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The impact of a notched peripheral intravenous catheter on the first attempt success rate in hospitalized adults: Block-randomized trial

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Abstract

Introduction: Peripheral intravenous cannulation is the preferred method to obtain vascular access, but not always successful on the first attempt. Evidence on the impact of the intravenous catheter itself on the success rate is lacking. Faster visualization of blood flashback into the catheter, as a result of a notched needle, is thought to increase first attempt success rate. The current study aimed to assess if inserting a notched peripheral intravenous catheter will increase first attempt cannulation success up to 90%, when compared to inserting a catheter without a notched needle.

Design: In this block-randomized trial, adult patients in the intervention group got a notched peripheral intravenous catheter inserted, patients in the control group received a traditional non-notched catheter. The primary objective was the first attempt success rate of peripheral intravenous cannulation. Intravenous cannulation was performed according to practice guidelines and hospital policy.

Results: About 328 patients were included in the intervention group and 330 patients in the control group. First attempt success was 85% and 79% for the intervention and control group respectively. First attempt success was remarkably higher in the intervention group regarding patients with a high risk for failed cannulation (29%), when compared to the control group (10%).

Conclusion: This study was unable to reach a first attempt success of 90%, although first attempt cannulation success was higher in patients who got a notched needle inserted when compared to those who got a non-notched needle inserted, unless a patients individual risk profile for a difficult intravenous access.

Keywords

Catheterization, peripheral, vascular access devices, risk factors

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Introduction

Most patients admitted to the hospital require vascular access, with a vascular access device inserted in up to 85% of hospitalized patients and many outpatients.[1] Peripheral intravenous cannulation is the preferred method to obtain vascular access in non-emergent situations, but also the most commonly performed emergency procedure. To continue, it has been established as the most common, quickest, simplest and least expensive method to gain vascular access, particularly for short-term medical interventions.[2,3] Furthermore, intravenous cannulation is usually the first procedure performed by anesthesia providers on patients

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presenting for procedures requiring anesthesia or procedural sedation.[4]

The traditional approach of peripheral intravenous cannulation involves visual inspection and palpation of the extremity to locate a suitable vein, followed by needle puncture and catheter insertion. Therefore, the practitioner requires knowledge of the vascular anatomy to estimate the target vessel location. Notwithstanding, intravenous access can be difficult to obtain, especially in those patients with a lack of visual or palpable apparent veins, smaller veins, and in patients with a known history of a difficult intravenous access.[5]

Although advances have been made by recent research, focus is mainly on the procedure of peripheral intravenous cannulation itself or on training and experience of the clinician.[6,7] Proper training in a fixed curriculum to achieve competency and proficiency before performing intravenous cannulation need to be emphasized as an important aspect influencing cannulation success, even with an ultrasound-guided or Near InfraRed (NIR) procedure.[8,9] Research on the impact of the intravenous catheter on cannulation success is lacking, despite several innovations were made in the design. Moreover, investigating the impact of the type of peripheral intravenous catheter that will be inserted to obtain vascular access can shed light on the grey zone of factors affecting first attempt cannulation success.[10,11]

In clinical practice, the intravenous catheter is inserted through the skin and advanced until a flashback of blood is observed by the practitioner. In most current catheters, blood must flow the entire length of the needle in order to reach the flashback chamber and alert the practitioner to be in the vein. During this critical instant of milliseconds of advancing the needle until flashback of blood is observed, there is a risk for traversing the opposite wall of the vein because the practitioner is cannulating the vein without knowing it. Faster visualization of the flashback of blood into the catheter will reduce the risk of transfixation by the simple fact that the critical instant of milliseconds in which the practitioner is advancing the needle is reduced.[10] The use of a notched needle is thought to improve cannulation success by confirming immediate vein entry at the point of insertion with the immediate flashback of blood.

