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## ABSTRACT

**Objective:** to analyze the scientific production regarding nursing care to patients using the Swan-Ganz catheter and nurses' knowledge about this device. **Method:** integrative literature review, with a search conducted in June and finalized in July 2020, in the Web of Science, PubMed, LILACS and SCIELO databases. **Results:** the sample comprised six studies, which were categorized according to the corpus of the study as: assistance regarding Swan-Ganz catheter care and nurses' knowledge about this device. It was identified in the scientific productions that for the provision of nursing care, it is important the professional's expertise to remove the catheter; the monitoring of pulmonary arterial pressure; the cleaning of the skin, additional dressing, among other actions. The nurses' knowledge was considered unsatisfactory, and difficulties in interpreting the information related to catheter use were also reported. **Conclusion:** nursing care to patients using this catheter corresponds to the monitoring and interpretation of parameters, prevention of infection associated with the catheter and its removal. Evidencia-se dificuldades entre os enfermeiros na interpretação dos dados coletados, apontando a necessidade de aprimoramento dos conhecimentos.

Descriptors: Swan-Ganz catheterism. Nursing care. Nurses and Nurses. Knowledge.

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## RESUMO

**Objetivo:** analisar a produção científica quanto a assistência de enfermagem ao paciente em uso de Cateter de Swan-Ganz e ao conhecimento dos enfermeiros relacionado a esse dispositivo. **Método:** revisão integrativa da literatura, com busca realizada no mês de junho e finalizada em julho de 2020, nas bases de dados da *Web of Science*, PubMed, LILACS e SCIELO. **Resultados:** Identificou-se nas produções científicas que para a prestação da assistência de enfermagem, torna-se importante a expertise do profissional em remover o cateter; o monitoramento da pressão arterial pulmonar; higienização da pele, curativo adicional, dentre outras ações. O conhecimento dos enfermeiros foi considerado insatisfatório e também foram relatadas dificuldades na interpretação das informações relacionadas ao uso do cateter. **Conclusão:** os cuidados de enfermagem ao paciente em uso deste cateter correspondem ao monitoramento e interpretação dos parâmetros, prevenção de infecção associada ao cateter e sua remoção. Evidencia-se dificuldades entre os enfermeiros na interpretação dos dados coletados, apontando a necessidade de aprimoramento dos conhecimentos. **Descritores:** Cateterismo de Swan-Ganz. Cuidados de Enfermagem. Enfermeiras e Enfermeiros. Conhecimento.

## RESUMEN

**Objetivo:** analizar la producción científica sobre la atención del enfermero al paciente que usa catéter de Swan-Ganz y el conocimiento de los enfermeros relacionado con este dispositivo. **Método:** revisión integradora de la literatura, la búsqueda se realizó en junio y julio de 2020, en las bases de datos de *Web of Science*, PubMed, LILACS y SCIELO. **Resultados:** la muestra estuvo compuesta por seis estudios, que fueron categorizados según el *corpus* del estudio en: atención sobre cómo realizar los cuidados del catéter de Swan-Ganz y conocimiento de los enfermeros sobre este dispositivo. Se identificó en los resultados científicos que, para la atención sanitaria, es importante la experiencia del profesional en la remoción del catéter; el monitoreo de la presión arterial pulmonar; la higienización de la piel, un apósito adicional, entre otras cosas. El conocimiento de los enfermeros se consideró insatisfactorio y también se manifestaron dificultades para interpretar la información relacionada con el uso del catéter. **Conclusión:** la atención de enfermería al paciente que usa este catéter implica el monitoreo y la interpretación de los parámetros, la prevención de la infección asociada al catéter y su remoción. Se observó que los enfermeros tenían dificultades para interpretar los datos obtenidos y se señaló que es necesario que mejoren sus conocimientos. **Descriptor:** Cateterismo de Swan-Ganz. Atención de enfermería. Enfermeras y Enfermeros. Conocimiento.

