

# Role of the perfusion nurse in cardiac surgery

*Atuação do enfermeiro perfusionista na cirurgia cardíaca*

*La actuación del enfermero perfusionista en la cirugía cardíaca*

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**ABSTRACT:** **Objective:** To analyze the role of the perfusionist nurse in cardiac surgery. **Method:** Exploratory study with a qualitative approach, conducted in a virtual environment from June 1<sup>st</sup> to June 30<sup>th</sup>, 2022. The sample consisted of 14 perfusionist nurses, selected intentionally and non-probabilistically. Data were analyzed through Bardin's content analysis. **Results:** Two thematic categories emerged: the role of the perfusionist nurse in extracorporeal circulation and the relevance of the nurse's interaction with team members during cardiac surgery with extracorporeal circulation. The reports identified that the perfusionist nurse performs numerous tasks ranging from nursing history to the preparation and selection of materials, circuits, devices, and machinery for extracorporeal circulation. The interaction of this professional with other team members regarding communication stands out, aiming to minimize risks and achieve positive surgical outcomes for the patient. **Conclusion:** The activity of the perfusionist nurse is complex and requires rigorous theoretical-practical preparation, recognized specializations by competent bodies, as well as frequent updates even for experienced professionals. **Keywords:** Extracorporeal Circulation. Thoracic surgery. Nurses. Perfusion.

**RESUMO:** **Objetivo:** Analisar a atuação do enfermeiro perfusionista na cirurgia cardíaca. **Método:** Estudo exploratório com abordagem qualitativa, desenvolvida em ambiente virtual no período de 1 a 30 de junho de 2022. Amostra intencional, não probabilística, constituída de 14 enfermeiros perfusionistas. Os dados foram analisados por meio da análise de conteúdo de Bardin. **Resultados:** Emergiram duas categorias temáticas: Atuação do enfermeiro perfusionista na circulação extracorpórea e A relevância da interação do enfermeiro com os membros da equipe durante a cirurgia cardíaca com circulação extracorpórea. Os relatos identificaram que o enfermeiro perfusionista realiza inúmeras atribuições que vão desde o histórico de enfermagem, até o preparo e a escolha de materiais, circuitos, dispositivos e maquinários para a condução da circulação extracorpórea. Destaca-se a interação desse profissional com os demais membros da equipe no tocante à comunicação a fim de minimizar riscos e obter resultado cirúrgico positivo para o paciente. **Conclusão:** A atividade do enfermeiro perfusionista é complexa e necessita de um rigoroso preparo teórico-prático, especializações reconhecidas pelos órgãos competentes, bem como frequentes atualizações mesmo já sendo um profissional experiente. **Palavras-chave:** Circulação extracorpórea. Cirurgia torácica. Enfermeiras e enfermeiros. Perfusion.

**RESUMEN:** **Objetivo:** Analizar el papel del enfermero de perfusión en la cirugía cardíaca. **Método:** Estudio exploratorio con enfoque cualitativo, desarrollado en ambiente virtual durante el período del 1 al 30 de junio de 2022. Muestra intencional, no probabilística, compuesta por 14 enfermeros de perfusión. Los datos fueron analizados mediante el análisis de contenido de Bardin. **Resultados:** Surgieron dos categorías temáticas: El papel del enfermero perfusionista en circulación extracorporea y la relevancia de la interacción del enfermero con los miembros del equipo durante la cirugía cardíaca con circulación extracorporea. Los informes identificaron que el enfermero perfusionista desempeña numerosas atribuciones que van desde el historial de enfermería hasta la preparación y elección de materiales, circuitos, dispositivos y maquinaria para la conducción de la circulación extracorporea. Se destaca la interacción de este profesional con los demás miembros del equipo en lo que respecta a la comunicación para minimizar riesgos y obtener resultados quirúrgicos positivos para el paciente. **Conclusión:** La actividad del enfermero de perfusión es compleja y requiere una preparación teórico-práctica rigurosa, especializaciones reconocidas por los órganos competentes, así como actualizaciones frecuentes incluso siendo un profesional experimentado. **Palabras clave:** Circulación extracorporea. Cirugía torácica. Enfermeras y enfermeros. Perfusion.