Peripheral intravenous cannulation is a routine and straightforward procedure, despite not every effort to obtain vascular access is successful on its first attempt. Multiple attempts to insert a vascular access device will logically lead to uncomfortable situations for the patient, delay of diagnoses and treatment, increased costs in terms of time and equipment, and exposes patients to the risk of central venous cannulation.[12–14] Patients at high risk for failed cannulation according to the A-DIVA scale should be referred to a specialized practitioner with advanced knowledge and experience in a difficult intravenous access.[15,16] Inserting a notched needle alone is not expected to solve the problem of failed cannulation in patients with a difficult intravenous access. For these patients, ultrasound guidance is said to be the preferred technology for peripheral intravenous cannulation.[16,17] Nevertheless, quicker flashback of blood and vessel entry may improve the chance of accessing difficult or compromised veins, and may for that reason be an added value in increasing first attempt cannulation success.[16]

First attempt success rates of 81% upon peripheral intravenous cannulation with a traditional needle were reported in a previous study.[5] A success rate of 90% on the first attempt of peripheral intravenous cannulation is mentioned as clinically relevant and acceptable throughout the entire hospitalized population.[5] Despite, there is no agreement about the extreme lower limit of first attempt cannulation success that is accepted. Quicker observation of blood by using a notched needle is thought to increase success on the first attempt of peripheral intravenous cannulation. The aim of this study, therefore, was to assess whether or not inserting a notched peripheral intravenous catheter will increase first attempt cannulation success during intravenous cannulation up to 90% in adult patients, when compared to the success rate in patients in which a peripheral intravenous catheter without a notched needle is inserted.

Materials methods

Design and setting

This study was conducted at the department of anesthesiology (holding area of the operating theatre complex) of the Catharina Hospital (Eindhoven, The Netherlands) as a block-randomized trial, and performed between September and December 2019. Peripheral intravenous cannulation with a notched needle (intervention group) and a traditional non-notched needle (control group) changed during the study period in predetermined blocks of 30, 40, or 50 catheters, until the needed sample size was reached and the number of inserted catheters was equal between both study groups. Patients were not aware of the catheter that was inserted. Blinding of practitioners who were responsible for obtaining vascular access was, however, not possible, because they saw which kind of needle was inserted by them. This trial was conducted according to the Consolidated Standards of Reporting Trials (CONSORT) statement.[18–20] The study protocol was approved by the Medical Ethics Committee United (MEC-U, Nieuwegein, The Netherlands) and registered with number W19.102, and registered in the Dutch Trial Register with number NL7753. Written informed consent was obtained from all participants prior to the procedure of peripheral intravenous cannulation during their interview at the preoperative screening department.

Participants, recruitment, and data collection

Potential subjects were surgical patients, which were asked to participate regardless the medical specialism or type of surgery they were admitted for. In order to be eligible to participate in this study, potential subjects were in the age of 18 years or older, conscious and able to adequately answer questions. A potential subject was excluded from participation when a catheter was already inserted on the ward, was unwilling or unable to provide consent to participate, or did not understand questions or generate adequate data due to physical or communicational disorders.

Procedure and intervention

Peripheral intravenous cannulation was performed according to practice guidelines and hospital policy.[21–23] In both study groups, peripheral intravenous cannulation was performed when the practitioner was able to detect a suitable, dilated vein by palpating and/or visualizing the extremity by the anatomical landmark approach. Cannulation was performed on the upper extremity. Veins on the dorsal and ventral surfaces of the extremity were considered for cannulation, including the metacarpal, cephalic, basilic, and median veins.[5,21] The size of the inserted catheters ranged between 18 and 22 gauge, whereas the size of the catheter depended on the clinical situation. Throughout the study, peripheral intravenous cannulation was performed by experienced nurse anesthetists and PACU nurses, who gained at least 1 year of experience in intravenous catheter placement. An aseptic technique, proper skin preparation and continued protection of the cannulation site were applied.[21] In the intervention group, a Venflon™ Pro Safety catheter with the InstaFlash™ Needle Technology (notched needle) was inserted, whereas patients in the control group received a Venflon™ Pro Safety catheter without the InstaFlash™ Needle Technology (non-notched needle). Practitioners were trained in inserting a Venflon™ Pro Safety catheter with InstaFlash™ Needle Technology and gained experience in inserting that type of catheter in a 2-week period prior to the start of the study, in which no data was collected. Training consisted of a 30 min lecture by the manufacturer, followed by a 30 min hands-on training on cannulation phantoms. Hereafter was the notched needle used in routine care in which the nurses got used in working with the notched device. Focus during this training period was on the immediate flashback of blood in the device after penetrating the venous wall, which is seen as the only difference when compared to the non-notched needle. Treatment in both study groups was equal, only the inserted catheter differed between both groups.

