Flexible endoscope processing: execution of the steps from the perspective of professionals

Processamento de endoscópios flexíveis: a execução das etapas sob a ótica dos profissionais

Procesamiento de endoscopios flexibles: la ejecución de las etapas desde la perspectiva de los profesionales

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ABSTRACT: Objective: To identify studies in the literature that address the processing of flexible endoscopes in the context of the challenges presented regarding the omission and difficulty of the steps and the perception of the process from the perspective of professionals. **Method:** Integrative review that included original articles, without an initial time frame, published up to February 2023, available in the Cochrane Library, Scopus, Web of Science, Medical Literature Analysis and Retrieval System Online (Medline), and United States National Library of Medicine (PubMed) databases. Controlled descriptors in Health Sciences and the PICO strategy were used. **Results:** Five articles were identified for analysis. The sealing test, pre-cleaning, alcohol instillation and manual cleaning were the steps most likely to be omitted (20%). Pre-cleaning (20%), drying (20%), manual cleaning (40%) and connecting the device to the automated washer (40%) are the most difficult steps. The lack of internal visibility of the channels (20%), lack of knowledge (40%), excessive use of memory by professionals (40%) and pressure to complete processing (60%) make it difficult to execute the steps. **Conclusion:** The omitted steps, the factors contributing to the omission and the perception of professionals can be valuable indicators for reviewing services and processes, aiming to ensure their effectiveness.

Keywords: Gastroscopes. Patient safety. Nursing staff. Disinfection. Endoscopes.

RESUMO: Objetivo: Identificar na literatura estudos que abordem o processamento de endoscópios flexíveis no contexto dos desafios apresentados quanto à omissão e dificuldade das etapas e à percepção do processo sob a ótica dos profissionais. **Método:** Revisão integrativa que incluiu artigos originais, sem recorte temporal inicial, publicados até fevereiro de 2023, disponíveis nas bases de dados *Cochrane Library*, *Scopus*, *Web of Science, Medical Literature Analysis and Retrievel System Online* (*Medline*) e *United States National Library of Medicine* (*PubMed*). Utilizou-se descritores controlados em Ciências da Saúde e estratégia PICO. **Resultados:** Foram identificados cinco artigos para análise. O teste de vedação, a pré-limpeza, instilação de álcool e limpeza manual foram as etapas mais propensas à omissão (20%). Pré-limpeza (20%), secagem (20%), limpeza manual (40%) e conexão do aparelho à lavadora automatizada (40%) são as etapas mais difíceis. A não visibilidade interna dos canais (20%), falta de conhecimento (40%), o uso excessivo da memória pelos profissionais (40%) e a pressão para concluir o processamento (60%) dificultam a execução das etapas. **Conclusão:** As etapas omitidas, os fatores contribuintes para omissão e a percepção dos profissionais podem ser indicadores valiosos para a revisão dos serviços e processos, visando a garantia de sua efetividade.

Palavras-chave: Gastroscópios. Segurança do paciente. Recursos humanos de enfermagem. Desinfecção. Endoscópios.

RESUMEN: Objetivo: Identificar estudios en la literatura que aborden el procesamiento de endoscopios flexibles en el contexto de los desafíos presentados en cuanto a omisión y dificultad de las etapas y la percepción del proceso desde la perspectiva de los profesionales. **Método:** Revisión integradora que incluyó artículos originales, sin marco temporal inicial, publicados hasta febrero de 2023, disponibles en las bases de datos de la Biblioteca Cochrane, Scopus, Web of Science, Sistema de Recuperación y Análisis de Literatura Médica en Línea (Medline) y Biblioteca Nacional de Medicina de Estados Unidos (PubMed). Se utilizaron descriptores controlados en Ciencias de la Salud y la estrategia PICO. **Resultados:** Fueron identificados cinco artículos

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para el análisis. Prueba de sellado, limpieza previa, instilación de alcohol y limpieza manual fueron los pasos que con mayor probabilidad a la omisión (20%). Limpieza previa (20%), secado (20%), limpieza manual (40%) y conexión del aparato a la lavadora automatizados (40%) son los pasos más difíciles. Falta de visibilidad interna de los canales (20%), desconocimiento (40%), uso excesivo de la memoria por parte de los profesionales (40%) y presión para completar el procesamiento (60%) dificultan la realización de los pasos. **Conclusión:** Los pasos omitidos, los factores que contribuyen a la omisión y la percepción de los profesionales pueden ser indicadores valiosos para evaluar los servicios y procesos, buscando garantizar su efectividad.
Palabras clave: Gastroscopios. Seguridad del paciente. Personal de enfermería. Desinfección. Endoscopios.