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## INTRODUCTION

The role of perfusion nurses is regulated by the Federal Nursing Council (*Conselho Federal de Enfermagem – Cofen*) through Resolution 528/2016, which has been updated by Resolution 667/2021. In accordance with these resolutions, the exclusive responsibility for the activity of perfusionist lies with nurses. Article 3 outlines the criteria for performing the role of perfusionist, which must be acknowledged by the Regional Nursing Council (*Conselho Regional de Enfermagem – Coren*) within its jurisdiction. Nurses are required to fulfill at least one of the following criteria: possess a *lato sensu* postgraduate degree or participate in a multidisciplinary residency program in the field, recognized by the Ministry of Education (*Ministério da Educação – MEC*), and have documented practice experience of at least 100 perfusions, and/or hold a Specialist Title issued by a Specialist Society. Article 4 mandates that the activities assigned to perfusion nurses must comply with the recommendations provided by the Specialist Society<sup>1,2</sup>.

The Brazilian Society of Extracorporeal Circulation is the specialized organization representing perfusionists in Brazil. According to its statute and Brazilian standards for perfusionists in extracorporeal circulation (ECC), only professionals with higher education in Biology, Biomedicine, Nursing, Physiotherapy, Medicine, and Pharmacy are permitted to perform perfusion<sup>3</sup>. Qualified perfusionists are responsible for conducting ECC and extracorporeal membrane oxygenation (ECMO), vital procedures in highly complex medical contexts including cardiovascular, pulmonary, thoracic, neurological, and hepatic surgeries. They also play a crucial role in treating conditions such as oncology and severe infections, including those induced by Corona Virus Disease (Covid-19), Influenza A virus (H1N1), and sepsis. Additionally, they provide circulatory and pulmonary support for patients awaiting organ transplantation<sup>4,5</sup>.

According to a report extracted from the Cofen registration system, there were 35 postgraduate titles registered in the field of perfusion. Among the nine different types of titles, “perfusionist” was the most registered, followed by “perfusion” and “Extracorporeal Circulation and Mechanical Circulatory Assistance — Perfusion.” Additionally, data compiled from the Brazilian Society of Extracorporeal Circulation (*Sociedade Brasileira de Circulação Extracorpórea – SBCEC*) as of April 2021 indicated that there were 568 health professionals registered with the organization and working as perfusionists. Of this total, 252 were nurses, accounting for 44.4%<sup>6</sup>.

Perfusion specialists are trained to operate ECC equipment and to select disposable devices, in addition to maintaining vital bodily functions, hydroelectrolyte balance, hemodynamics, blood pressure, and blood balance during surgery. ECC is a highly complex intervention designed to temporarily replace the functions of the heart and lungs, allowing surgical treatment of the heart and other target organs. This process involves the use of machines, devices, circuits, and techniques to pump and oxygenate the blood and to protect the myocardium during surgical procedures. This method is a significant milestone in the history of cardiac surgery, enabling the successful completion of numerous complex procedures and contributing to patient survival. It should be noted that, before the invention, the majority of these procedures were not feasible<sup>3,7</sup>.

The perfusion nurse assumes a vital role in ECC procedures, encompassing tasks from patient care to the execution of ECC procedures. Their primary responsibilities include ensuring the availability of materials required for ECC, testing ECC equipment components, and overseeing its preventive and corrective maintenance to ensure optimal functionality. Additionally, they are tasked with planning and organizing the assembly of the ECC machine and gathering essential patient information from medical records to facilitate ECC planning throughout the anesthetic-surgical process<sup>4</sup>.