Measurements

The primary objective was stated as the first attempt success rate of peripheral intravenous cannulation with either the notched and non-notched needle. An attempt was defined as a percutaneous needle puncture, regardless the amount of subcutaneous exploration from the single puncture site.[24] After each puncture, the inserter checked whether the attempt was successful or not. After a failed attempt, a new attempt was stated as any change in localizing a vein, followed by a new percutaneous puncture. Peripheral intravenous cannulation was successful if a saline flush could be injected without compromising the vein and signs of subcutaneous injection were absent.[23] Secondary objectives were the effect of the type of catheter (notched or non-notched needle) on the time in minutes needed for intravenous cannulation, the total number of attempts needed for successful cannulation, pain score upon intravenous cannulation as measured on an eleven-point Verbal Numeric Rating Scale (VNRS) with "0" representing no pain and "10" representing the worst pain imaginable, and complications or side effects. Additionally, factors related to the patient (age, sex, length, weight, and the A-DIVA score) and procedure related data (size of the vein as measured in millimeters with a ruler placed upon the vein after applying a tourniquet, size of the inserted catheter, side of cannulation, and the site of cannulation on the extremity) were collected to determine its relation with the outcome of interest.[5]

Sample size calculation

Two study groups were created: a control and an intervention group. A first attempt success rate of 81% was reported in a previous study.[5] The current study aspired to increase the success ratio of first attempt peripheral intravenous cannulation to as high as 90%, which was deemed clinically relevant.[5] Power analysis indicated that at least a sample size of 291.3 patients in each study group was required, assuming a mean difference of 9% regarding first attempt success of peripheral intravenous cannulation, with $\alpha = 0.05$, and $\beta = 0.80$. Finally, 660 patients were asked to participate divided over both study groups, allowing a 10% attrition due to data collection incompleteness.

Statistical analyses

The Kolmogorov-Smirnov test assessed the normality assumption for continuous variables. Continuous variables with normal distribution were represented as mean and standard deviation, those without normal distribution as median and interquartile range. Discrete variables were expressed as frequencies with percentages. The Mann-Whitney *U* test, Kruskal-Wallis *H* test, and the unpaired *t* test were used to compare the outcome of continuous variables based on the normality assumption for continuous variables, and the χ^2 test for discrete variables. Spearman's ρ or Pearson's ρ correlation analysis were applied to determine any relation between variables and the outcome of interest as appropriate. Throughout the study, a *p* value

Table 1. Demographic and baseline data of the included participants in both study groups.

		Intervention group (*N* = 328)	Control group (*N* = 330)
Sex	Male	155 (46%)	136 (41%)
	Female	173 (54%)	194 (59%)
Age	Years	58 ± 17	59 ± 17
Length	Centimeters	172 ± 10	171 ± 10
Weight	Kilograms	77 ± 17	80 ± 18
BMI		26 ± 6	27 ± 5
ASA classification	ASA 1	76 (23%)	56 (17%)
	ASA 2	175 (53%)	200 (61%)
	ASA 3	69 (21%)	74 (22%)
	ASA 4	8 (3%)	0 (0%)

Data are represented as mean ± standard deviation for continuous variables, and as absolute numbers (percentages).