## INTRODUCTION

Hemodynamic monitoring is an important element of health care for critically ill patients. Knowledge of cardiovascular function, follow-up of therapeutic interventions and the need for differential diagnosis make monitoring techniques an essential component for the

management of these patients.<sup>1</sup> It constitutes an important ally in providing safe care, minimizing damage and encouraging professionals to use more effective interventions.

Measurement of pulmonary artery occlusion pressure and cardiac output form the basis of hemodynamic monitoring.

These procedures were performed only in the laboratory environment.<sup>2</sup> But this scenario was modified when the Pulmonary artery catheterization was first performed in the mid-1940s, under fluoroscopy guidance.<sup>3</sup> However, only in 1970, Swan and Ganz reported the use of a flexible catheter, directed flow, with a balloon at its end, to measure the filling pressure of the left ventricle, inserted at the edge of the bed, being used continuously.<sup>2</sup>

The Swan-Ganz catheter or Pulmonary Artery Catheter (PAC) is a sophisticated device used in invasive hemodynamic monitoring. It has several lumens capable of capturing the pressure of the different cardiac chambers, cardiac output and pulmonary artery pressure, providing important hemodynamic data. This catheter can be inserted into large vessels, such as the subclavian, internal jugular and femoral veins.<sup>4</sup> The PAC is considered the gold standard, as it allows the real-time verification of several parameters related to the pressures, volumes, resistances and flows of the cardiac chambers.<sup>5</sup>

The PAC allows the assessment of hemodynamic status with some reliability because it is a monitoring technique, with properties for diagnostic purposes.<sup>1</sup> It is used in intensive care areas, interventional cardiology laboratories and coronary units, with indication for hemodynamic

optimization preoperative care in high-risk patients, intraoperative monitoring and to assist in the management of severe conditions.<sup>6</sup>

To the intensive care professional, the CAP provides in addition to critical hemodynamic data that include cardiac output, mixed venous oxygen saturation, intrapulmonary and intracardiac pressures. These variables, together with the additional data obtained from the calculation of these measurements, such as pulmonary and systemic vascular resistance, right and left ventricular work rates, left ventricular end-systolic and end-diastolic indices, ventricular ejection fraction right, arterial and venous oxygen, oxygen consumption, oxygen delivery, and oxygen extraction ratio are used to guide the treatment of critically ill patients.<sup>7</sup>

The use of CAP is indicated to evaluate hemodynamic variables through serial measurements, in the face of acute heart failure, right ventricular infarction, refractory congestive heart failure, pulmonary hypertension, cardiogenic shock or hemodynamic instability, high risk in intra and postoperative periods. -operative, high-risk obstetric patients, medical emergencies (sepsis, drug intoxication, respiratory distress syndrome) among other conditions.<sup>8</sup>

The advantages of performing this procedure are related to the possibility of

being performed in bed, avoiding the transport of seriously ill patients; the catheter is flexible, with a padded tip by the balloon, cushioning the contact against the ventricular wall, to reduce arrhythmias; low morbidity associated with the procedure; pulmonary artery pressure more faithfully expresses myocardial function than central venous pressure; pressure and cardiac output measurements are simple, safe and can be repeated at short intervals; the tracings are of good quality and samples for oximetry can be easily taken.<sup>9</sup>

Although there are several advantages, many complications associated with this procedure are described in the literature, which may be related to venipuncture: (arterial puncture, pneumothorax, brachial plexus injury, Horner's syndrome, transient phrenic nerve injury and gas embolism); catheter passage (arrhythmias, transient right bundle branch block, kinking, damage to the valve systems, pulmonary artery rupture and right ventricular perforation) and related to the continuous presence of the catheter in the pulmonary artery (venous thrombosis at the insertion site, pulmonary infarction, endocarditis and sepsis).<sup>8,9</sup>

In a study carried out with physicians from several hospitals in Brazil, 59% of respondents reported using PAC for invasive hemodynamic monitoring, to the detriment of less invasive technologies,

despite the reduction in its use in recent years, as it is an invasive technology and is associated with potentially serious complications.<sup>1</sup>