Moreover, perfusion nurses are tasked with assessing the presence of comorbidities or any conditions that might impact ECC execution or necessitate special attention. They conduct blood circulation and extracorporeal oxygenation procedures under the surgeon’s direction, monitoring parameters such as blood gas tension, hematocrit levels, diuresis, arterial and venous pressures, and anticoagulation levels, and making necessary adjustments as required. Additionally, they oversee the conclusion of the procedure once the heart resumes its functions, returning mechanical ventilation control to the anesthetist, and ensuring the preservation of blood volume and optimal hemodynamic conditions crucial for effective cardiorespiratory function<sup>4</sup>.

It is noteworthy that ECC plays a pivotal role in cardiac surgery, as approximately 90% of cardiovascular surgical procedures rely on this technology. Its introduction marked a significant advancement in 20<sup>th</sup>-Century healthcare, facilitating continuous heart management and offering treatment, and even cures, for numerous cardiac pathologies previously deemed untreatable<sup>8</sup>. The crucial contribution of professional nurses to the success of cardiac surgery with ECC is

underscored, as they not only fulfill technical duties but also engage in pre-, intra-, and postoperative patient care actions<sup>9</sup>.

A narrative review was conducted with the objective of identifying the primary factors contributing to adverse events during ECC in cardiovascular surgeries. Based on this information, the aim was to develop a checklist to be utilized intraoperatively, (pre-assembly of the circuit, pre-ECC, and during ECC).

The checklist items included:

1. Patient data;
2. Equipment;
3. Materials;
4. Planning;
5. Circuit assembly;
6. Perfusate;
7. Cannulation;
8. Monitoring; and
9. Anticoagulation.

According to the author of the review, the implementation of a targeted checklist plays a crucial role in enhancing patient safety during cardiovascular surgeries involving ECC<sup>10</sup>.

In light of the Sustainable Development Goals (SDGs), which aim to reduce premature deaths from non-communicable diseases by one-third by 2030<sup>11</sup>, the shortage of international professionals in perfusion<sup>12</sup> and the growing qualification of professionals in extracorporeal technology in Brazil<sup>13</sup>, there arose a necessity to address the gap in literature regarding the role of perfusion specialist nurses and their significance in cardiac surgery with ECC, describing their actions and responsibilities.

## OBJECTIVE

To analyze the role of perfusion nurses in cardiac surgery.

## METHOD

Exploratory study with a qualitative approach. A checklist for qualitative research was used, the Consolidated Criteria for Reporting Qualitative Research (COREQ)<sup>14</sup>.

The research was conducted in a virtual environment, utilizing online data collection methods that involved perfusion nurses from across Brazil, constituting a national survey. Participant eligibility was determined through the SBCEC

website, which hosts the registry of perfusionists in Brazil; and via the Lattes Platform, which provides information on professionals' training and contact details, facilitating the invitation process for study participation.

Inclusion criteria for participation in the study encompassed perfusionists with a nursing background, with five or more years of experience, and actively working during the research period, which took place in June 2022. Those who failed to confirm their participation within the specified deadline were excluded from the study. In accordance with these criteria, 30 perfusion nurses were invited to take part in the research; however, only 14 responded affirmatively to the email, indicating their willingness to participate.

Data collection took place from June 1<sup>st</sup> to June 30<sup>th</sup>, 2022, utilizing a virtual questionnaire comprising both open-ended and closed-ended questions, administered via Google Forms and distributed through email. Participants were allotted an estimated time of 20 minutes to complete the questionnaire.

It is important to note that access to the questionnaire was granted only after participants agreed to take part in the research by consenting to the Informed Consent, presented online (Google Forms link).

Data analysis was conducted utilizing Bardin's content analysis methodology. This approach involves three core phases: pre-analysis, exploration of the material and treatment of results through inference, and interpretation<sup>15</sup>. The findings were presented via thematic analysis and interpreted based on the researchers' examination of the virtually answered questionnaires, guided by relevant literature on the emerging themes within the data.

The results were organized into two thematic categories for contextual discussion, titled: "The Role of the Perfusion Nurse in ECC" and "The Relevance of Nurse Interaction with Team Members during Cardiac Surgery with ECC." Each participant was identified by "(P)" followed by randomly assigned numbers.