Table 2. Data regarding the procedure of peripheral intravenous cannulation in both study groups.

		Intervention group (*N* = 328)	Control group (*N* = 330)	*p* value
Successful first attempt	Yes	278 (85%)	260 (79%)	0.004
	No	50 (15%)	70 (21%)	
Number of attempts	Numbers	1.0 (0)	1.0 (0)	<0.001
Side of cannulation	Left	96 (29%)	67 (20%)	<0.001
	Right	232 (71%)	263 (80%)	
Location on the extremity	Hand	187 (57%)	258 (78%)	<0.001
	Lower arm	113 (35%)	63 (19%)	
	Elbow crease	23 (7%)	9 (3%)	
	Upper arm	3 (1%)	0 (0%)	
Size of the cannula	22 gauge	14 (4%)	24 (7%)	<0.001
	20 gauge	146 (45%)	240 (73%)	
	18 gauge	167 (51%)	66 (20%)	
Time to successful cannulation	Minutes	2.4 ± 2.9	2.5 ± 2.9	0.902
Pain upon cannulation	VNRS	2.0 ± 1.8	2.6 ± 2.4	0.002

Data are represented as mean ± standard deviation or median (IQR) for continuous variables, and as absolute numbers (percentages).

less than 0.05 will be denoted as statistical significant. SPSS, version 25.0 (SPSS Inc., Chicago, Illinois, USA) was used for all statistical analyses.

Results

In total, 660 patients were included in this study, divided into a control group and an intervention group. In the intervention group, two patients were excluded because of incompleteness of data. Demographic and baseline data of the included patients are represented in Table 1. Study groups were comparable according to their demographics. All patients were in stable hemodynamic conditions prior to peripheral intravenous cannulation.

The first attempt success rate of the total cohort of included patients was 82%, whereas a first attempt success rate of 79% was recorded in the control group and a 85% success rate in the intervention group ($\chi^2 = 8.32$, df = 1, $p = 0.004$). The median number of attempt to obtain successful vascular access was 1.0 (0) in both study groups (U = 48090, Z = −3.88, $p < 0.001$), with a mean difference of 0.226 attempts between both study groups. The relative risk for a failed first attempt of peripheral intravenous cannulation was 0.72 (0.52–0.98) in the intervention group with respect to those in the control group. Other data regarding the procedure of peripheral intravenous cannulation is shown in Table 2.

Data according to the outcome of interest for the intervention and control group are represented in Table 3. A difference could not be objected between both study groups regarding the A-DIVA risk profiles ($\chi^2 = 0.75$, df = 2, $p = 0.689$). For the total study cohort, success rates in the low, moderate and high risk patients according to the A-DIVA scale were 93%, 59%, and 20% respectively. The first attempt success rate for patients with a low risk profile was higher in the intervention group with respect to the control group ($\chi^2 = 6.28$, df = 1, $p = 0.012$). Unless higher success rates for patients in the intervention group with a

Table 3. Data according to the outcome of interest, represented separated for both study groups.