An example of the decreasing use of this device for invasive hemodynamic monitoring can be evidenced in a cohort study involving Medicare beneficiaries, in the United States, where the rates of PAC use decreased by 67.8% from 1999 to 2013, while the rate of use of CAP in admissions for heart failure decreased from 1999 to 2009. The use of PAC in admissions for myocardial infarction and respiratory failure decreased during the study period.<sup>10</sup>

There are controversies reported in the use of PAC related to the increase in mortality rates and length of stay, in addition to high costs. This is because these variables would be associated with the lack of training of health professionals and, consequently, with the misinterpretation of the information obtained.<sup>5</sup>

The inadequate use of hemodynamic data by the health team has aroused the interest of the scientific community, because the lack of knowledge in the management of PAC is a variable that makes it difficult to verify the effectiveness of the catheter, leading to recommendations for the evaluation of the knowledge of these professionals and the review and modification of staff training and continuing education methods.<sup>11</sup>

Although there are several contraindications, it is a fact that the rational and well-justified use of the Swan-Ganz catheter is considered useful in the treatment of critically ill patients, requiring rigorous training for doctors and nurses, not only the technique for its insertion, but also for the interpretation of the data it provides.<sup>12</sup>

Thus, nursing care for patients using PAC requires a rigorous scientific foundation, associated with invasive and non-invasive parameters. The parameters used by nurses for the clinical assessment of patients undergoing hemodynamic monitoring by the CAP must be intrinsically related to the correct interpretation of these data.<sup>13</sup>

For its use, nursing care refers to the constant observation of changes in the patient's clinical status, evaluation of the effectiveness of treatments, evaluation of the catheter insertion site, dressing with aseptic technique, monitoring of complications and positioning of the catheter, patient in the supine position with the transducers correctly positioned to avoid reading errors.<sup>14</sup>

The role of the nurse, who is responsible for assisting critically ill patients with this type of monitoring, as a link within the interdisciplinary team is highlighted. However, there are limitations regarding the approach to this theme during

graduation, resulting in professionals with little experience, with unpreparedness to understand and lead this service. Therefore, the search for knowledge in this sector makes nurses pioneers in the development and publication of works in this area, due to their scarcity.<sup>15</sup>

Considering the above, the study addresses a fundamental issue for the nursing professional working in the care of critically ill patients using the Pulmonary Artery Catheter. This integrative review is justified due to the scarce record in the scientific literature regarding the knowledge of nurses and nursing care, making it relevant to gather the published knowledge on the subject and identify gaps, regarding the possibilities of carrying out studies that involve aspects still not completely clarified.

In this way, it becomes relevant to understand the behavior of the professional nurse during the nursing care provided to the patient using a Swan-Ganz Catheter and how this care has been carried out over the years. Therefore, the objective of this study was to analyze the scientific production regarding nursing care for patients using a Swan-Ganz Catheter and the nurses' knowledge related to the use of this device.

## METHODOLOGY

This study consists of an integrative literature review, a method that includes the analysis and synthesis of scientific evidence, in a systematic way, providing support for decision-making and for the improvement of clinical practice. The integrative review makes it possible to summarize the state of knowledge on a given subject, in addition to pointing out knowledge gaps that need to be filled with new studies.<sup>16</sup>

The elaboration of this integrative review covered the following steps: identification of the theme and elaboration of the guiding question; literature search or sampling, data collection, critical analysis of included studies, synthesis and discussion of results and presentation of the integrative review.<sup>16</sup>

In this sense, the first stage of the study was carried out. Thus, the theme chosen for this review was: nursing care directed to the patient using the Swan-Ganz catheter and nurses' knowledge about the device. For the elaboration of the guiding question, the strategy "PVO" was adopted, an acronym in the English language that means in Portuguese "patient/population, variables and results".<sup>17</sup> Based on this strategy, the present review considered "P", which corresponds to for nurses, "V" refers to the variables of interest, Swan-Ganz

catheterization in patients and "O" consists of the result, which is about knowledge and nursing care/assistance to the patient undergoing this procedure. Thus, the following guiding question was formulated: "How is the nursing care provided to the patient with Swan-Ganz catheter and what is the knowledge of nurses about this device?"