INTRODUCTION

Gastrointestinal endoscopy is a widely utilized procedure and is among the most recommended techniques for investigating and treating diseases of the gastrointestinal tract. It is regarded as an essential method for evaluating lesions in this area through diagnostic imaging[1-3].

Data from the Ministry of Health indicate that in Brazil, 1,178,636 digestive endoscopy exams were performed in 2022 within the outpatient network of the Brazilian Unified Health System (*Sistema Único de Saúde* – SUS), including upper digestive endoscopy and colonoscopy[4]. This figure is likely underreported, as it does not account for procedures conducted in private facilities or through health insurance plans.

The use of a flexible endoscope is required to perform these procedures. This demands significant attention, as the device consists of long channels, is made of delicate materials, has a complex design, is highly challenging to clean, and, most importantly, involves a high acquisition cost[2,5].

Thus, the processing of these devices presents a challenge for professionals, as the external and internal surfaces of gastroscopic devices are exposed to a high microbial load during use, with the channels accumulating a load ranging from 10^5 to 10^8 CFU/mL. In this context, more than 100 steps are required to adequately decontaminate the equipment, which must be performed in sequence, beginning with pre-cleaning, followed by cleaning, rinsing, disinfection, drying, and storage in a safe and rigorous manner[2,6-10].

Numerous studies report human errors related to the processing steps[11-13], with the most frequent being the omission of pre-cleaning[11,14], the absence of leak testing[8,11-12], insufficient drying[13,15], and improper storage of the equipment[12,14-16]. Other studies have documented the recovery of microorganisms with pathogenic potential, such as *Streptococcus* spp., *Staphylococcus* spp., *Escherichia coli*, *Pseudomonas* spp., and *Klebsiella* spp., on the channels and surfaces of endoscopic devices, even after the equipment has undergone high-level disinfection[9,17,18].

Factors contributing to failures in the processing of these devices, aside from the structural aspects of the equipment and the human resources involved, include: the absence of properly implemented decontamination protocols; lack of water quality control; insufficient equipment to meet procedural demand; inadequate training, and lack of feedback for professionals responsible for cleaning and disinfecting the devices, among other factors[2,7,8].

In this context, while numerous studies highlight flaws in the processing of gastroscopic devices, few have focused on analyzing the challenges of implementing this process and the perception of its stages from the perspective of the professionals involved.

OBJECTIVE

To identify studies in the literature that address the processing of flexible endoscopes in the context of the challenges presented regarding the omission and difficulty of the steps and the perception of the process from the perspective of professionals.

METHOD

An integrative literature review was conducted to compile and synthesize research findings on a specific topic, contributing to the advancement of knowledge on the subject under investigation[19]. To achieve this, the following guiding question was established: How has the processing of flexible endoscopes been carried out in relation to the challenges of execution and the perception of its stages, from the perspective of the professionals involved in this activity?

Challenges in executing endoscopic processing steps are understood as the omission or neglect of certain stages, influenced by various factors that compromise proper processing practices[20].

The construction of this study covered the following methodological steps:

1. Definition of the research question;
2. Establishment of criteria for literature review article selection;
3. Categorization of the studies;
4. Full evaluation of the articles included in the review;
5. Data analysis and interpretation (5); and
6. Data synthesis and knowledge dissemination[21].

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were also applied to ensure the quality and reliability of the information obtained[22].

To address the research question, the literature review focused on studies that examined the processing of flexible endoscopes in the context of the challenges involved in its implementation, from the perspective of the professionals involved. The PICO strategy[23] was adopted to select the search descriptors: P (Population) = nurses, endoscopy professionals, human resources; I (Intervention) = reprocessing, disinfection, infection control; C (Comparison) = not applicable; O (Outcomes) = endoscopic devices, quality, perception.

Publications were selected from the Health Sciences Descriptors (*Descritores em Ciências da Saúde* – DeCS) and Medical Subject Headings (MeSH) in both Portuguese and English, using the following terms: gastrointestinal endoscopes, disinfection, infection control, quality control, patient safety, nursing, nurses, and endoscopy. Additionally, the following uncontrolled descriptors were used: human factor, processing technician, endoscope processing, and reprocessing. All descriptors were applied individually and in combination using the AND connector across all databases. Articles were retrieved from the Coordination for the Improvement of Higher Education Personnel (*Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* – CAPES) Portal and the Virtual Health Library (*Biblioteca Virtual em Saúde* – BVS), utilizing databases such as the Cochrane Library, Scopus, Web of Science, Medical Literature Analysis and Retrieval System Online (Medline), and the United States National Library of Medicine (PubMed).

