG, Fojtik JP. Success rate of peripheral IV catheter insertion by emergency physicians using ultrasound guidance. *Acad Emerg Med*. 2003;10(5):487.
14. Aponte H, Acosta S, Rigamonti D, Sylvia B, Austin P, Samolitis T. The use of ultrasound for placement of intravenous catheters. *AANA J*. 2007;75(3):212-6.
15. Costantino TG, Parikh AK, Satz WA, Fojtik JP. Ultrasonography-guided peripheral intravenous access versus traditional approaches in patients with difficult intravenous access. *Ann Emerg Med*. 2005;46(5):456-61.
16. Keyes LE, Frazee BW, Snoey ER, Simon BC, Christy D. Ultrasound-guided brachial and basilic vein cannulation in emergency department patients with difficult intravenous access. *Ann Emerg Med*. 1999;34(6):711-4.
17. Lininger RA. Pediatric peripheral IV insertion success rates. *Pediatr Nurs*. 2003;29(5):351-4.
18. Machado AF, Pedreira MLG, Chaud MN. Adverse events related to the use of peripheral intravenous catheters in children according to dressing regimens *Rev Latino Am Enferm*. 2008;16(3):362-7.
19. Pereira CC, Zanetti ML, Ribeiro KP. Motivos de interrupção da terapia endovenosa relacionada ao tempo e permanência do dispositivo venoso periférico *in situ*. *Rev Gaúcha Enferm*. 2002;23(1):70-83.
20. Tripathi S, Kaushik V, Singh V. Peripheral IVs: factors affecting complications and patency – a randomized controlled trial. *J Infus Nurs*. 2008;31(3):182-8.
21. Machado AF, Pedreira MLG, Chaud MN. Prospective, randomized and controlled trial on the dwell time of peripheral intravenous catheters in children, according to three dressing regimens. *Rev Latino Am Enferm*. 2005;13(3):291-8.

## Acknowledgement

To Conselho Nacional de Desenvolvimento Científico e Tecnológico - CNPq - Processes: 476295/2004-1 and 502382/2007-4, for the financial support.

Study registered at ClinicalTrials.gov, US National Institute of Health under number NCT00930254.