ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 10, Issue, 09, pp. 39935-39938, September, 2020
https://doi.org/10.37118/ijdr.19919.09.2020

RESEARCH ARTICLE OPEN ACCESS

PROTOTYPE WITH TWO WAVELENGTHS TO LOCATE THE VENIPUNCTURE SITE

Pedro Coelho Nogueira Diógenes[1], Marcela Sobreira Kubrusly[2], Ana Paula Bomfim Soares Campelo[3], Anderson Magalhaes Souza[2], Claudia Roberta de Andrade[4], Marcos kubusly[4] and Marcio Wilker Soares Campelo*[4]

[1]Fellow Master Degree, Postgraduate Program (TEMIS), Centro Universitário Christus, Fortaleza-Ce, Brazil
[2]Student of the Medical School, Centro Universitário Christus, Fortaleza-Ce, Brazil
[3]PhD, Researcher, Full professor, Medical School, Centro Universitário Christus, Fortaleza-Ce, Brazil
[4]PhD, Reseachers of INPEC and Full Professor, Medical School and Postgraduate program (TEMIS), Christus university center, Fortaleza-Ce, Brazil

ARTICLE INFO

Article History:
Received 14th June 2020
Received in revised form
09th July 2020
Accepted 21st August 2020
Published online 23rd September 2020

Key Words:
Vein; Puncture;
Phleboscope; Arms.

****Corresponding author:***
Marcio Wilker Soares Campelo

ABSTRACT

Venipuncture is often performed in health care for collecting blood samples or infusion of medications. Up to about 20% of venipuncture is unsuccessful on the first attempt, often due to difficulty in locating veins. The prototype developed aims to facilitate the visualization of veins in the upper limbs. A luminous device was made using two monochromatic waves of light (620–750 nm and 495–570 nm) simultaneously. Each wave on a Y prototype arm. The usability and utility of the prototype was tested using the System Usability Scale with answers based on the Likert scale applied to volunteer users. The veins were located in two groups of patients: patients with normal body mass index (BMI) and with BMI> 35. On the Bangor scale, the usability of the prototype was classified as A and on the Lewis &Sauro scale as A +. There was no statistical difference (p <0.05) in the time to identify the vein between the groups. Regardless of the body mass index, more than 90% of the venipuncture sites identified obtained maximum scores. In conclusion, the use of two waves of light simultaneously is easy to use with utility in locating the ideal vein for puncture.

Citation: ***Pedro Coelho Nogueira Diógenes, Marcela Sobreira Kubrusly, Ana Paula Bomfim Soares Campelo, Anderson Magalhaes Souza, Claudia Roberta de Andrade, Marcos kubusly and Marcio Wilker Soares Campelo.*** "Prototype with two wavelengths to locate the venipuncture site*", International Journal of Development Research*, 10, (09), 39935-39938.

INTRODUCTION

The superficial veins of the limbs are the main access route, used for insertion of catheters, collection of blood samples necessary in the hematological and biochemical, bacteriological and immunological analysis, infusion of various medications, nutrients and replacement of blood elements (Griffiths *et al*. 2017, Lima-Oliveira *et al*. 2011, Sebbane *et al*. 2013). Currently, for an adequate peripheral venous access, recommended to puncture of the superficial venous system of the upper limbs, in the most distal position possible, with a distance of at least 4 cm from the joints, in addition to avoiding bifurcations and tortuosities (Fukuroku *et al*. 2016). In Brazil and in most countries, venipuncture using anatomical reference points is the method of choice for peripheral venous access. Prospective studies show that about 20% of puncture attempts using anatomical points, even by experienced physician, are not successful on the first attempt (Sebbane *et al*. 2013, Fukuroku *et al*. 2016, Lapostolle *et al*. 2007, John 2007). The numerous reports have emerged describing the peripheral nerve injuries due to improper venipuncture (Stevens, Mahadevan, and Moss 2012, Ramos 2014). However, the magnitude of this issue is very likely to have been underestimated (Moore and Stringer 2012). Indeed, in the US (ultrasound) venipuncture has been reported to be the number one cause of injury among patients. This reality has lead to many efforts to identify optimal venipuncture technique (Parisotto *et al*. 2014). In addition, there have been many reports on the development of various tools and methods for improving the success rate of venipuncture, in practice (Balter *et al*. 2015, Juric *et al*. 2014). In the 1970s, the use of transillumination (originated from diaphanoscopy - Greek diaphanés, meaning transparent, and skopeĩn, which means to observe) was started, which refers to the use of light through a body area or organ to evaluate abnormalities. Normally the ambient light is reduced to provide a better view of the illuminated area (Lapostolle *et al*. 2007, John 2007). Transillumination has been used to visualize superficial blood vessels to obtain vascular access for several years. Currently, exist several devices with this aim, however, limiting the light to the wavelength of 610 to 660 nm and maintaining a visualization effectiveness similar to white light, with less heating of the tissues (John 2007, Stevens, Mahadevan, and Moss 2012). The purpose of this study was to evaluate the usability/learning of the new device (F500/700) with two wavelength 500 and 700 nm for the selection of venipuncture sites for indwelling needle placement in the forearm for enhancing learning for novice students and extends current knowledge regarding the application of this technology in medical education, to ensure the provision safe and precise care of obese patients.

