Sterile Processing Department: technological innovations in the last 45 years

Centro de Material e Esterilização: inovações tecnológicas nos últimos 45 anos

Centro de Material y Esterilización: innovaciones tecnológicas en los últimos 45 años

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ABSTRACT: Objective: To report the evolution of processes and technological innovations that occurred in the Sterile Processing Department (SPD) in Brazil, in recent decades. **Method:** Report of the experiences of a group of five nurses, from different generations, who witnessed changes in the SPD, from 1980 to 2025. **Results:** In the 1980s, SPDs were decentralized or partially centralized, with reuse of essential materials such as syringes and gloves. Over the years, there has been a worldwide concern about patient safety. In Brazil, in the 1990s, the Brazilian Health Regulatory Agency (Anvisa) was created. Legislation on infection control and prevention began to be published, along with the surgical and technological evolution, directly impacting the growth and evolution of SPD in terms of hard, soft-hard, and soft technologies. Although the uniformity related to the SPD routine practices of health institutions in the country consists in a challenge, currently, there are SPDs equipped with high technology similar to those of developed countries. **Conclusion:** Technological advances in the SPD, especially in hard and soft-hard technologies, have followed the global evolution, highlighting the importance of the role of nurses working in this area to promote safety and prevent the risk of healthcare-associated infections, improving patient quality and safety.

Keywords: Sterile Processing Department. History. Products technology.

RESUMO: Objetivo: Relatar a evolução dos processos e das inovações tecnológicas ocorridos no Centro de Material e Esterilização (CME) no Brasil, nas últimas décadas. **Método:** Relato das experiências de um grupo de cinco enfermeiros, de diferentes gerações, que presenciaram as mudanças no CME, no período de 1980 a 2025. **Resultados:** Na década de 1980, os CMEs eram descentralizados ou parcialmente centralizados, com reutilização de materiais essenciais, como seringas e luvas. Com o passar dos anos, surgiu a preocupação mundial com a segurança do paciente. No Brasil, na década de 1990, foi criada a Agência Nacional de Vigilância Sanitária (Anvisa). Legislações sobre o controle e a prevenção de infecção começaram a ser publicadas, juntamente com a evolução cirúrgica e tecnológica, impactando diretamente o crescimento e a evolução do CME no quesito tecnologia dura, leve-dura e leve. Embora a uniformidade relacionada às rotinas do CME das instituições de saúde no país seja um desafio, existem atualmente CMEs equipados com alta tecnologia, semelhantes aos de países desenvolvidos. **Conclusão:** Avanços tecnológicos no CME, principalmente na tecnologia dura e leve-dura, acompanharam a evolução do mundo, evidenciando a importância do papel do enfermeiro que atua nessa área para promover a segurança e prevenir o risco de infecções relacionadas à assistência à saúde, melhorando a qualidade e a segurança do paciente.

Palavras-chave: Central de material e esterilização. História. Tecnologia de produtos.

RESUMEN: Objetivo: Relatar la evolución de los procesos y de las innovaciones tecnológicas ocurridos en el Centro de Material y Esterilización (CME) en Brasil, en las últimas décadas. **Método:** Relato de las experiencias de un grupo de cinco enfermeros, de diferentes generaciones, que presenciaron los cambios en el CME, en el período de 1980 a 2025. **Resultados:** En la década de 1980, las CME eran descentralizadas o parcialmente centralizadas, y

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se reutilizaban materiales esenciales como jeringas y guantes. Con el paso de los años, surgió una preocupación mundial por la seguridad del paciente. En Brasil, en la década de 1990, se creó la Agencia Nacional de Vigilancia Sanitaria (Anvisa). Se comenzaron a publicar legislaciones sobre el control y la prevención de infecciones, junto con la evolución quirúrgica y tecnológica, lo que impactó directamente en el crecimiento y la evolución de las CME en cuanto a tecnología dura, blanda-dura y blanda. Aunque la uniformidad en las rutinas de las CME de las instituciones de salud del país sigue siendo un desafío, actualmente existen centrales equipadas con alta tecnología, similares a las de los países desarrollados. **Conclusión:** Los avances tecnológicos en las CME, principalmente en la tecnología dura y blanda-dura, acompañaron la evolución del mundo, evidenciando la importancia del rol del enfermero que actúa en esta área para promover la seguridad y prevenir el riesgo de infecciones asociadas a la atención de la salud, mejorando la calidad y la seguridad del paciente.