This study adhered to the guidelines outlined in Resolution 466/2012 of the National Health Council, which governs research involving human subjects. Additionally, Resolution 510/2016 of the National Health Council, which emphasizes ethics in research and the protection of human dignity and participants' rights in scientific research involving human subjects, was also observed.

The project received approval from the Research Ethics Committee of the primary institution under reference number 5.416.053. Participants were provided with the online Informed Consent via a Google Forms link, and only after

consenting were they allowed to proceed with the survey. It is important to highlight that the identities of the participants were kept anonymous throughout the study.

## RESULTS

Fourteen perfusion nurses took part in the study, comprising three males and eleven females, with ages ranging from 33 to 59 years. Their experience in perfusion work spanned from 6 to 30 years, and the number of perfusions performed per month ranged from 8 to 40.

The responses from the questionnaire were structured and categorized into two thematic domains: “The Role of Perfusion Nurses in ECC” and “The Relevance of Nurse Interaction with Team Members during Cardiac Surgery with ECC.”

### Role of perfusionist nurses in extracorporeal circulation

Perfusion nurses fulfill a critical role throughout ECC procedures. As reported by one participant, nurses are integral members of the care team, involved in tasks ranging from selecting ECC materials to calculating medication dosages, as well as monitoring patients in the Intensive Care Unit (ICU) post-surgery, ensuring ongoing care and maintaining hemodynamic stability.

The procedure commences with patient preparation during the preoperative phase, during which the nursing professional admits the patient utilizing the Systematization of Perioperative Nursing Care (*Sistematização da Assistência de Enfermagem Perioperatória – SAEP*). Additionally, they conduct a thorough anamnesis, delving into the patient’s dietary habits, existing comorbidities, and family medical history. Participants noted:

*Admission to the surgical suite is done in accordance with SAEP. Preparation and positioning on the operating table, checklist of material needed to perform ECC, preparation of material for ECC execution, calculations of cardiac outputs, primes, medications, blood components, preparation of cardioplegia, assembly of all circuits, preparation of the Perfusion form (P8).*

*Before and during ECC: choosing ECC materials, selecting cannulas based on the patient’s weight, calculating*

*heparin and protamine doses, monitoring gas and metabolic exchanges through arterial and venous blood gas analysis, temperature control, and preparing and administering cardioplegia (P1).*

*Patient history, physical examination, laboratory and imaging tests, past health history and family history, habits, comorbidities, etc. ECC planning: selection of materials and drainage techniques, myocardial protection (cardioplegia), flow calculations, drugs, desired parameters for vital signs, hematocrit, and electrolytes. Preparation of machinery and devices for ECC, selection and priming of the circuit with definitive priming, as well as maneuvers to remove bubbles from the system and calibration of all rollers for cardiac output flows and aspirations, preparation of cardioplegia (P14).*

*Preparation, maintenance, and conduction of ECC (P6).*

Furthermore, based on participants’ statements, in the preoperative phase, perfusion nurses are responsible not only for patient admission and anamnesis but also for selecting and procuring all the required materials for ECC. This includes selecting cannulas, circuits, and devices tailored to the patient’s weight and body surface, and performing all necessary calculations for flows, medications, and primes. Additionally, they oversee the maintenance and preparation of the system, as well as calibration before surgery.

During the intraoperative period, as highlighted by most participants, the nurse’s role extends beyond direct patient care to encompass the maintenance of hemodynamic and electrolyte stability throughout the surgical procedure. Key care measures frequently mentioned include: monitoring, assessing, and maintaining hemodynamic stability; interpreting arterial and venous blood gases; and analyzing and correcting laboratory test results:

*(...) Control of gas and metabolic exchanges through arterial and venous blood gas analysis, temperature control, preparation, and administration of cardioplegia (P1).*

*Planning, circuit assembly, priming preparation, cardioplegia solution, flow calculations and medication dosage, perfusion chart, analysis and correction of laboratory tests, perfusion management, patient fluid and blood balance (P4).*

*(...) Conducting ECC, monitoring Heparin anticoagulant action via TCA and calculation, adding Hepatic if necessary, reversing Heparin action using Protamine, interpreting arterial blood gas analyses, correcting acid-base or electrolyte imbalances, monitoring vital signs and other relevant parameters during ECC, preparing and administering cardioplegia, etc. (P7).*

*Correction of gasometry and other test alterations, avoiding excessive hemodilution, maintaining balance (P10).*

In light of this, participants underscore the significance of conducting arterial and venous blood gas analyses throughout the ECC procedure to facilitate necessary corrections. Additionally, they emphasize the importance of preparing and administering the cardioplegia solution.

