

## Near-infrared light devices utilized during the peripheral venous catheterization of the elderly: a scoping review protocol on device characteristics and methods of use

Características e métodos de utilização de dispositivos de luz quase-infravermelha utilizados na cateterização venosa periférica de idosos: um protocolo de scoping review

Características y métodos de utilización de dispositivos de luz casi-infrarroja utilizados en la cateterización venosa periférica de ancianos: un protocolo de scoping review

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### ABSTRACT

**Background:** Peripheral venous catheterization is the most performed clinical procedure by health professionals in hospital settings. However, elderly patients often display a number of factors that increase difficulty in the selection of an optimal puncture site, supporting the need to use auxiliary devices to reduce associated complications and costs. In the literature, near-infrared light emerges as a standard practice in these scenarios; however, there are no known studies on these devices' characteristics and methods of use. **Objective:** To map the available evidence on near-infrared light devices used in the peripheral venous catheterization of the elderly, as well as identify its characteristics and methods of use. **Review method:** Methodology proposed by the Joanna Briggs Institute. A scoping review protocol was established, suitable to each database/repository, with the purpose of identifying relevant studies that meet the outlined criteria. Two independent reviewers will assess all articles for relevance, as well as perform data extraction and synthesis. **Conclusion:** This scoping review is expected to contribute to the critical analysis of the current near-infrared light devices in use, highlighting their methods of use, potentialities and gaps. Furthermore, this review may substance the development of a new near-infrared light device that enhances the efficacy and quality of the procedure.

**Keywords:** catheterization, peripheral; spectroscopy, near-infrared; medical devices, elderly, scoping review.

### RESUMO

**Introdução:** A cateterização venosa periférica é o procedimento clínico mais frequentemente realizado pelos profissionais de saúde em contexto hospitalar. Todavia, os doentes idosos são detentores de diversos fatores que aumentam a dificuldade na seleção de um local ideal de punção, sustentando a necessidade de se utilizarem dispositivos auxiliares para reduzir as complicações e custos associados. Na literatura, a utilização da luz quase-infravermelha surge como uma prática recomendada nestes contextos; no entanto, não existe evidência produzida sobre as características e métodos de uso destes dispositivos. **Objetivo:** Mapear a evidência disponível sobre dispositivos de luz quase-infravermelha utilizados na cateterização venosa periférica de idosos, bem como identificar as suas características e métodos de uso. **Método de Revisão:** Metodologia proposta

pelo Joanna Briggs Instituto. Foi estabelecido um protocolo de *scoping review* adequado a cada base de dados/repositório, com o objetivo de identificar estudos relevantes que atendam aos critérios de inclusão delineados. Dois revisores independentes avaliarão todos os artigos quanto à sua relevância, bem como realizarão a extração e síntese de dados. **Conclusão:** Espera-se que esta *scoping review* contribua para a análise crítica dos atuais dispositivos de luz quase-infravermelha existentes, destacando os seus métodos de utilização, potencialidades e lacunas. Adicionalmente, esta revisão poderá substanciar o desenvolvimento de um novo dispositivo que potencialize a eficácia e a qualidade do procedimento.

**Palavras-chave:** Cateterismo Periférico; Luz quase-infravermelha; dispositivos médicos; idosos; scoping review

## Introduction

Population ageing is a phenomenon affecting most countries around the world (OECD, 2017). By 2050, 79% of the population will be 60 years of age or over, amounting to nearly 1.6 billion people (Department of Economic and Social Affairs of the United Nations Secretariat, 2007). It is estimated that almost half of 65–74 year-olds have five or more chronic health conditions, and this may reach 70% once individuals are aged over 85 years (Lomonte et al., 2016). This exponential growth is expected to place a substantial demand on healthcare systems worldwide due to the intensive use of healthcare services, specifically acute settings (Brandão, Ribeiro, Freitas & Paúl, 2017).

In acute clinical settings, the insertion of peripheral venous catheters (PVC) is the most often performed invasive procedure, and there is evidence that up to 96.7% of patients need to have a PVC inserted (Braga, 2017; Grüne et al., 2004, Wallis et al., 2014). In this sense, PVC have become an indispensable resource in acute care for the intravenous administration of medications, solutions, blood components, parenteral nutrition and diagnostic purposes (Braga et al., 2018).

Traditionally, health professionals detect and select a new venous access using the landmark technique (Infusion Nurses Society, 2016). This technique involves applying a tourniquet at a proximal location to the insertion site, promoting venous distention, followed by the palpation and observation of the limb (Infusion Nurses Society, 2016; Oliveira et al., 2018).