Palabras clave: Centro de Material y Esterilización. Historia. Tecnología de Productos.

INTRODUCTION

The Sterile Processing Department (SPD) emerged in hospitals with the advent of surgery, and its evolution is related to technical and logistical advances to reduce the impact of infections on patients submitted to these procedures[1]. Currently, at the hospital level, it is the sector responsible for cleaning, preparation, disinfection, sterilization, storage, and distribution of Healthcare Products (HP) that can be processed, used in the Surgical Center (SC) and other care units, playing a prominent role in preventing infections and ensuring patient safety[2].

It is a fundamental sector in the hospital environment by promoting patient safety, processing healthcare products, eliminating microorganisms, and thus ensuring the prevention of Healthcare-Associated Infections (HAI), providing indirect care to the patient. According to the World Health Organization (WHO), HAI are a global health issue[3,4].

In Brazil, Resolution No. 15 of the Brazilian Health Regulatory Agency (*Agência Nacional de Vigilância Sanitária* – Anvisa) guarantees the requirements of good practices for the processing of healthcare products by determining what the standardization of SPDs should be in the country. It classifies SPDs into class I and class II according to their organizational conditions[2]. In class I, noncritical, semi-critical, and critical healthcare products of noncomplex conformation, susceptible to processing, are processed; and in class II, noncritical, semi-critical, and critical healthcare products of complex and noncomplex conformation, susceptible to processing, are processed[2].

According to Emerson Mehry, technology can be classified into three types within the health area: soft, soft-hard, or hard[4]. Hard technology comprises machinery, equipment, cleaning and disinfection products, tests for process control; soft-hard, in turn, comprises structured knowledge, such as protocols, routine practices, legislation, and theories; and at last, soft technology comprises the technology linked to the relationships developed by health professionals, such as welcoming, humanization, and interaction with the other sectors of the hospital[5,6]. New technologies have driven the evolution of the SPD, positively impacting work processes[3].

In Brazil, the team working in the SPD is composed mostly of nursing professionals (nurses, nursing technicians, and assistants)[3,7]. The nurse is fundamental in this department, acting on several fronts, such as in the management of the unit, training, supervision of the team and the functioning of the sector, in the guarantee of processing flows, reducing costs and, consequently, prolonged hospitalizations due to infections, promoting safe patient care indirectly[3,7].

This report was developed based on the authors' reflection, all with extensive experience in the SPD, reflecting historical aspects that involve the evolution of this department. Nowadays, technologies, especially hard ones, are an essential part of the routine and assist in ensuring the delivery of products with proper cleaning and sterilization. The retrospective of evolution over the last 45 years will help new generations of professionals to understand the technological evolution in this sector.

OBJECTIVES

To report the evolution of processes and technological innovations that occurred in the SPD, in Brazil, in recent decades.

METHODS

This is a reflective report describing the experiences of a group of nurses from different generations, who witnessed changes that occurred in the SPD, from 1980 to 2025.

The five nurses who wrote this study completed their undergraduate nursing degree in 1981, 2000, 2007, 2011, and 2020, reflecting a heterogeneous generational composition and with different educational contexts over four decades. The nursing student, who receives a Research Initiation Scholarship from the National Council for Scientific and Technological Development (*Conselho Nacional de Desenvolvimento Científico e Tecnológico* – CNPq) and who contributed to this article, took a course that contemplated the study of this sector. Three nurses, during their professional career, worked in several SPDs, both in general hospitals and specialized hospitals, public and private, with time working in this area corresponding to 45, 14, and 13 years. Two of them are currently managers of this sector, one in a public hospital and the other in a private institution. The other two authors work in sectors closely linked to the SPD such as the surgical center and Intensive Care Unit (ICU). It was considered that everyone has experience in the SPD, directly or indirectly. Three of the authors are part of the board of the Brazilian Association of Nurses of the Surgical Center, Anesthetic Recovery and Sterile Processing Department (*Associação Brasileira de Enfermeiros de Centro Cirúrgico, Recuperação Anestésica e Centro de Material e Esterilização* – SOBECC), in the 2026–2027 administration, and are recognized in their fields of activity.