*Performs flow calculations, medication dosages, selection of membrane and cannulas, and monitors the care and outcomes of ECC (P5).*

*(...) Conducting ECC with continuous monitoring of hemodynamic parameters (MAP, SVR, Temp., HR, arterial and cardioplegia line pressures), diuresis, corrections of acid-base and electrolyte balance, hemofiltration during and after ECC, blood sampling for arterial and venous blood gas analysis, and TCA (P14).*

*Hemodynamic control, post-op, hypo or hypervolemia, Lab exams, Acid-base gasometry control (P11).*

Another role emphasized is monitoring the patient's transportation to the Intensive Care Unit (ICU) and overseeing the patient's entire post-surgical process:

*(...) Post-surgery, patient preparation for transportation to the ICU with proper care of the necessary accessories for maintaining the clinical condition, as well as invasive monitoring (BIA, BI, SWAN GANZ, PERIPHERAL INFUSIONS, PIA), transfer of care to the intensive care unit according to protocol. Postoperative analysis of the patient's general condition in the immediate postoperative period, according to the postoperative evolution protocol (P8).*

*(...) All records of drugs used, duration of ECC and clamping, hydroelectrolytic balance, and if there are any*

*complications, they are reported to the Surgical Center Nurse, who is responsible for handing over to the ICU, through these records the ICU team plans the postoperative period. Postoperative care is only through visits and discussion of the case with the team regarding the discharge plan (P9).*

*(...) In the ICU: Assess level of consciousness, presence of bleeding, hematuria due to hemolysis, risk of infections, hemodynamic instability (P1).*

In addition to the roles mentioned, nursing professionals stress the importance of maintaining comprehensive records of all medications used and any surgical complications encountered, necessitating thorough nursing assessments. Following this process, patients are transferred to the ICU, where perfusionists must conduct post-operative evaluations, monitoring for signs of bleeding, infection risks, and hemodynamic instability — as highlighted by (P1). Understanding the patient's progression and evaluating the procedure's effectiveness is crucial. In cases of complications, it is essential to assess potential causes during surgery and explore new strategies to prevent them. As mentioned by (P9), once all records are complete and post-operative planning proceeds smoothly, the health-care team can then deliberate on the patients' discharge plan.

### **The relevance of the nurses' interaction with team members during cardiac surgery with extracorporeal circulation**

Nurses unanimously emphasized the crucial nature of interaction with all members of the surgical team. According to the participants, this interaction functions akin to a gear: for it to operate effectively, each part relies on the other.

*Absolutely, there's no individual working alone. It's a human mechanism, where each relies on the performance of the other. Interaction within the group is fundamental (P1).*

*Of utmost importance for the whole team, ensuring organization of materials, patient care, and interaction with everyone from the operating room to the ICU (P2).*

*Postoperative management (P3).*

*Very important (P12).*



Other participants also underscore the necessity of exchanging information among the entire team for successful navigation through each stage of heart surgery.