This study included original articles, with no initial time frame, published up until February 2023, that explored the perceptions of digestive endoscopy professionals regarding endoscopic processing. Articles were excluded if, despite addressing the topic, they were not freely available in full text.

Based on the established strategy, 1,160 articles were identified. The initial selection involved exploratory reading of titles and abstracts, resulting in the identification of 30 studies. These selected articles were read in full, and after excluding duplicates and those that did not fit the research scope, a final sample of 5 articles was obtained, as shown in Figure 1.

The studies were classified according to their level of evidence, based on the evaluation of reliability and validity, which takes into account the methodological approach and research design employed:

Level 1: meta-analysis (randomized controlled clinical trials);
Level 2: experimental design;
Level 3: quasi-experimental studies;
Level 4: descriptive studies or studies with a qualitative approach;
Level 5: case or experience reports;
Level 6: evidence based on expert opinions or consensus[24].

This study did not involve research with human subjects and, therefore, did not require approval from the Research Ethics Committee (CEP).

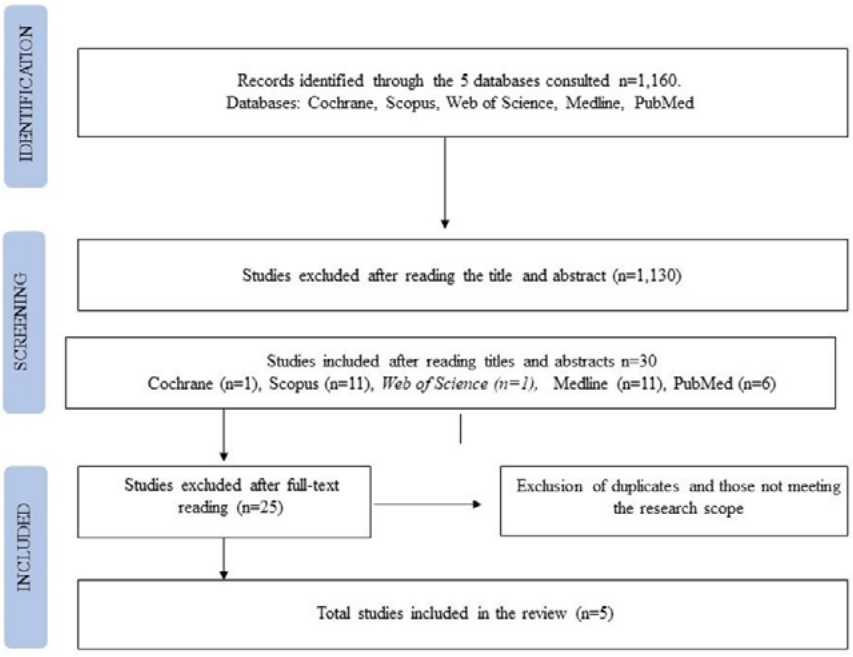
RESULTS

The sample comprised 5 articles: 1 published in 1992 (1/5), 2 in 2010 (2/5), 1 in 2011 (1/5), and 1 in 2022 (1/5). In terms of publication origin, there was a predominance of studies conducted in the United States (4/5), followed by Canada (1/5).

All studies (5/5) were classified as descriptive research designs (cross-sectional and prospective), corresponding to an evidence level of 4. For data collection, 60% (3/5) of the studies utilized a questionnaire; 20% (1/5) employed field observation; and 20% (1/5) used interviews.

The following is a summary table of the identified works, organized by year of publication, location, objectives, and the main results based on the perceptions of professionals involved in the processing (Chart 1)[20,25-28].

Among the steps in the processing of endoscopic devices, 20% of the studies indicated that the sealing test, rinsing, brushing, and drying are very important during the process. Conversely, cleaning the brush each time it is inserted into the channels during the cleaning step and performing the leak test were identified as the steps with the lowest degree of difficulty (20%).



Source: PRISMA, 2020.

Figure 1. Prisma of the publication search strategy

The sealing test, pre-cleaning, alcohol instillation, and manual cleaning were the steps most frequently omitted (20%). Pre-cleaning (20%), drying (20%), manual cleaning (40%), and connecting the device to the automated washer (40%) were identified as the most challenging steps in the process.