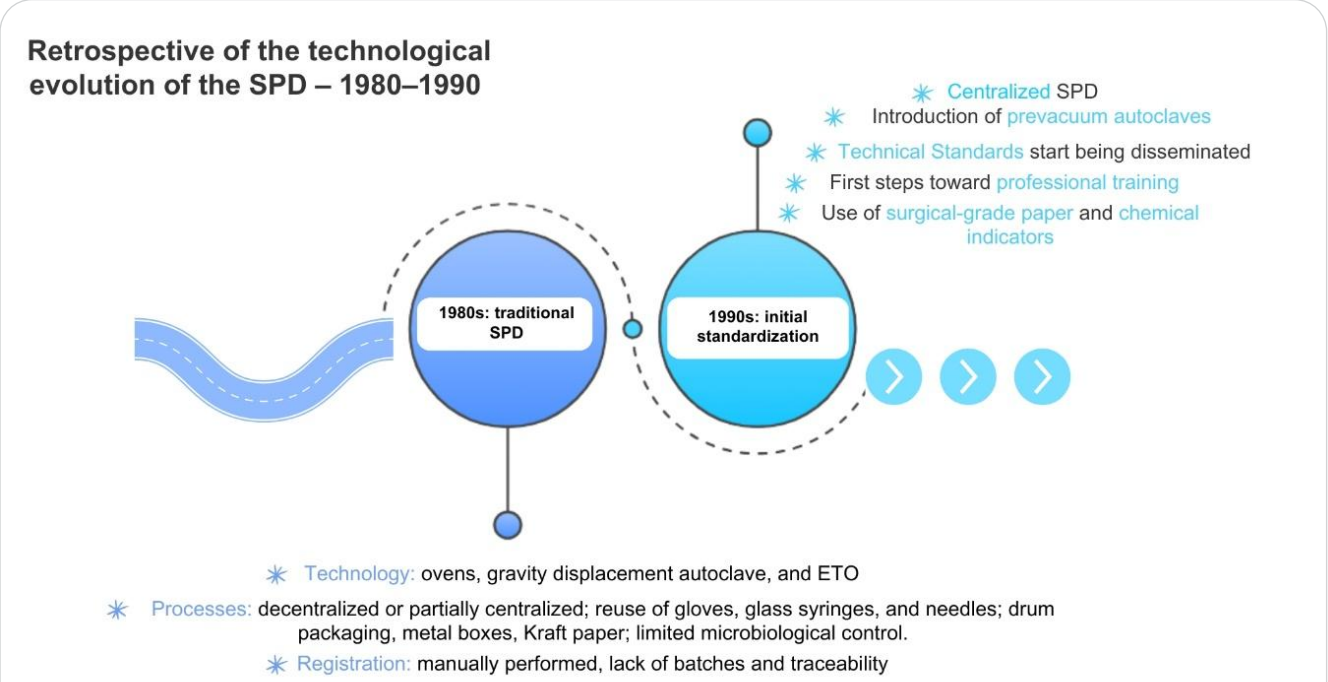
The experience report was carried out during meetings and collective development, via *Google Meeting, WhatsApp* tools, and emails.

RESULTS

The results are presented in infographics, as shown in Figures 1 and 2. The images were developed to present a synthetic overview, making a retrospective of the technological evolution of the SPD, with highlights that marked the described period and reflected the experience of nurses and their work in the sector.