*The activity requires continuous transfer of information among the team for the management, stability, and postoperative success. It's a dynamic process with continuous feedback (P8).*

*This is of great importance because cardiac surgery involves a range of procedures and care that the Perfusionist cannot provide assistance with (P10).*

*Good communication (exchange of information among team members) in the surgery and anesthesia team is essential for defining and understanding surgical correction strategies, drug choices, and perfusion techniques (P14).*

*In reality, Nurses and Perfusionists have distinct and significant roles. Nurses, within cardiac surgery, needs to have knowledge and mastery of the entire surgical procedure, from a holistic perspective. They need to be attentive, along with the Nursing Team, to everything that should happen in the operating room and anticipate events, as well as provide all the materials, equipment, and supplies to be used during the proposed surgery. Perfusionists, on the other hand, are connected to the surgical team itself (Surgeon, Anesthesiologist, and Perfusionist), needing to have knowledge of the patients' clinical conditions, the surgical technique to be employed, and the drugs to be used by anesthesia so that they can plan, assemble, and conduct ECC (P13).*

Hence, it becomes evident that due to its vast and intricate nature, cardiac surgery necessitates effective communication across the entire team. This ensures the establishment of clear goals, streamlined processes, and prompt corrections during the procedure, thereby mitigating potential failures and ultimately achieving a positive surgical outcome for the patient.

## DISCUSSION

During the latter half of the 20<sup>th</sup> century, the development and utilization of ECC represented one of the most significant advancements in open-heart surgery. Alongside this

innovation, various other devices emerged, including extracorporeal circulatory support, ventricular assist devices, mechanical circulatory support, and total artificial hearts. As the utilization of these devices continues to rise, so does the demand for competent professionals capable of operating these complex machines, notably perfusionists. Regrettably, these professionals often do not receive recognition commensurate with the importance of their work. Therefore, it is pertinent to disseminate studies on the performance of these professionals within the scientific community. This serves as a means to encourage further research and enhance society's understanding of the intricate and indispensable role played by these professionals.

In tandem with the innovation of ECC, various other devices have emerged, including extracorporeal circulatory support, ventricular assist devices, mechanical circulatory support, and total artificial hearts. As the utilization of these devices continues to rise, so does the demand for competent professionals capable of operating these complex machines, notably perfusionists. Regrettably, these professionals often do not receive recognition commensurate with the importance of their work<sup>16</sup>. Therefore, it is pertinent to share studies on the performance of these professionals within the scientific community. This serves as a means to encourage further research and enhance society's understanding of the intricate and indispensable role played by these professionals.

Cardiac surgery involving ECC is inherently complex and high-risk, necessitating collaborative efforts from multiple specialists to ensure safe and effective care. Throughout the ECC phase, critical decisions must be made, and perfusionists play a pivotal role in evaluating available information and determining the appropriate course of action<sup>17</sup>. Among the array of specialists involved, perfusion nurses are required to possess the capability, in accordance with prevailing legal regulations, to operate within this surgical domain. This professional is tasked with adhering to systematic care protocols, beginning from the patient's admission, and must maintain constant communication and collaboration with other members of the surgical team.

Pre- and post-operative patient histories and physical examinations, along with the assessment of laboratory tests, serve as indispensable tools for delivering quality care. They enable nurses to identify diagnoses and nursing problems that guide the planning of perfusion-related actions, as well as monitoring and evaluating patient progress during intra-operative and postoperative phases. Consequently, the collection of patient data is of utmost importance, allowing

professionals to identify needs, concerns, and reactions aimed at the patient, thus assisting them with a holistic and humanized approach<sup>18</sup>. It is worth noting that SAEP operationalizes the significance of comprehensive, participatory, continuous, individualized, and systematic nursing conduct. This ensures that care can be documented and evaluated, while also facilitating the adaptation of routines and conduct to meet the needs of patients<sup>8</sup>.

Following the assessment of the patient's health history and physical examination, the perfusionist proceeds to gather all necessary materials and commence the assembly of the machine. They dilute medications according to a specific protocol established by the surgical medical team for cardiac surgery and perfusion, while also performing all calculations required to initiate ECC and commence surgery<sup>19</sup>. It is crucial to emphasize that medication administration to the patient adheres to current nursing legislation, requiring a medical prescription. Perfusion nurses assume responsibility for conducting necessary corrections to laboratory tests, administering and adjusting medication doses during perfusion under medical supervision, and managing the materials and equipment used in the procedure, followed by the completion of the perfusion form to document the process<sup>1,20</sup>.