		Intervention group		Control group		*p* value
		Successful first attempt (*N* = 278)	Failed first attempt (*N* = 50)	Successful first attempt (*N* = 260)	Failed first attempt (*N* = 70)	
A-DIVA risk profile	Low risk	232 (96%)	10 (4%)	227 (90%)	25 (10%)	0.012
	Moderate risk	39 (64%)	22 (36%)	31 (53%)	27 (47%)	0.246
	High risk	7 (29%)	18 (71%)	2 (10%)	18 (90%)	0.134
History of difficult access	Yes	53 (19%)	20 (40%)	24 (9%)	32 (46%)	0.088
	No	225 (81%)	30 (60%)	236 (91%)	38 (54%)	
Expectation of difficult access	Yes	58 (21%)	19 (38%)	58 (22%)	42 (60%)	0.058
	No	220 (79%)	31 (62%)	202 (78%)	28 (40%)	
Absence of palpable veins	Yes	20 (7%)	10 (20%)	8 (3%)	50 (71%)	0.004
	No	258 (93%)	40 (60%)	252 (97%)	20 (29%)	
Absence of visible veins	Yes	24 (9%)	17 (34%)	18 (7%)	52 (74%)	0.003
	No	254 (91%)	33 (66%)	242 (93%)	18 (26%)	
Diameter less than 3 mm	Yes	63 (23%)	18 (36%)	31 (12%)	9 (13%)	0.002
	No	215 (77%)	32 (64%)	229 (88%)	61 (87%)	
Number of attempts		1.0 ± 0.0	2.2 ± 1.1	1.0 ± 0.0	2.8 ± 1.4	<0.001
Time	Minutes	2.1 ± 2.7	4.9 ± 3.4	2.6 ± 3.1	4.2 ± 3.1	<0.001
Pain	VNRS	1.8 ± 1.5	3.9 ± 2.4	1.9 ± 1.7	4.8 ± 2.9	<0.001

Data are represented as mean ± standard deviation and absolute numbers (percentages).

moderate risk profile and high risk profile when compared to those in the control group, no significance was detected ($\chi^2 = 1.35$, df = 1, $p = 0.246$ and $\chi^2 = 2.25$, df = 1, $p = 0.134$, respectively).

Unless the represented outcomes of statistical testing of the variables as represented in Table 3, resulted subgroup analyses in different results. When comparing the intervention and control group in patients with a successful first attempt, less time to obtain vascular access ($U = 32{,}591$, $Z = -1.66$, $p = 0.097$) and pain as experienced upon the procedure ($U = 35{,}981$, $Z = -0.46$, $p = 0.649$) were recorded. For patients with an unsuccessful first attempt, less attempts were needed to obtain vascular access ($U = 1088$, $Z = -0.27$, $p = 0.789$), less pain was experienced ($U = 962$, $Z = -1.16$, $p = 0.248$), but more time was needed ($U = 322$, $Z = -5.65$, $p < 0.001$).

The relation between the type of catheter inserted (control group or intervention group) and the first attempt success was significant, indicating the notched needle to increase the first attempt success rate ($\rho = 0.11$, $p = 0.004$). A patients history for a difficult intravenous access ($\rho = 0.66$, $p < 0.001$), a practitioners expectation for a difficult intravenous access ($\rho = 0.77$, $p = 0.048$), an inability to detect the target vein by palpating ($\rho = 0.12$, $p = 0.003$) and visualizing ($\rho = 0.12$, $p = 0.003$) the extremity, a target vein with a diameter <3 mm ($\rho = 0.17$, $p < 0.001$), and therefore the A-DIVA score ($\rho = 0.51$, $p < 0.001$), had a positive relation with the outcome of interest as well. Any correlation between other collected variables could not be obtained, assuming that the outcome measure was not biased by any of these factors.

Discussion

The current study focused on the effect of peripheral intravenous cannulation with a notched needle on the first attempt success rate. A first attempt success rate of 85% was recorded in patients in whom a notched needle was inserted, whereas a success rate of 79% we seen in patients in whom a non-notched needle was inserted. This study offers insight on the impact of the device itself. First attempt cannulation success can be increased slightly by choosing a notched needle, in contrast to the traditional non-notched needle. This can be an important issue, especially in those patients with a known risk for failed cannulation.