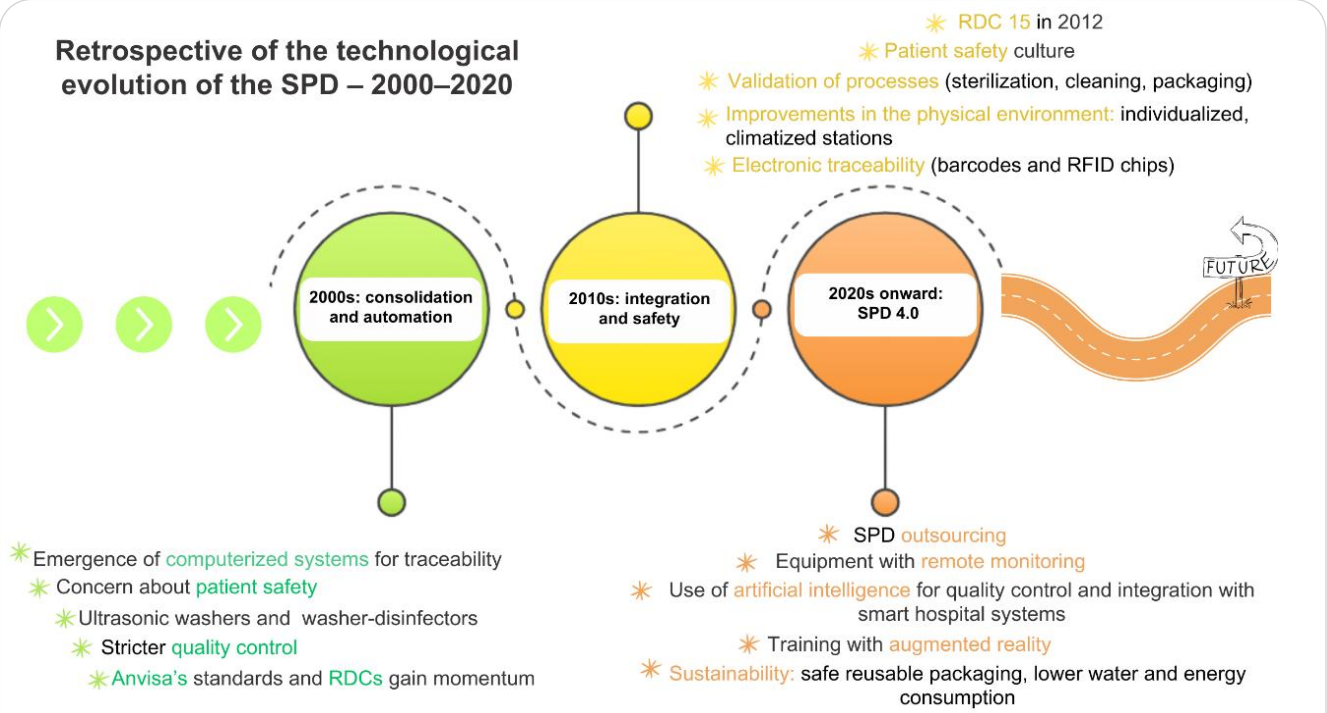
DISCUSSION

In the history of nursing education in Brazil, it is observed that, since its organization, the curricula have contemplated the presence of disciplines focusing on surgical care, healthcare products processing, and prevention and control of infections, usually inserted in the curricula under the name "Surgical Nursing"[8]. Although the SPD is linked to the history of nursing education, the advancement in knowledge



SPD: Sterile Processing Department; ETO: Ethylene oxide sterilization.
Source: Prepared by the authors.

Figure 1. Retrospective of the technological evolution of the Sterile Processing Department, from 1980 to 1990.



SPD: Sterile Processing Department; RDC: Anvisa Board Resolution; RFID: radio-frequency identification; Anvisa: Brazilian Health Regulatory Agency.
Source: Prepared by the authors.

Figure 2. Retrospective of the technological evolution of the Sterile Processing Department, from 2000 to 2020.

and in systematization of the work practice in the SPD has occurred in the last four decades. Next, we will discuss each step of the HP processing.

Cleaning process

Cleaning, the central nucleus of HP, had a steady advance in processes and procedures, as surgical instruments have become increasingly complex and sophisticated, hindering their hygiene and forcing the constant updating of equipment aimed at methods for material processing[9].

According to one of the authors of this report, in the early 1980s, when she started working as a nurse at the SPD, materials were manually sanitized and the processes were not standardized, as the SPD was decentralized or partially centralized, that is, the cleaning of these materials was either carried out in the patient care sector and sterilization, in existing ovens in the very sector; or the items were taken to the SPD only for sterilization. Reuse of materials, such as surgical gloves, glass syringes, and stainless-steel needles, was a common practice. At that time, the Ministry of Health started to worry about multidrug-resistant microorganisms (MDROs), in such a way that, in 1983, the agency published the first ordinance (No. 196) on the prevention and control of hospital infections, forcing all hospitals in the country (private and public) to implement hospital infection control committees (HICCs)[10].

In the late 1990s, in Brazil, video-assisted surgeries began. To expedite one surgery after the other, with few instruments of video-assisted surgery, the materials used in these procedures were washed without being dismantled and then dipped in a sterilizing chemical solution, without waiting for the specified time for sterilization. These inadequate practices were determinant for the emergence of a rapidly growing mycobacteria (RGM) outbreak[11] throughout the country. In 1999, two historical milestones indirectly determined changes in the SPD: the creation of Anvisa and the publication of the report *To Err is Human: Building a Safer Health System*, by the United States Institute of Medicine (IOM), showing the alarming occurrence of errors in the health system and its devastating impact on hospitals[12,13].