To mitigate post-surgical complications of cardiac surgeries, various hemodynamic parameters of the patient are continuously monitored during the procedure. These parameters include blood gases, hematocrit, sodium and potassium levels, and anticoagulation levels. When imbalances are detected in these values, medications are administered to control and correct these changes, including diuretics, which, while effective, can potentially lead to dehydration and electrolyte depletion, hypokalemia, hypocalcemia, or hyponatremia. Hence, it is imperative to rigorously monitor these parameters throughout the entire duration of the surgery to ensure optimal patient outcomes<sup>21</sup>.

Arterial and venous blood gas analysis is a critical procedure during ECC, encompassing a group of tests that collectively measure pH and levels of oxygen ( $O_2$ ) and carbon dioxide ( $CO_2$ ) in the blood. Arterial blood gas analysis involves utilizing arterial blood, while venous blood gas analysis utilizes venous blood. The procedure is conducted using a blood gas analyzer, which is a device equipped with software or applications for analyzing blood gases. Given the significance of this examination in assessing pH, partial pressure of oxygen ( $PaO_2$ ), partial pressure of carbon dioxide ( $PaCO_2$ ), oxygen saturation ( $SaO_2$ ), bicarbonate ( $HCO_3$ ), and base excess (BE), nurses must be capable of directly collecting samples from

the ECC equipment and interpreting test results to effectively address any deviations<sup>22</sup>.

Despite advancements in cardiac surgery and preoperative care, postoperative complications continue to be prevalent. A study conducted in Rio de Janeiro involving 230 individuals who underwent elective cardiac surgery with ECC revealed that the primary complications were linked to electrolyte balance, fluid management, acid-base equilibrium, and endocrine function: bleeding, hypotension, hypokalemia, hyperglycemia, reoperation, cardiac tamponade, acute renal failure, ventricular tachycardia, sepsis, stroke, and cardiorespiratory arrest<sup>23</sup>.

In such circumstances, when complications arise, it falls upon the perfusionist to effectively manage them and utilize their expertise to seek strategies to minimize or prevent them altogether. For nurses, their training and acquired knowledge through professional practice equip them to handle occurrences that are inherent in the daily routine of their profession with proficiency<sup>6</sup>. A study conducted in Boston aimed to develop predictive decision-making models for perfusionists during critical situations in the operating room through simulation. The findings revealed that simulation achieved an accuracy of 78.2% in predicting perfusionists' actions, highlighting the potential incorporation of computerized clinical decision support tools in the operating room to enhance patient safety and surgical outcomes<sup>17</sup>. Additionally, a systematic review indicated that simulation-based training can enhance subjective measures such as participants' confidence and short-term skill improvement<sup>24</sup>. Consequently, the use of simulators for (advanced) training is widely accepted and explicitly requested by perfusionists<sup>25</sup>.

Numerous factors contribute to the occurrence of adverse effects during surgery, including poor communication among multidisciplinary teams. Within the operating room, ensuring the quality and safety of care during the intraoperative period is a managerial responsibility of professional nurses. Nursing is engaged throughout the perioperative continuum, making it the primary team and catalyst for transformation within the healthcare system. In the surgical setting, nurses play a pivotal role in implementing best practices to ensure patient safety and deliver optimal care<sup>26</sup>.

Hence, continuous enhancement of understanding and communication among the entire surgical team regarding effective techniques based on studies is indispensable to deliver care to cardiac surgical patients that is free from harm and errors. An integrative literature review highlights that misunderstandings between surgeons and perfusionists during

weaning from ECC can arise due to unclear communication, potentially jeopardizing surgical success. To bolster surgical patient safety, the literature advocates for the utilization of checklists and communication protocols featuring standardized commands and responses. It is advised to avoid using ambiguous responses such as “ok” or “yes” during checks. When properly implemented and utilized, these tools amalgamate verification elements with objective information, providing the surgical team with a framework for decision-making and executing safety measures capable of mitigating the occurrence of adverse events<sup>27</sup>.