MATERIALS AND METHODS

This study was submitted to the Research Ethics Committee of Center Educational Christus (UNICHRISTUS), approved under protocol number 1.881.447/2016, following principles of bioethics in resolution No. 466, December/2012 (Brazil) andconduced in compliance with the Helsinki Declaration of 1975, as revised in 2008 (www.wma.net/e/policy/b3.htm) and Resolution 196/96 of the Brazilian National Health Service.

New device components (F500/700): The structure in Y was made using polyethylene and contents: LED lights with wavelength of 500 nm with 2v/20mA and 700 nm with 2.5v/20 mA; 6.8 – 47 Ω resistors; I/0 key with 2 levels of intensity adjustment; internal rechargeable battery of 3.8 V. Product patent deposited number # BR 20 2017 028345 9, for details the website of the National Institute of Industrial Property (INPI).

Experimental flowchart: Previous studies showed that the System Usability Score (SUS) is able to reach a correct diagnosis about the usability of a product when the sample is at least 12 participants. Participated voluntarily in this study 13 students to operate the F500/F700 of the Medicine graduation of the University Center Christus, where they received basic lessons about anatomy and puncture peripheral venous without viewing equipment. Each participant evaluated the venous system of six upper limbs, in patients with Body Mass Index below 35 and patients with Body Mass Index over 35, using the new equipment (F500/700), searching of a better option for venous puncture. The using time was measured in each limb for each one of the upper limbs (left and right), as the location of the chosen vein was registered based on the quantitative topic. After using the device on 12 upper limbs for venous localization, the examiner (medical student) responded to a survey to investigate an opinion on the use / learning of the device. Using a like Likert scale who then generated a score in the evaluation of the device. The mean time of venous location was measured and the vein identified as the best option was scored according to the criteria published in a previous study (Sebbane *et al*. 2013).

Quantitative measures

Time for venous location: It was verified with a digital timer the time that the participant took to identify the vein in each limb of each volunteer patient.

Evaluation of the venous site more adequate for puncture: It was observed that the venous site is classified according to the characteristics informed in the table 1 and scored according to the risk of complications (Sebbane *et al*. 2013).

Statistical analysis: Data were expressed as mean ± SEM. After a Kolmogorov–Smirnov test of normality, parametric data were submitted to unpaired t test and nonparametric data were analyzed mann-whintney. The level of statistical significance was set at 5%.

RESULTS

The prototype F500/700 developed: The device was developed at a cost of R$ 152,50 with the materials that include a polyethylene fairing fixed with a glue of cyanoacrylate, LEDs mounted on the teflon board, some resistors, cathodes and anodes to form the electric circuit, always involved with a non-conductive material to protect the user (see Figure 1 A, B and C). This cost represents 10% of the value of products sold on the market actually.