In the 2000s, enzymatic detergents began to be incorporated. Supplies, such as specific brushes, were inserted to assist in the manual cleaning of materials, parallel to the

advance of hard technologies, with equipment for the automated cleaning process and washer-disinfectors, which began to be used in some SPDs.

The World Alliance for Patient Safety, launched by the WHO in 2004, in order to reduce adverse health consequences and promote safe care, reinforced the importance of the SPD as an essential sector for infection control and patient safety. This alliance published, in its last edition (2021), the Global Action Plan for Patient Safety, with targets until 2030[14]. In 2009, Anvisa published its Board Resolution (RDC) No. 08[11], which provides for measures to reduce RGM infections in health services.

The journal of the Brazilian College of Surgeons published a note describing possible causes for the outbreak of RGM infections after video procedures, such as failures in disinfection or sterilization methods, mechanical cleaning process, and dismantling of parts, time of exposure to sanitizers, and possible emergence of a strain resistant to disinfecting agents[11,15].

Between 2010 and 2019, pre-cleaning was established as a routine practice to reduce microbial load in order to avoid biofilm formation, increasing automated cleaning by washer-disinfectors with the use of enzymatic detergents[9]. During this period, cleaning tools were improved, such as water and air pressure guns and brushes for various purposes. A soft-hard technology deemed a historical milestone for Brazilian SPDs was the first specific legislation, also published by Anvisa (RDC No. 15/2012), which provides for requirements for good practices for the processing of healthcare products, including aspects such as infrastructure, team training, safety at work, and quality of processes[2].

From 2020 to 2025, hospital cart washers, steam sterilizers, and ultrasonic washers were incorporated into several SPDs for cleaning HP. Cleaning chemical controls, such as tests for detection of protein residues and cleaning indicators for disinfecting cannulated washers, were improved[9]. The monitoring of the cleaning of processed products should be extensive, including both the results of visual inspections and chemical and biological tests, encompassing the internal (lumens) and external (surfaces) parts of the equipment and the processed products. It is paramount to test the effectiveness of the equipment used and to monitor critical process parameters, such as temperature, usually obtained by the parametric register of the equipment. The importance of this monitoring lies in the possibility of the presence of residual biological load in instruments and equipment capable of compromising both cleaning processes, disinfection, and sterilization[16].

Preparation process: inspection and packaging

According to the experience of one of the authors of this report, in 1980, the inspection of materials after cleaning was not a daily practice, because many materials arrived at the SPDs already washed and packaged, coming from other units. In the 1990s, the SPDs began to be centralized and the inspection of the cleaning of the materials became part of the routine practices, relying on the aid of magnifying glasses, lighting in the stands, among other materials, for inspection. Manual traceability was also established after cleaning the materials. Currently, this traceability is automated. In 2010, the traceability system started the automation process, with the implementation of specialized software, including barcode labels, DataMatrix codes (two-dimensional barcodes), Radio-Frequency Identification (RFID), and batch registration of all processing steps.

Since the 1980s, material packaging has undergone continuous evolution. Initially, they were packed in drum packaging, metal boxes, Kraft paper, cotton fabric (double-cloth), manila paper, and paper towel. However, in 2012, through RDC No. 15, Anvisa banned these types of packaging, requiring the use of regulated materials, such as surgical-grade paper, approved for sterilization in SPDs[2]. Currently, crepe paper, surgical-grade paper, Tyvek, Spundbond-Meltblow-Spundond (SMS), and containers are utilized.

Packaging for surgical instruments depends on compatibility with the equipment used in the sterilization process. For instance, cellulose-containing packaging is not compatible with hydrogen peroxide sterilization[9]. Packaging is essential to ensure the microbial barrier, maintaining product sterility, protecting it from contamination, physical damage and dust during storage and transportation until use. Therefore, defects or failures in this process can compromise their quality and patient safety[17]. The supplies used for the development of packaging must meet some criteria, such as allowing effective microbial barrier, enabling sterilization and nontoxicity, and having good physical properties and dimensional stability[17].

Since 2025, there are SPDs in Brazil that have, in the preparation area, individualized computerized work stations with the traceability of materials and tables adapted for the ergonomics of professionals working in this sector[2].