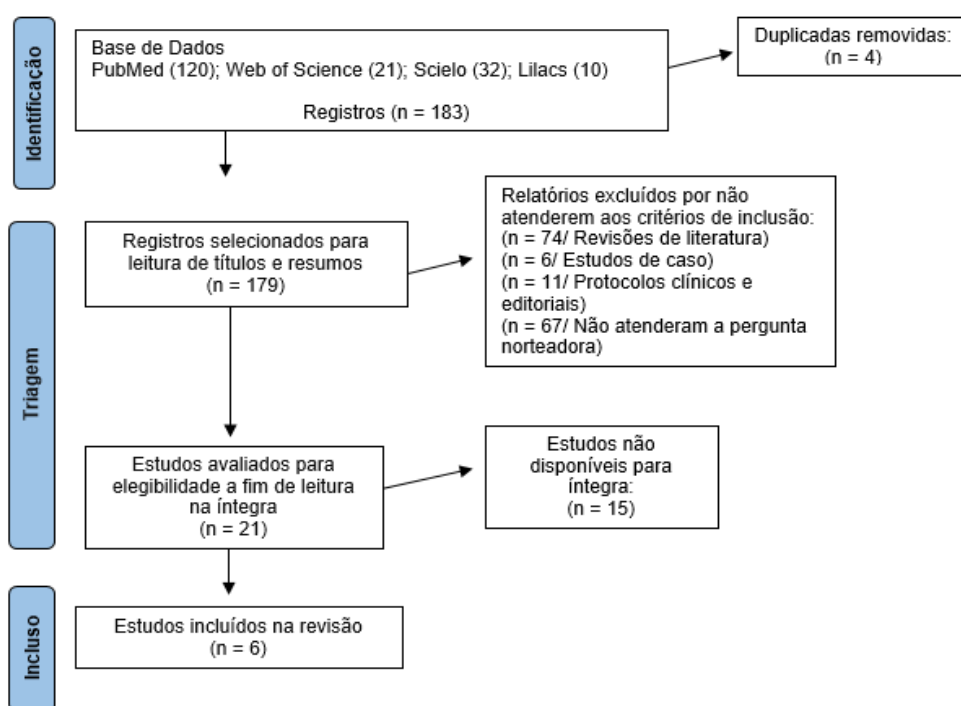
To carry out the second stage of the study, the databases, the descriptors and crossings to be performed and the inclusion and exclusion criteria were defined. The databases selected for the study were: National Library of Medicine National Institutes of Health (PubMed), Latin American and Caribbean Literature on Health Sciences (LILACS), Web of Science and Scientific and Electronic Library Online (SCIELO). The descriptors indexed in the Medical Subject Headings (MeSH) were used during the search in the databases, combined with the Boolean operator "AND". The MeSH terms used were: "Catheterization, Swan-Ganz", "Nursing Care", "Nurses" and "Knowledge", which in Portuguese correspond to "Swan-Ganz Catheterization", "Nursing Care", "Nurses and Nurses" and "Knowledge", respectively. So, the following crosses were used: "Catheterization, Swan-Ganz" AND "Nursing Care"; "Knowledge" AND

“Nurses” AND “Catheterization, Swan-Ganz”.

Data collection was carried out in June, and the analysis of the corpus was completed in July 2020. Inclusion criteria were all national and international articles existing in the databases, available in full, without taking into account time frame and language. As exclusion criteria, repeated articles, editorials, case studies, letters to

the editor, theses, dissertations, review articles, reports, study protocols and other studies that were not consistent with the theme of this review were considered.

The entire process for selecting the studies was based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)<sup>21</sup> flowchart, which is shown in Figure 1 below.



**Figure 1.** Study selection process based on the PRISMA flowchart, 2020.

It is important to emphasize that in the searches carried out in the predetermined databases, the vast majority did not meet the inclusion criteria of this integrative review, as shown in Figure 1, so in the end, 6 studies were included for the composition of this review.