Table 1. Description of the identified vein localization

	(0) YES	(1)PROBABLE	(2) NO
Short venoussegment			
Veinbranching			
Local cutaneousnerve			
<4cm from cubital fossa			

Note: the best site por vein pucture is with score = 10 and the worse is score = 0

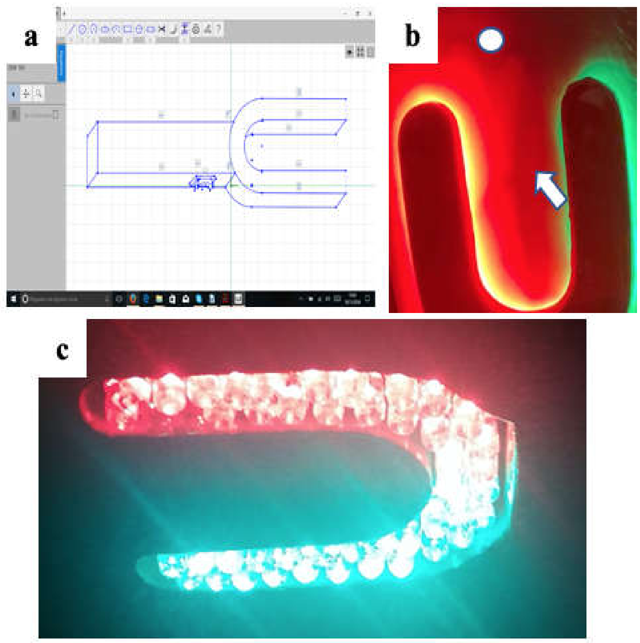

Figure 1. a) Schematic drawing of the F400 / 500. In the U-frame, the LEDs were placed, the I / O switch was placed laterally on the support segment where the electrical circuit is also located. b) The led on showing the two wavelengths. c) Vein in the forearm being viewed with the two-wavelength device. Arrow identifying rectilinear vein segment suitable for puncture. Circle idenfying tortuous venous segment (inappropriate place for puncture).

Quantitative measures: The results showed no statistical difference about the time of localization between individuals with BMI >35 (28.38 $\pm$ 2.63) and BMI <35 (30.78 $\pm$ 2.69) ($p>0.05$) (see Figure 2).

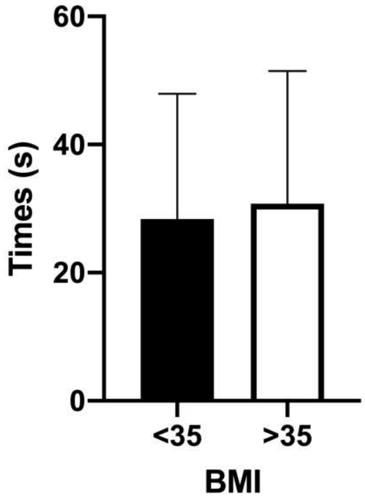

Figure 2. Comparison venous localization time between individuals with BMI <35 vs. BMI >35 (p>0.05) – Data expressed as means ± SEM. Abbreviation: BMI = body mass index

There was no statistical difference between the groups BMI <35 (9.91 ±0.47) vs. BMI >35 (9.79 ± 0.73) in relation to the quality of puncture site with F400/500 (see Figure 3).

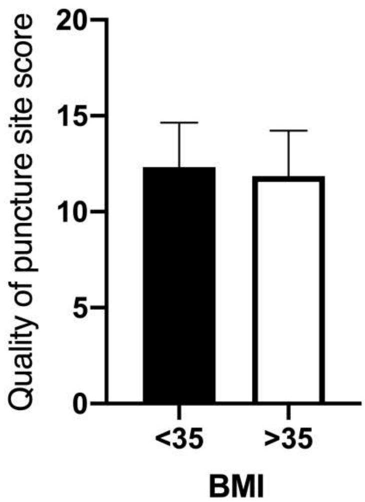

Figure 3. Number of points (score) of the best venous puncture site found in the upper limbs with F500/700. Data expressed as means ± SD