Sterilization and indicators

The evolution of sterilization in the SPD was determined by the type of steam sterilizer (autoclave) that marked each decade: in the 1980s, the gravity displacement autoclave was used[18]; in the 1990s, prevacuum sterilizer was gradually introduced, improving steam penetration and reducing sterilization failures[19]; in the 2000s, high-speed prevacuum sterilizers were used[20]; in 2010, prevacuum sterilizer with advanced monitoring[20]; from 2020 to 2025, prevacuum autoclaves with digital monitoring and parametric validation[21,22].

There are other alternative methods of sterilization, and the choice will depend on the type of material to be processed. One of the nurses in this report found that, in 1980, there was a dry-heat oven in the SPD. Ethylene Oxide (ETO) was also used at the time to sterilize heat-sensitive materials, although in 1999 ETO was not allowed within hospital institutions[23]. In the late 1990s, hydrogen peroxide began to be used for thermosensitive materials[24]; currently, there are options for sterilization—such as ethylene oxide, hydrogen peroxide plasma, and low-temperature steam and formaldehyde sterilization.

Advances have also occurred in chemical and biological monitoring. Chemical indicators have evolved, and currently there are six classes to monitor specific sterilization parameters, namely: Type 1—sterilization process indicator tapes; Type 2—Bowie & Dick; Type 3—a single process parameter is assessed; Type 4—multiparameter indicators; Type 5—integrators (react to all critical variables); and Type 6—emulating indicators, designed to react to all critical variables for specific sterilization cycles. These controls evolve according to technological advances in health, for example, process challenge device with pre-assembled chemical and/or biological indicator equivalent to that produced in the SPD, with fabric and Bowie & Dick electronic test[9].

The turnaround time for biological indicator results has evolved over the decades. Ovens used for test incubation initially released the result from 24 to 48 hours; later, the reading took 1 to 3 hours; and currently, reading can take 20 minutes to 7 seconds.

Nowadays, one of the greatest concerns related to sterilization is the impact of gases released by machines on the environment. Low-temperature sterilizers based on hydrogen peroxide plasma have been highlighted by their high microbiological efficiency, lower energy consumption, and reduced toxic waste generation[25]. The use of sustainable technologies, without compromising the quality and safety of processes within the SPD, is an effective strategy to reduce environmental impact[25].

Storage of sterile material and sterilization indicators

While in the 1990s the materials were stacked on wooden shelves without concern for air quality and humidity control at storage locations, in the 2000s, the shelves were made of metal, plastic, and Formica, with storage at appropriate locations—such as metal towers and baskets—for each type of material processed. Nowadays, it is known that sterile materials kept with intact packaging and sealing remain sterile until an event or damage to the integrity of the package occurs, in such a way that the storage process of the sterile material must maintain the safety of the process, preserve packaging and air quality, and control humidity[26], although legislation still recommends the need to indicate the shelf life.

CONCLUSION

This experience report, based on the perspectives of five nurses, described the changes and advances of hard and soft-hard technologies in SPDs over the last 45 years. Although soft technology has also evolved in the SPD, it was not the focus of this report. This evolution has accompanied broader societal and technological developments, showing positive impacts on the health area, with prevention and control of infections and increased patient safety. The nurse, historically, is the professional most qualified for managing the SPD. Technology is a powerful instrument, but the human factor (communication, appreciation, leadership) remains irreplaceable to ensure process effectiveness and patient safety.

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None.

CONFLICT OF INTERESTS

The authors declare there is no conflict of interests.

AUTHORS' CONTRIBUTIONS

LMS: Project administration, Conceptualization, Data curation, Investigation, Methodology, Writing – original draft. CFMO: Conceptualization, Data curation, Investigation. IBRS: Conceptualization, Writing – review & editing. LLM: Conceptualization, Writing – review & editing. DDT: Conceptualization, Writing – review & editing. RCAC: Project administration, Formal analysis, Investigation, Methodology, Writing – review & editing, Supervision, Validation.

DECLARATION OF USE OF ARTIFICIAL INTELLIGENCE (AI)

During the writing of this article, the authors used ChatGPT to assist in some information, Opens Evidence and Consensus to search for articles, and Napkin AI for the development of images. After using these tools/services, the authors reviewed and edited the content, as necessary, and take on full responsibility for the publication content.

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