The difficulties encountered in executing the processing steps were attributed to several factors: lack of internal visibility of the channels (20%), forgetfulness (20%), inadequate facilities (20%), quality of training (20%), design of endoscope devices (20%), lack of knowledge (40%), excessive reliance on memory (40%), and pressure to complete processing quickly (60%). Figure 2 illustrates the frequency of professionals' perceptions regarding the processing steps as reported in the evaluated articles.

DISCUSSION

Safe processing of endoscopic devices necessitates strict adherence to both national and international guidelines, with human error identified as the primary cause of inadequate processing[29]. The numerous stages and steps involved in processing these devices contribute to the potential for errors, as over 100 sequential actions must be performed[2,6-8]. This extensive list of actions, combined with structural issues of the devices and the specificities of endoscopy services, can result in a mentally taxing process. Professionals often face challenges related to memorizing multiple tasks and the pressure to complete them swiftly, given the tight schedules for examinations and limited technological resources to meet this demand[30].

In the analysis of the studies included in this review, pre-cleaning was identified as one of the steps most likely to be omitted by endoscopy professionals[25]. It is important to note that pre-cleaning serves to remove coarse debris from the surfaces of the device before the microbial load dries on the equipment, which can hinder its removal — promoting biofilm formation within the channels[31-33]. The thorough execution of pre-cleaning is essential for the success of subsequent steps, especially considering that inadequate cleaning can compromise the effectiveness of the entire process[11-14].

It is noteworthy that the sealing test, although regarded as an important and straightforward step, is frequently omitted[25]. This test should be conducted prior to cleaning, as its primary purpose is to identify any damage to the external and internal surfaces of the equipment, including perforations, inadequate fitting between parts, gaps, and breaks that may allow air to escape and liquids to enter. Neglecting this test can compromise the safety of the endoscopic device processing. The most significant risk arises from the potential for secretions, organic matter, water, and sanitizing products to infiltrate, leading to

Chart 1. Synopsis of articles included in the study, according to objectives and main results, related to the processing stages of endoscopic devices. Belo Horizonte (MG), Brazil, 2023.

Author/Location	Study Objective	Main Results
Hildebrand et al.[25] The United States of America	To determine the most difficult steps and tasks prone to errors, as well as to identify potential factors contributing to errors.	– Connection of the device to the automated washer – the most difficult step. – Perception: the complexity of the endoscope design, lack of knowledge about the device, and excessive reliance on professional memory contribute to errors and omissions in processing.
Ofstead et al.[20] Canada.	To evaluate endoscope reprocessing practices, staff perceptions, and occupational health.	– Sealing test, brushing, rinsing, and drying – very important steps.
		– Sealing test, pre-cleaning, alcohol instillation, and manual cleaning — the most frequently omitted steps.
		– Perception: pressure to complete processing quickly leads to the omission of steps.
Hildebrand et al.[26] The United States of America.	To identify human factors that influence the reprocessing of flexible endoscopes.	– Excessive use of memory is required for performing all steps. – Cleaning — hindered by the lack of visibility in the channels. – Connection of the device to the automated washer —the most difficult step. – Cleaning of the brush with each introduction into the channels and sealing test — the least difficult steps. – Perception: forgetfulness regarding the sequence and lack of knowledge.
Foss et al.[27] The United States of America	To identify endoscope cleaning practices and perceived risk of cross-contamination.	– Cleaning — the most difficult step. – Perception: pressure to process quickly contributes to step omissions.
Sivek et al.[28] The United States of America	To assess endoscope reprocessing practices, to identify human issues, and occupational health concerns in the reprocessing of duodenoscopes.	– Pre-cleaning, manual cleaning, and drying — the most difficult steps. – Perception: factors such as pressure to complete processing quickly, inadequate facilities for processing, quality of training, and memory overload hinder processing steps.