To carry out the third step, the information to be extracted from the articles was defined. For data extraction, the present study was based on an instrument previously developed by Ursi (2005), capable of ensuring that all relevant information was extracted, minimizing the risk of errors in transcription and ensuring

accuracy in checking the information and serve as a record.<sup>18</sup> Thus, the data listed from the instrument included: database in which the article was indexed, title, authorship, year of publication, journal, objectives, main results and conclusion.

In the fourth and fifth stages, the studies were evaluated and their main results were interpreted. To this end, the main information extracted was analyzed exhaustively and critically, seeking to answer the objective of the study. In addition, the articles included were also classified according to the quality of their evidence, as recommended by Stillwell et al.,<sup>19,20</sup> where the types of scientific evidence can be described as systematic review or meta-analysis, randomized controlled trial, controlled study without randomization, case control or cohort study, qualitative or descriptive studies and finally, opinions or consensus, classified respectively, in levels of evidence ranging from I to level VI, as shown in Table 2.

In the sixth stage, which is the presentation of the review itself, the information was summarized in a summary of the main results and is presented in

Charts 1 and 2 (arranged in the study results) to facilitate the understanding of the analysis. It should be noted that also for a better understanding of the review, the findings were categorized into two categories, namely: assistance regarding care with the Swan-Ganz catheter and nurses' knowledge about the Swan-Ganz catheter, which are presented in the study discussion.

## **RESULTS**

Initially, the search in the databases retrieved 183 articles, which after applying the inclusion and exclusion criteria, the analysis corpus consisted of 6 articles tabulated in a spreadsheet, arranged in Table 1 for better visualization of information regarding the title, authorship and year of publication and journal in which the article was published. The analysis of the studies showed that 83.3% of the publications came from other countries, namely: Turkey (01), Australia (02), Japan (01), United States (01). Only one (01) publication was national, from the southern region of Brazil.



**Table 1.** Articles organized according to title, authorship, year of publication and journal in which it was published. Fortaleza, CE, Brazil, 2020.

No.	Title	Author and Year	periodical
01	Comparison of complications and procedural activities of pulmonar artery catheter removal by critical care nurses versus medical doctors	Oztekin, Akyolcu, Oztekin, Kanan, Göksel <sup>22</sup> , 2008	Nursing in Critical Care
02	Expert critical care nurses' use of pulmonary artery pressure monitoring	Aitken <sup>23</sup> , 2000	Intensive and Critial Care Nursing
03	The effectiveness of a nurse-initiated intervention to reduce catheter-associated bloodstream infections in an urban acute hospital: an intervention study with before and after comparison	Tsuchida, Makimoto, Toki, Sakai, Onaka, Otani <sup>24</sup> , 2007.	Internacional Journal of Nursing Studies
04	Pulmonary Artery Catheters Impact of e-Learning on Hemodynamic Assessments	Oldenburg, Muckler, Thompson, Smallheer <sup>25</sup> , 2019	Critical Care Nursing Quarterly
05	Monitorização hemodinâmica invasiva à beira do leito: avaliação e protocolo de cuidados de enfermagem	Ramos, Dal Sasso, Martins, Nascimento, Barbosa, Martins, et al., <sup>13</sup> 2008	Revista da Escola de Enfermagem da USP
06	Survey of intensive care nurses' knowledge relating to the Pulmonar Artery Catheter	Johnston, Jane, Fraser, Kruger, Hickling, <sup>26</sup> 2004	Anaesthesia and Intensive Care

From the information provided in Table 1, it is also noted that only 16.7% of the studies were published in the last 5 years, with only 1 recent study in 2019. It is also worth noting that the knowledge produced on the subject seems to have started at least 22 years ago. Considering the number of studies retrieved in the searches, it is necessary to emphasize the need for attention to the development of

more research, both internationally and mainly nationally focused on this issue.