DISCUSSION

There are devices to increase prominence vizualization of peripheral veins to assist venous puncture which include ultra-sonography, infrared visualizers and transilluminators. Ultra-sonography has a steep learning curve and is operator dependent and cumbersome to obtain and utilize (Dietrich *et al*. 2016). Infrared visualizers (Yen and Gorelick 2013) identify hemoglobin, while transilluminators (Katsogridakis *et al*. 2008) work on the differential absorption of light in hemoglobin. Both devices cause veins to show up as silhouette among the surround tissue. The greatest downsides of these devices are its high cost and the difficulty in procurement, especially in resource poor countries. The device developed is a vein locator and it is focused on the visualization of superficial vascular structures, up to five millimeters depth. It's inovation is on the simultaneous use of LED lights with emission of light beam in two different spectrums of color, red and green, and it possesses a fixation track on the limb that it will be used to identify the vein, resulting on more mobility to the operator. At up portion of the device are located the LED lights and they are splited in two different spectrums of color: the right arm of the device emits red light on the 620-750nm wavelength, and the left arm emits green light on the 495-570nm wavelength. The bottom part consists on the manual handle and fixation to the limb of the puncture. In this part of the device are located the rechargeable batteries. The LED lamps are electronic components that has lower consumption and low heat emission if compared to other kinds of lamps. The LED lights need less power or electrical potential difference the generate the same bright flow as an incandescent light(Fukuroku *et al*. 2016)which makes them safe for use in the skin such as in the treatments for psoriasis (Ablon 2010). In addition, the LED lights save up to 80% of electricity. Despite being considered cold lamps by not presenting infrared light beam the LEDs they dissipate the power in heat form through the cooper track where the LEDs are glued(Gu, Baker, and Narendran 2007). This efficiency in lower heat production makes the use of LED lamps ideal for skin contact necessary for the venous visualization.

The energy source is connected to the electric circuit on the device's handle to a I/0 engage key that controls the light emission, allowing or not that the electrical potential difference generated through the chemical source of energy, the batteries, get to the LED lamps so that the energy can be transformed in a red or green light beam (Ohno 2004). The cutaneous transilumination devices available in the Brazilian market using LED lamps do not come with a fixation to the limb. Besides the infrared devices have size and weight much more elevated which reduces its portability and also it costs much more than the devices that transilluminates by direct contact with the skin through LED light. The device developed has low cost, is portable and, by presenting fixation with side handles and sticker tracks, it keeps the freedom of the non-dominant hand to do the venous puncture and maintaining the venous trajectory between the arms of the device. The using of a transiluminator to help in the venous puncture has solid theoretic basis and its use is not disseminated because of the cost involved in the devices acquisition. In conclusion, the prototype innovates by transilluminating the skin using LED lights in two different monochromatic wavelengths (red and green) and showed no difference in time and quality of the venous site between patients with different BMI.

Acknowledgments

The authors acknowledge UNICHRISTUS for the scientific initiation program, INPEC for support and facility sharing.

Conflict of interest: The authors declare that they have no conflict of interest.

REFERENCES

Ablon, G. 2010. "Combination 830-nm and 633-nm light-emitting diode phototherapy shows promise in the treatment of recalcitrant psoriasis: preliminary findings." *Photomed Laser Surg* 28 (1):141-6. doi: 10.1089/pho.2009.2484.

Balter, M. L., A. I. Chen, T. J. Maguire, and M. L. Yarmush. 2015. "The System Design and Evaluation of a 7-DOF Image-Guided Venipuncture Robot." *IEEE Trans Robot* 31 (4):1044-1053. doi: 10.1109/TRO.2015.2452776.

Dietrich, C. F., R. Horn, S. Morf, L. Chiorean, Y. Dong, X. W. Cui, N. S. Atkinson, and C. Jenssen. 2016. "Ultrasound-guided central vascular interventions, comments on the European Federation of Societies for Ultrasound in Medicine and Biology guidelines on interventional ultrasound." *J Thorac Dis* 8 (9):E851-E868. doi: 10.21037/jtd.2016.08.49.

Fukuroku, K., Y. Narita, Y. Taneda, S. Kobayashi, and A. A. Gayle. 2016. "Does infrared visualization improve selection of venipuncture sites for indwelling needle at the forearm in second-year nursing students?" *Nurse Educ Pract* 18:1-9. doi: 10.1016/j.nepr.2016.02.005.