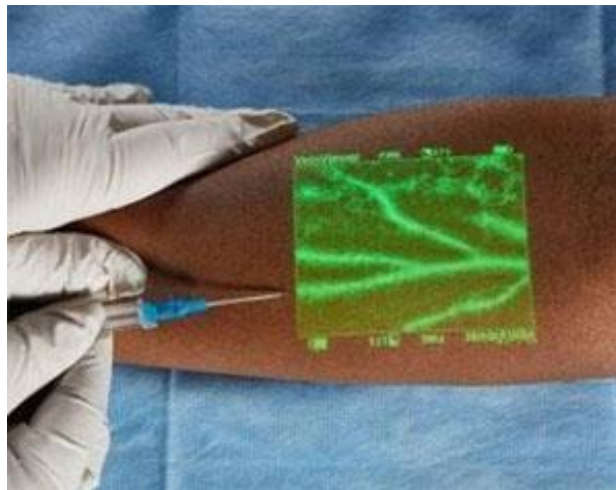
However, this technique may not be suitable for the elderly population, since they often display a number of factors that increase difficulty, such as: disease processes that result in structural vessel changes (eg, diabetes, hypertension); history of recurrent venipuncture and/or extensive courses of infusion therapy; variations in skin such as excessive hair and scars; and advanced age (Infusion Nurses Society, 2016; Royal College of Nursing, 2016).

Guidelines state that puncture should be attempted only twice per professional up to a maximum of four attempts (Infusion Nurses Society, 2016). However, against this

recommendation, there is evidence that the total number of puncture attempts amounts to 49 times, at an average of 6.5 times per patient (Braga, 2017).

In this regard, as a practice standard, international guidelines recommend the use of near-infrared light technology to aid health professionals in "locating viable superficial peripheral venous sites and decreasing procedure time for short peripheral catheter insertion" (Infusion Nurses Society, 2016, p. 44).

Infrared technologies allow illuminating the vein with a near-infrared light, which is absorbed by blood and reflected by contiguous tissue (Figure 1). This technology can improve peripheral venous catheterization first-attempt success rates, reduce the number of associated complications, prevent health professionals' frustration and improve the patient's overall experience (Curtis et al., 2015; Fekonja & Pajnikihar, 2017; Sun et al., 2013).



*Figure 1.* Example of the use of near-infrared light in peripheral venous catheterization. Adapted from "Evaluating the Effectiveness of a Vascular Access Imaging Device Used in Training Recently Graduated Nurses" by Y. Murakami, Y. Ohno, M. Nishimura, M. Kido, and K. Yamada, 2017, *J. Robot. Mechatron.*, 29(2), pp. 346-352.

Existing technologies on the market include hands-free devices that enable the capture of an image of the peripheral venous network, reflecting it on the surface of the patient's skin or to a screen (Infusion Nurses Society, 2016). Health professionals can use a static process by imaging and marking the vein location on the skin or a dynamic process of using the image to guide catheter insertion (Infusion Nurses Society, 2016).

However, no studies are known that have mapped all the near-infrared light devices on the market, exploring which features of these devices enhance or limit their use in clinical practice. Furthermore, no studies have compared the various methods of device use, "leaving this

decision to the discretion of the clinician" (Infusion Nurses Society, 2016, p.45).

## **Review Method**

In order to review the existing evidence on this topic, a scoping review was outlined because its main purpose is to map the evidence available on a particular research focus and identify gaps as a primary effort to substantiate the development of a systematic literature review (Peters et al., 2017). Moreover, specific scoping reviews can assist health professionals during their decision-making process and clinical practice.

### ***Search strategy and study identification***

According to the Joanna Briggs Institute guidance (Peters et al., 2017), this scoping review will use the participants, concept, and context strategy (PCC). Concerning the participants, this review will focus on studies that include elderly people who need to have a PVC inserted. For the purpose of this review, we will adopt the cutoff age of 60+ years proposed by the United Nations to refer to elderly persons.

As regards the concept, it will include studies focused on near-infrared light devices used for peripheral venous catheterization. For the purpose of this scoping review, we will use the definition proposed by the Infusion Nurses Society (2016, p.150), that defines near-infrared light devices as those that operate within the range of 700 to 1000 nanometers on the electromagnetic spectrum and "may transilluminate the extremity and project the vessel image to a screen or by capturing an image of the superficial veins and reflecting it to the skin surface".