The information, in full, referring to the objective of each study, the main results listed, conclusion and the level of evidence, as recommended by Stillwell et al.<sup>19,20</sup> and Ursi<sup>18</sup>, are detailed in Tables 2 and 3, divided into two categories in order to answer the guiding question.

**Table 2.**Articles organized according to the assistance category regarding care with the Swan-Ganz catheter. Fortaleza, CE, Brazil, 2020.

No.	objective	Main results	Conclusion	HUH <sup>#</sup>
01	To determine the occurrence and type of complication associated with pulmonary artery catheter removal by critical care nurses/intensivists and physicians. <sup>22</sup>	Trained intensive care nurses from Turkey worked more efficiently on catheter removal, and on necessary actions before and after the procedure, such as disconnecting the monitor, deflating the balloon, removing the catheter, compressing the site and dressing.	Pulmonary artery catheters were removed correctly by both groups, but the nurses' role vis-à-vis physicians stood out.	II
02	Describe the processes and results of decision-making by nurses. <sup>23</sup>	Pulmonary arterial pressure monitoring was used by nurses to achieve the concepts of preload, cardiac output and blood pressure. Monitoring through data recording.	Evidence suggests that not all nurses who work in the field for a long period reach the specialist level, as some participants did not use many of the decision-making resources normally associated with a specialist professional.	V
03	To identify problems associated with Swan-Ganz catheter care and the effectiveness of nurse-initiated care. <sup>24</sup>	Nursing interventions such as hygiene of the patient's skin before the procedure, additional dressing, staff guidance, and use of a checklist decrease bloodstream infection rates.	After the identification of problems associated with the management of the Swan-Ganz catheter and the implementation of nursing interventions, a decrease in bloodstream infection rates was observed.	V

<sup>#</sup>Level of Evidence.

The findings presented in Chart 2, in short, show that internationally it is common for critical care/intensive care nurses to manage the Swan-Ganz catheter and, in addition, praise and criticism are presented to this assistance, as one of the studies indicates that professionals do not use all the tools for decision making related

to specialist professionals. While another, already points out that nursing care, through nursing interventions, was effective in reducing bloodstream infection rates.

Table 3 presents the synthesis of the findings of the category: nurses' knowledge about the Swan-Ganz catheter.

**Table 3.**Articles organized according to the category nurses' knowledge about the Swan-Ganz catheter. Fortaleza, CE, Brazil, 2020.

No.	objective	Main results	Conclusion	HU H#
04	Assess knowledge and increase self-efficacy among nurses in an Intensive Care Unit who manage invasive hemodynamic devices. <sup>25</sup>	Assessment of nurses' knowledge before and after the application of educational material on the pulmonary artery catheter, with an improvement in self-efficacy and knowledge.	Workplaces should use additional educational tools for nurses, because through these training professionals can feel more empowered and motivated to further improve patient care management.	V
05	Establish the clinical evaluation parameters necessary for the patient undergoing hemodynamic monitoring by the Pulmonary Artery Catheter and build a nursing care protocol. <sup>13</sup>	The data showed that the interpretation of pressures and the time required for patient follow-up are the points in which nurses have greater difficulty. In this study, there was a collective process of creating a patient care protocol in hemodynamic monitoring.	It was concluded that the clinical evaluation criteria are the invasive and non-invasive parameters and the nursing care protocol is relevant to support clinical decision-making for patient care.	V
06	To assess the level of knowledge of nurses in Intensive Care Units in Australia. <sup>26</sup>	When answering questions about aspects related to the catheter, the average score obtained was 13.3 points (42.8% of correct answers), with the need to improve knowledge.	The knowledge of nurses with more experience in the ICU was greater. Half of the nurses were unable to correctly identify the significant pressure change as the catheter is advanced from the right ventricle to the pulmonary artery, evidencing low knowledge.	V

#Level of Evidence.