Failed first attempts of peripheral intravenous cannulation may negatively affect patients by causing anxiety, unnecessary pain, a delay in therapy, and loss of potential venous access sites.[25,26] Moreover, increasing first attempt success rates may potentially improve patient satisfaction, turnover and throughput in the hospital, and outcomes related to various time-sensitive diseases.[25] Due to the high prevalence of the procedure of peripheral intravenous cannulation and the relatively high incidence of failure on the first attempt, was this subject of many recently performed studies.[27] Most of these studies considered few aspects simultaneously and focused mostly on patient- or practitioner-related factors, without covering device-related factors.[28,29] To underline this, successful peripheral intravenous cannulation depends on the coherence between patient-related factors, practitioner-related factors, and device-related factors.[29]

The original Rochester over-the-needle principle, as developed by Massa in the 1950s, is still the most common used technique for catheter insertion.[30,31] After properly aligning the needle and catheter tip, the practitioner performs the venipuncture. The device will be advanced until the practitioners obtains blood flowing into the flashback chamber. Upon visualization of blood return, the entire catheter and needle unit need to be slightly lowered and advance to ensure the catheter tip is within the vessel. Hereafter, the catheter will be advanced off the needle into the vein. It seems trivial that the earlier one sees blood flashback after penetrating the vein, the more likely one is to stop advancing the needle and less likely to traverse the opposite venous wall. This is currently provided by notched needles, which reveal the presence of blood almost the instant the vein wall is penetrated.[10]

Early recognition of the patient at risk for a difficult intravenous access is important to apply strategies that are able to increase the likelihood of success, which can be performed with the A-DIVA scale.[5] No differences were obtained in the distribution of patients with regard to their risk profile according to the A-DIVA scale in the current study. Although inserting a notched needle resulted in significant higher first attempt success rates, failed this study to demonstrate a success rate of 90% on the first attempt of peripheral intravenous cannulation. A success rate of 90% on the first attempt was denoted as clinically relevant and acceptable in clinical practice, although there is no consensus or agreement about the minimal accepted success rate.[5] The success rate of 82% on the first attempt of peripheral intravenous cannulation as observed in the current study, corresponds to the first attempt success rates in other publications.[5,32,33] Success rates of 90% and 96%, however, were recorded in patients with a low risk profile according to the A-DIVA scale in the control and intervention group respectively, showing significant higher first attempt success rates in patients in which a notched needle was inserted. For patients in the moderate and high risk groups, success rates differed not significantly between both study groups, although first attempt success rates were slightly higher in the intervention groups.

Patients with a high risk profile according to the A-DIVA scale suffer from a higher a priori risk for failed cannulation. Important risk factors for failed cannulation are smaller sized veins, and the impossibility to detect suitable veins by palpating and visualizing the extremity.[5,34] Witting et al.[35] found in their observational study that success rates were significantly higher for veins at low to moderate depth, and in those with a targeted diameter greater than or equal to 0.4 square centimeter. Transfixation by the intravenous catheter will occur most easily in patients with small veins, but is thought to be prevented by using a notched needle. However, it was unable to prove this expectation, with an insignificant difference between the intervention and control group for patients with a diameter of the target vein <3 mm. Furthermore, no significance in first attempt success could be obtained regarding patients with no visible and palpable apparent veins between the intervention and control groups on the first attempt success rate.

Veins on the dorsal site of the hand are, in general, smaller when compared to those on the lower arm or in the elbow crease, but are more superficial.[4] Therefore, veins on the dorsum of the hand are easier to detect by palpating and visualizing the extremity.[36] Nevertheless, cannulation of veins on the forearm is preferred, because of its reduced risk of catheter dislodgement, extravasation, and obstruction due to movement of the extremity.[4,37] Despite early recognition of flashback of blood being a helpful aid when a blind trial-and-error strategy is applied in patients with no visual and palpable apparent veins, it is strongly discouraged to apply this strategy due to its risks. It is established that a failed first attempt of peripheral intravenous cannulation is likewise expected in patients with a high risk profile according to the A-DIVA scale due to smaller peripheral veins and the impossibly to detect them, for instance.[4,26] Therefore, according to international guidelines, it is recommended to use real-time ultrasound guidance or NIR in patients with a difficult intravenous access.[9,16,38]