In efforts to enhance perfusionists’ skills, a study aimed to develop a non-technical intraoperative skills tool specifically tailored for these professionals. The Perfusionists’ Intraoperative Non-Technical Skills tool is designed to train and assess perfusionists in pertinent non-technical skills, potentially enhancing safety and optimizing surgical outcomes<sup>28</sup>. Additionally, within the context of ECMO, a study underscores the importance of utilizing tests for ECMO Specialist Certification<sup>29</sup>. Moreover, a study conducted at a California hospital outlines the transition from a perfusionist-led ECMO program to a nurse-led program. This change proved beneficial, as while perfusionists are experts in their field, their focus often centers solely on managing the ECMO device. By incorporating nurses into this role, a higher level of care was achieved, maintaining patient safety and bolstering the ability to provide holistic care<sup>30</sup>.

Given the multifaceted nature of perfusionists’ roles, it is imperative to evaluate these professionals concerning workload, stress, and physical exhaustion. In this context, a recent study showcased the utilization of digital biomarkers for the objective assessment of perfusionists’ workload and stress, derived from heart rate variability metrics captured using wearable physiological sensors during cardiac surgery. The study revealed that the high-frequency parameter of heart rate variability (HRV) exhibited the most robust association with task workload, bypass time, and patient length of stay in the hospital<sup>31</sup>.

In China, a study sought to gauge the prevalence of burnout among perfusionists and identify associated factors. The research involved 1,813 perfusionists. Findings revealed a high prevalence of burnout, with 86% experiencing burnout and 13.3% reporting severe burnout. Logistic regression analysis unveiled several factors associated with burnout and severe burnout. These included being in the age range of 20-29 years, education level, and professional training, while severe burnout was linked to factors such as being in

the age range of 20–29 years, professional training, annual number of ECC cases in the last three years, and income level among perfusionists<sup>32</sup>.

The interplay among task workload, acute stress, physical exhaustion, and professional performance is inherently complex and requires examination through a feedback loop perspective. Nevertheless, conducting research to evaluate the physical and mental health of healthcare professionals is crucial for upholding the quality of health services.

Despite acknowledging limitations such as the small number of perfusion nurses who participated in the research questionnaire, the study successfully achieved its objectives and offers significant insights into the performance of these professionals in cardiac surgery.

## CONCLUSIONS

The complexity of cardiovascular surgeries with ECC demands advanced and up-to-date knowledge, rapid clinical decision-making, proficiency in advanced technical skills, and adept handling of sophisticated technological equipment — attributes that define unique expertise. Consequently, the demand for competent professionals capable of delivering personalized and humanized care across multiple dimensions of patient needs becomes imperative.

In light of this, the role of perfusionist nurses holds significant relevance, encompassing a multitude of responsibilities in cardiac surgery, many of which are made feasible by the presence of ECC. These responsibilities span from compiling the patient’s nursing history to meticulously preparing and selecting equipment and monitoring strategies, materials, machinery, circuits, and devices for initiating and managing ECC. Moreover, the perfusionist nurses’ adept interaction with other team members before, during, and after surgery, characterized by effective communication, plays a crucial role in ensuring patient safety throughout the perioperative period.

The research findings underscored that specialization in perfusion and pursuing a career as a perfusionist nurse present promising prospects for nurses, elevating their prominence, relevance, and autonomy within the field. This is particularly evident when nurses embrace the challenge of becoming perfusionists with unwavering dedication and responsibility. However, it is worth noting that the study is constrained by the scarcity of current publications on the subject.



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None.

## CONFLICT OF INTERESTS

The authors declare there is no conflict of interests.

## AUTHORS' CONTRIBUTION

SBC: Project administration, Formal analysis, Conceptualization, Resources, Writing – review & editing, Validation, Visualization. LMSC: Data curation, Investigation, Methodology, Writing – original draft, Software. FAAS: Supervision, Validation. IPR: Supervision, Validation. HEFC: Writing – review & editing, Supervision, Validation, Visualization.

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