Among the synthesis of the findings highlighted in Chart 3, it is highlighted that the knowledge of nurses with more experience in intensive care about the Swan-Ganz catheter was well evaluated. In addition, educational training about the device was seen as empowering and motivating factors to further improve patient care management.

findings involving care related to the use of the Swan-Ganz catheter and the nurses' knowledge emerged both from the guiding question of the study, as well as through the analysis of the six articles included. Thus, the two categories emerged from the analysis corpus by grouping and similarity, which are explained below:

## DISCUSSIONS

The choice for categorizing the

### **Nursing care related to the Swan-Ganz catheter**

The articles selected in this integrative literature review addressed, even if minimally, questions about nursing care provided in situations where the CAP is used.

According to a study<sup>22</sup>, the occurrence and type of complication associated with the removal of the pulmonary artery catheter by the nurse and physician were verified. With regard to the removal of the PAC by the intensive care nurse, the steps related to the actions before the procedure, during the procedure and after the procedure were observed. Prior to catheter removal, professionals explain the procedure to the patient, sanitize hands, proceed with opening the transducer stopcock and discontinuing the monitor, deflating the balloon, and removing the dressing from the insertion site. During this process, patient stabilization was ensured. The authors emphasize that before removing the PAC, the nurse must make sure that the balloon is completely deflated, because if it is minimally inflated,

For the actual removal, all catheters were removed by the nurses, slowly, using one hand with a constant movement. In fact, this work reinforces that trained nurses were successful in performing this technique, and no harm was observed to the patient. Post-procedure activities included

cutting and removing sutures, maintaining pressure, and applying the dressing.<sup>22</sup>

In addition to these data, Gresta and Bastos<sup>4</sup> reinforce the idea that catheter manipulation should be performed by a trained professional and nurses should remove the catheters after analyzing laboratory data, in elective situations and preferably during the daytime, facilitating the attendance to eventual interurrences associated with this procedure. Also according to the authors, the suggested catheter removal techniques are gentle traction with continuous tension and the use of warm compresses to promote vasodilation in cases of resistance to removal.

Regarding PAC patient monitoring and data collection, Aitken<sup>23</sup> states that pulmonary artery pressure monitoring was associated with the concepts of preload, afterload and blood pressure by most participants, suggesting to participants that they placed a significant emphasis on objective attributes, such as those obtained by invasive monitoring, laboratory investigations, and therapeutic interventions. These attributes are beneficial for the professional's decision making, as they are useful in obtaining concepts with maximum correctness. On the other hand, subjective attributes, such as clinical assessment, do not have such a specific defining statement and,

consequently, may be perceived as less valuable.<sup>23</sup>

It is important to emphasize that according to Tsuchida, Makimoto, Toki, Sakai, Onaka, Otani<sup>24</sup>, we have to the nursing conducts related to the PAC, interventions such as the hygiene of the patient's skin before the procedure, additional dressing, team orientation and use of a list of verification decreased bloodstream infection rates.<sup>24</sup> Corroborating this statement, Öztekin<sup>22</sup> and his collaborators reported that, in fact, NAC-related infection is related to the microbiota of the patients' skin and to the catheter insertion site. Intense colonization at the insertion site, contamination during manipulation by the healthcare professional, and ineffective skin disinfection are associated with a higher risk of infection.

Also according to Aitken<sup>23</sup>, the significant findings in relation to the low infection rates were contributed by the low turnover of nursing professionals in the institution where the study was carried out, which facilitates the implementation of standardized actions by nurses who are already used to the routine of nursing unit and consequent monitoring of interferences. When it comes to the importance of standardizing nursing actions, it is highlighted that standardization of care related to

management, dressing changes, evaluation of catheter insertion, as well as the recording of these interventions is essential, since these factors are paramount in the prevention of possible complications.<sup>27</sup>

### **Knowledge about the Swan-Ganz catheter**

Among the studies, three reported nursing care with emphasis on the professional's expertise in removing the catheter without causing harm to the patient; pulmonary artery pressure monitoring to achieve broader concepts; skin cleaning, additional dressing, among other actions to prevent bloodstream infection. The rest of the studies showed low knowledge among the professionals interviewed and difficulties in interpreting the information.