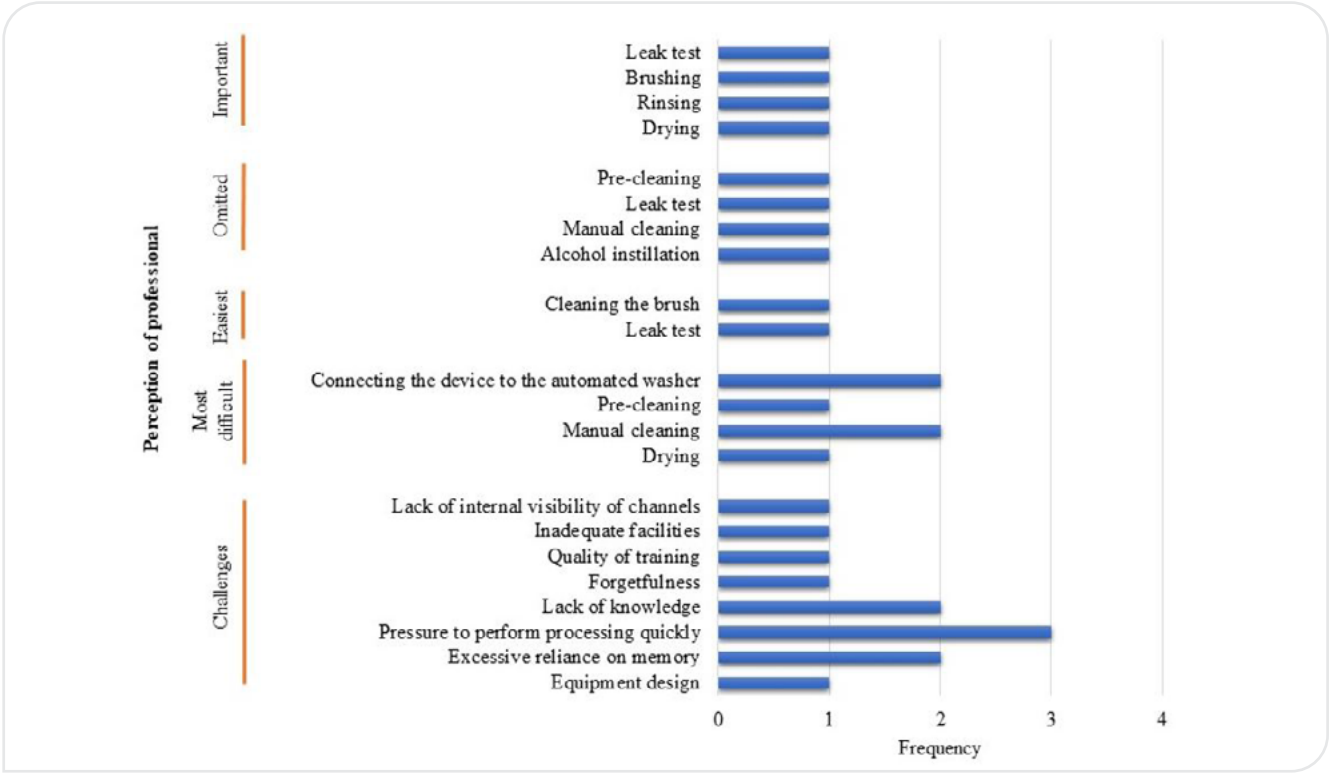


Figure 2. Frequency of perceptions regarding the challenges reported for completing the processing steps found in the evaluated articles (n=5). Belo Horizonte (MG), Brazil, 2023.

structural damage, device malfunction, failures in disinfection, and the transmission of microorganisms[6,34]. The omission of the sealing test has been supported by other studies, indicating that it is often not performed across various services[11,12].

Cleaning has also been identified as a frequently omitted step, despite the acknowledged importance of brushing the channels[25]. This step is essential for effective equipment processing and should be performed immediately after the sealing test. To achieve the desired results, it is critical to use appropriate tools, such as specific brushes that are of the correct diameter and allow for adequate friction along the entire length of the equipment channels[2,31,35]. Neglecting this step raises significant concerns, as failures during this phase can lead to the accumulation of organic matter in the channels, the formation of biofilm, and the transmission of microorganisms, which have been linked to multiple outbreaks[13,36,37].

Rinsing and drying, although considered very important steps[25], represent a critical phase in the processing of endoscopic devices and warrant particular attention[35]. Rinsing should be conducted using ample amounts of sterile or filtered water to effectively remove residues of the sanitizing agent[38], thereby preventing contamination of the equipment[1,39]. Subsequently, the endoscopic devices must be thoroughly dried to eliminate all moisture from both the internal and external surfaces. This is essential to prevent the proliferation of microorganisms, as residual moisture can serve as a breeding ground for pathogens[40-42].