Griffiths, J., A. Carnegie, R. Kendall, and R. Madan. 2017. "A randomised crossover study to compare the cross-sectional and longitudinal approaches to ultrasound-guided peripheral venepuncture in a model." *Crit Ultrasound J* 9 (1):9. doi: 10.1186/s13089-017-0064-1.

Gu, Yimin, Alex Baker, and Nadarajah Narendran. 2007. *Investigation of thermal management technique in blue LED airport taxiway fixtures*. Vol. 6669, *Optical Engineering + Applications*: SPIE.

John, J. M. 2007. "Transillumination for vascular access: old concept, new technology." *Paediatr Anaesth* 17 (2):197-8. doi: 10.1111/j.1460-9592.2006.02061.x.

Juric, S., V. Flis, M. Debevc, A. Holzinger, and B. Zalik. 2014. "Towards a low-cost mobile subcutaneous vein detection solution using near-infrared spectroscopy." *ScientificWorldJournal* 2014:365902. doi: 10.1155/2014/365902.

Katsogridakis, Y. L., R. Seshadri, C. Sullivan, and M. L. Waltzman. 2008. "Veinlite transillumination in the pediatric emergency department: a therapeutic interventional trial." *Pediatr Emerg Care* 24 (2):83-8. doi: 10.1097/PEC.0b013e318163db5f.

Lapostolle, F., J. Catineau, B. Garrigue, V. Monmarteau, T. Houssaye, I. Vecci, V. Tréoux, B. Hospital, N. Crocheton, and F. Adnet. 2007. "Prospective evaluation of peripheral venous access difficulty in emergency care." *Intensive Care Med* 33 (8):1452-7. doi: 10.1007/s00134-007-0634-y.

Lima-Oliveira, G., G. Lippi, G. L. Salvagno, M. Montagnana, M. Scartezini, G. C. Guidi, and G. Picheth. 2011. "Transillumination: a new tool to eliminate the impact of venous stasis during the procedure for the collection of diagnostic blood specimens for routine haematological testing." *Int J Lab Hematol* 33 (5):457-62. doi: 10.1111/j.1751-553X.2011.01305.x.

Moore, A. E., and M. D. Stringer. 2012. "Venepuncture-associated peripheral nerve injuries." *Clin Anat* 25 (8):1099; author reply 1100. doi: 10.1002/ca.22148.

Ohno, Yoahihiro. 2004. "Color rendering and luminous efficacy of white LED spectra." *Proc. SPIE*:88-98. doi: 10.1117/12.565757.

Parisotto, M. T., V. U. Schoder, C. Miriunis, A. H. Grassmann, L. P. Scatizzi, P. Kaufmann, A. Stopper, and D. Marcelli. 2014. "Cannulation technique influences arteriovenous fistula and graft survival." *Kidney Int* 86 (4):790-7. doi: 10.1038/ki.2014.96.

Ramos, J. A. 2014. "Venipuncture-related lateral antebrachial cutaneous nerve injury: what to know?" *Braz J Anesthesiol* 64 (2):131-3. doi: 10.1016/j.bjane.2013.06.003.

Sebbane, M., P. G. Claret, S. Lefebvre, G. Mercier, J. Rubenovitch, R. Jreige, J. J. Eledjam, and J. E. de La Coussaye. 2013. "Predicting peripheral venous access difficulty in the emergency department using body mass index and a clinical evaluation of venous accessibility." *J Emerg Med* 44 (2):299-305. doi: 10.1016/j.jemermed.2012.07.051.

Stevens, R. J., V. Mahadevan, and A. L. Moss. 2012. "Injury to the lateral cutaneous nerve of forearm after venous cannulation: a case report and literature review." *Clin Anat* 25 (5):659-62. doi: 10.1002/ca.21285.

Yen, K., and M. H. Gorelick. 2013. "New biomedical devices that use near-infrared technology to assist with phlebotomy and vascular access." *Pediatr Emerg Care* 29 (3):383-5; quiz 386-7. doi: 10.1097/PEC.0b013e31828680f9.

****