However, regarding the aspect of catheter management, Aitken<sup>23</sup> identified the dexterity of the participants. These were able to deal simultaneously with several aspects, where they had no difficulty in managing clinical situations quickly and allocated adequate time and resources, paying attention to their relevance and urgency of the situation. An expanded view of hemodynamic assessment and the variety of different attributes and concepts inherent to it were demonstrated.<sup>23</sup>

As for the level of evidence of the studies, most correspond to level 5, and

only one was classified with a better level of evidence. It is important to emphasize that the evidence found must be evaluated in terms of validity and methodological reliability, in addition to its clinical applicability, and that studies with a higher level of evidence are eligible for the use of Evidence-Based Practice in Nursing. This, in turn, comprises the judicious use of the best current evidence for decision-making on individual patient care, through a compilation of clinical findings generated by existing systematic research.<sup>19</sup>

For Oldenburg et al.,<sup>25</sup> knowledge and self-efficacy among nurses in an Intensive Care Unit (ICU) who manage invasive hemodynamic devices were assessed by means of a questionnaire before and after the nurses were submitted to an educational material. This material covered the following topics: cardiac anatomy; general hemodynamic concepts; CAP indications, complications, configuration, insertion, value interpretation and waveforms; vasoactive pharmacology and a case study.

For some authors<sup>13,25</sup>, the aspects listed above are similar when they show that the interventions developed and applied resulted in a statistically significant increase in the self-efficacy of nurses in the Intensive Care Unit in relation to PAC and hemodynamic monitoring, since before the intervention, nurses reported not feeling

fully qualified for this function.<sup>25</sup> In fact, difficulties in carrying out the hemodynamic study through the CAP are frequently reported, as well as the underutilization of data obtained in the planning of nursing care, resulting from the lack of knowledge of professionals.<sup>11,13</sup>

Ramos, et al.,<sup>13</sup> when judging in the results how the clinical evaluation of the patient submitted to invasive hemodynamic monitoring by the PAC takes place, they showed that the interpretation of pressures and the time required for patient follow-up are the points in which nurses have greater difficulty. The authors emphasized that the correct interpretation of pressures by nurses is extremely important for conducting care, preventing complications and evaluating the patient's response to nursing care, and it is important to implement continuing education, always considering an evidence-based practice.

Finally, Johnston et al.,<sup>26</sup> assessed the level of knowledge of nurses about the use of PAC in the ICU, using a questionnaire that addressed topics such as waveform analysis, care management, interpretation of results, PAC indications, physiology, complications and calculations, showing a low level of knowledge. The authors reported that this fact is worrisome, given that basic questions of interpretation were often answered incorrectly and, therefore, a reassessment of the education of ICU

nurses regarding the use and safety of the CAP should be carried out.

## CONCLUSION

According to the publications analyzed and the discussions presented, it could be inferred that nursing care for patients using a Pulmonary Artery Catheter corresponds to monitoring, interpretation of parameters and interventions to prevent infection. However, nurses have difficulty interpreting the data collected, making it imperative to improve knowledge on the subject.

In addition, there is a need to carry out unpublished studies, with a quantitative and qualitative approach, with methodological rigor, to ensure good scientific evidence and updating of existing information, which allows nurses to employ a practice based on knowledge in a professional environment evidence.

Given the above, it is suggested that nurses are in a constant process of improving knowledge, so that they can provide qualified and safe nursing care for the patient. Managers, in turn, must be sensitive to the importance of adhering to continuing education in health services, in order to qualify professionals, aiming at an excellent service.

Finally, the limitations found in this review are related to not including all the articles identified during the search in the

databases, as they are not freely available. In addition, the selected studies did not provide a detailed approach to nursing care for patients using a Pulmonary Artery Catheter, especially regarding parameters and their interpretation. Thus, the gap identified in the published literature, since the beginning of the implementation of this technique for invasive hemodynamic monitoring, is represented by the scarce amount of studies on nursing care and insufficient depth and detail of these actions.

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