Concerning the context, all clinical settings and geographical regions will be included in this review. With regard to study design, this review will consider experimental and epidemiological designs, including randomized controlled studies, quasi-experimental studies, case and before-and-after studies. Moreover, this review will also consider literature reviews, observational studies, cross-sectional and longitudinal descriptive designs. Recognizing that the research question is intrinsically linked to the areas of innovation and technological development, other forms of gray literature such as academic dissertations and theses, opinion documents, reports and newsletters will be considered.

In relation to the search strategy and study identification, the following online databases will be searched: Cochrane Central Register of Controlled Trials, JBI Data- base of Systematic Reviews and Implementation Reports, Scopus, MEDLINE (via PubMed), CINAHL Complete (via EBSCO), and SciELO. The search for unpublished studies will be performed in OpenGrey, ProQuest, Scientific Open Access Repository of Portugal, and Banco de Teses CAPES.

Initial keywords and search expressions to be used will be: Catheter; Cannula; "vascular access devices"; "peripheral access"; "peripheral intravenous catheterization"; "peripheral venous catheterization"; "peripheral intravenous access"; "venous access"; "peripheral venous access"; infrared\*, NIR\*, Accuvein; "Active Vascular Imaging Navigation"; near-infrared\*; infra-red\*; VeinViewer\*; technolog\*; machine\*; light\*; device\*; "Spectroscopy, Near-Infrared". The search strategy will consider studies published until December 2018 in Portuguese, Spanish, French, and English.

### ***Data extraction***

Data will be extracted by two independent reviewers, using an extraction tool developed by the researchers consistent with the scoping review objective and questions (Figure 2). Throughout the data extraction process, this instrument can be revised and altered contingent on the researchers' requirements.

**Review title**  
Near-infrared light devices utilized during the peripheral venous catheterization of the elderly: a scoping review protocol on device characteristics and methods of use.

**Review questions:**

- What are the main characteristics of the current near-infrared light devices used in the peripheral venous catheterization of the elderly?
- What methods do health professionals employ when using near-infrared light devices for the peripheral venous catheterization of the elderly?
- What are most commonly advantages and disadvantages reported by health professionals regarding the use of near-infrared light devices for the peripheral intravenous catheterization of the elderly?

**Inclusion criteria**

- **Population**  
Studies that include elderly people, older than or equal to 60 years of age, who need to have a PVC inserted.
- **Concept**  
Studies focused on near-infrared light devices used for peripheral venous catheterization.
- **Context**  
All clinical settings and geographical regions.

Extraction of details and study characteristics

Authors:	
Year of Publication:	
Type of study:	
Study objectives:	
Clinical setting:	
Number of participants:	
Relevant concepts for the review question:	

Figure 2. Extraction tool designed by the research team.

### Data synthesis

Data will be presented in narrative form, using tables, consistent with the objective and focus of this scoping review. This process will be accomplished through consensus between two reviewers. Any disagreement will be resolved with a third reviewer.

In the review question “What are the main characteristics of the current near- infrared light devices used in the peripheral venous catheterization of the elderly?”, the tables and charts can include data indicated in Figure 3.

Study	Type of Device	Brand (if known)	Characteristics of the device	(...)

Figure 3. Data synthesis grid for the first review question.

In the review question “What methods do health professionals employ when using near-infrared light devices for the peripheral venous catheterization of the elderly?”, the tables and charts can include data indicated in Figure 4.

Study	Health professional using the device	Method employed	Guidelines/recommendations followed	(...)

Figure 4. Data synthesis grid for the second review question.

In the review question “What are most commonly advantages and disadvantages reported by health professionals regarding the use of near-infrared light devices for the peripheral intravenous catheterization of the elderly?”, the tables and charts can include data indicated in Figure 5.

Study	Reported advantages	Reported disadvantages	Associated complications	Strategies used to overcome potential complications	(...)

Figure 5. Data synthesis grid for the third review question.

## Conclusion

This scoping review will allow the mapping of the available evidence on current near-infrared light devices used in the peripheral venous catheterization of the elderly, contributing to the identification of their methods of use, potentialities and possible gaps, guiding health professionals and managers in the selection of the most suitable devices. In addition, this review may contribute to the creation of a new near-infrared light device, whose characteristics and methods of use enhance its effectiveness during the peripheral venous catheterization of the elderly, contributing not only to the quality and safety of the care provided, but also to the well-being of the elderly.

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