Concerning the instillation of alcohol into the equipment channels, its omission was noted in the study by Ofstead et al.[20]. The practice of instilling alcohol after the drying stage, recommended by various guidelines[33,35], is not universally accepted, particularly in countries with a high incidence of prion diseases, such as France and the United Kingdom. This caution arises from alcohol's potential to promote protein fixation and contribute to biofilm formation[2,8,15]. Additionally, some studies have demonstrated that instilling alcohol into the channels may not effectively enhance the drying process[41].

Connecting the device to the automated washer was identified as the most challenging step by some professionals[24]. Utilizing such equipment necessitates a higher level of skill, as it involves connecting the endoscopic device to specific connectors on the washer and programming all processing steps through the equipment panel[2]. It is crucial to acknowledge that failures in the automated disinfection process can jeopardize patient safety by potentially triggering outbreaks[12,38], and difficulties in executing this step may result in procedural failures or even the omission of the process entirely[25].

Regarding potential difficulties in processing endoscopic devices, professionals reported feeling pressured during the processing of equipment[25,27] and reported excessive use of memory[26,28]. This pressure is often attributed to overloaded exam schedules and an insufficient number of devices, which hinders the ability to meet demand without delaying scheduled procedures. Such circumstances contribute to professionals feeling compelled to skip steps or abbreviate procedures, thereby compromising the overall safety of the processing[25].

Memory overload must be carefully considered, particularly given that the processing of endoscopes involves numerous steps that need to be performed sequentially and with attention to detail. Additionally, different services may utilize equipment from various manufacturers, each with distinct configurations and technologies. Consequently, professionals are required to memorize diverse processing methods[2].

The complexity of endoscopic equipment[24,26], characterized by long channels, delicate materials, and intricate designs that hinder internal visual inspection of cleaning quality[35], should be recognized as a predisposing factor for processing failures[43].

In addition to design considerations, the lack or scarcity of knowledge[26] regarding processing has also been identified as a complicating factor. To address this issue, endoscopy services must prioritize the training and continuous qualification of their professionals prior to the commencement of activities and on an ongoing basis, aligning with the developed activities[44]. This training process should encompass topics such as infection prevention and control in healthcare settings, the use of personal protective equipment (PPE), monitoring the effectiveness of sanitizing agents; and the cleaning, disinfection, sterilization, storage, transportation, operation, and handling of equipment and accessories[2,9,35,45]. Research has shown that professional participation in training focused on endoscope processing is significantly associated with improved adherence to processing guidelines for the devices[45,46].

It is important to recognize that endoscopy services vary in their particularities, degrees of complexity, technological infrastructure, and the availability of human and financial resources, resulting in diverse experiences for workers. The fact that crucial steps — such as pre-cleaning, sealing testing, and cleaning — are frequently omitted whether due to the pressure to expedite the process in response to tight schedules or due to a lack of awareness of their significance, raises significant concerns about the safety of the process.

Another important aspect to highlight is the limited body of research focusing on the perspective of professionals involved in endoscopic processing. This underscores the need to deepen

and intensify discussions on the topic, as understanding and considering the viewpoints of those performing these processes can be a promising step toward improving practices and ensuring process safety. Protocols and guidelines must be aligned with the actual tasks performed to ensure safe care for patients, professionals, and institutions. It is crucial to recognize that established protocols alone may not guarantee safe execution. Factors such as human resources training, infrastructure, scheduling, and the technological capacity of the services must also be considered.

The limited number of studies addressing the proposed topic was identified as a limitation of this study, which hindered a broader analysis of the challenges and perceptions of professionals regarding endoscopic processing.

CONCLUSION

From this literature review, it was observed that the processing of flexible endoscopes, particularly regarding the stages involved from the professionals' perspective, is a topic that has been insufficiently explored and warrants further attention from researchers.

The studies analyzed indicate that critical steps such as the sealing test, pre-cleaning, and cleaning are often omitted or abbreviated, which can severely compromise the safety of procedures. These omissions are frequently linked to equipment design, the demand for excessive memory use, the pressure to expedite processing, and issues such as forgetfulness or lack of knowledge. This highlights the urgency of understanding the perspective of the professionals responsible for processing the equipment, as their tasks must be aligned with established protocols to ensure safe and compliant service. Finally, it is crucial that well-established practices are closely tied to properly trained professionals, whose activities are continuously monitored and receive feedback aimed at improving processes.

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CONFLICT OF INTERESTS

The authors declare there is no conflict of interests.

AUTHORS' CONTRIBUTION

MLM: Project administration, Conceptualization, Data curation, Writing – original draft. **AO:** Project administration, Data curation, Writing – review & editing.

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