Perchance will the combination of inserting a notched needle with ultrasound-guidance further increase first attempt success rates, although experienced ultrasound users determine whether or not the catheter is in the vein based on what is seen on the ultrasound monitor instead of watching the flashback of blood.[17] There is a discrepancy between what is shown on the ultrasound monitor and the underlying anatomy, which is reinforced by the reverberation of the needle and the small target of the vein.[38,39] The advantage of the early visualization of blood flashback with a notched needle can possibly respond to this problem, which is the delay between the action in real-time and the projection on the ultrasound monitor.[39] To add on this, it would be interesting to discover the actual difference in the moment until the flashback of blood is obtained in catheters with a notched needle and those without. Notwithstanding, focus of further research should be on increasing the first attempt success rate in patients at moderate and high risk according to the A-DIVA scale. Successful ultrasound-guided vascular access by experienced clinicians may be influenced by early blood return in the flashback chamber, although blood flashback and flushing without obstruction or discomfort are the main factors for successful cannulation.

Limitations

The current study was not performed as a blinded trial. This is, naturally, impossible due to the simple fact that the practitioner will always know which catheter is inserted. To add on this, blind insertion of a catheter nullifies the effect of the notched needle and its early visualization of

the flashback of blood.[40,41] Although randomization is key to ensure the balance of confounders between study groups, was this study performed as a block-randomized trial.[42] Block randomization ensures that the number of patients between the groups is equal, and is easier to perform with respect to logistic and organizational aspects.[42,43] Nonetheless, block randomization affords big rewards in scientific accuracy and credibility.[42] Furthermore, the Hawthorne effect may possibly have affected the study results, because the practitioner was aware of the aim of this study.[44,45] The Hawthorne effect can both provide insight into individuals' behavior and confound the interpretation of experimental manipulations, and therefore influence the procedure of intravenous cannulation as performed by the practitioner.

The choice of the cannulation site and the peripheral intravenous catheter is mostly guided by habit, peer-advice, and "eye-balling" the patient.[4] The smallest possible gauge needle related to the indication for intravenous treatment and the size of the vein need to be chosen. During this study, practitioners were free to choose the cannulation site and catheter size, the study design did not account for specific vein selection. This could have possibly influenced study results. For instance, selecting the cephalic vein in the forearm is often the largest and straightest vein out of an area of flexion, and will therefore create an increased à priori first attempt cannulation success. Likewise, vein selection has an impact of first attempt cannulation success.

Conclusion

First attempt cannulation success of peripheral intravenous cannulation was increased in patients in which a notched needle was inserted, when compared to those in which a traditional non-notched needle was inserted. This study was unable to reach a first attempt success rate of 90% throughout the total cohort of included patients. In patients at low risk for a difficult intravenous access according to the A-DIVA scale, first attempt cannulation success increased up to 96%. Despite the fact that first attempt success rates in patients at high risk for a difficult intravenous access were higher after inserting a notched needle when compared to those who got a non-notched needle inserted, should those patients be referred to a specialized practitioner with advanced knowledge and experience in ultrasound-guided intravenous cannulation. In our believe, it should be possible to reach a 90% cannulation success when various interventions are combined and multiple conditions are met, including the use of ultrasound or NIR by experienced and trained practitioners, as well as with optimal and comprehensive training of practitioners who are responsible for the insertion of vascular access devices. Nonetheless, any increase in first attempt success that can be achieved by simple interventions as changing the type of peripheral intravenous catheter itself, indicates a potential impact by the design of the device on the outcome of the procedure.

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Author contributions

All authors have agreed on the final version, and those listed as authors are qualified for authorship according to the following criteria: Have made substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data; been involved in drafting the manuscript or revising it critically for important intellectual content; given final approval of the version to be published. Each author should have participated sufficiently in the work to take public responsibility for appropriate portions of the content; and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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