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ORIGINAL RESEARCH ARTICLE

Differences in organizational impact, performance and quality related to the use of single- and/or reusable bronchoscopes in anesthesiology and resuscitation

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ABSTRACT

Introduction: The use of fibrobronchoscopy increased significantly for collecting airway microbiological samples and during percutaneous tracheostomies and difficult intubations. Reusable bronchoscopes pose risks of contamination and damage due to their fragile structure and difficulties of cleaning and sterilization; single-use bronchoscopes have been introduced, offering reliability in terms of vision, maneuverability, suctioning capacity, and sterility, reducing the risk of hospital-acquired infections and improving logistical management.
Methods: The study analyzed healthcare workers' and management's perceptions of single-use bronchoscopes versus reusable ones. Among the main objectives were to evaluate the organizational impact, quality, and performance of bronchoscopes, while also analyzing opinions on device features, safety in infection prevention, and ease of use during training.
Results: In this analysis 66% of clinicians rated optimal image quality, and 90% of respondents highly appreciated the "plug & play" feature of disposable endoscopes; also, 45% of clinicians noted no significant differences in aspiration performance. Healthcare professionals felt more exposed to infectious agents with reusable endoscopes, believing disposable endoscopes required less vigilance and monitoring. In training, 80% of doctors and 100% of nurses considered disposable endoscopes more suitable due to their greater ease of use. Finally, the Overall Satisfaction of all healthcare workers was 75%.
Conclusion: The analysis of results demonstrated that the use of single-use bronchoscopes in anesthesia and resuscitation is highly comparable in terms of clinical effectiveness to reusable ones and that significant advantages in costs and organizational impact were highlighted, positively impacting the daily workflow of healthcare workers.

Keywords: Bronchoscope, ICU, Medical devices, Organizational impact

Introduction

The use of bronchoscopy in intensive care and resuscitation units began in the early 1970s (1). A flexible bronchoscope, equipped with fiber optics, camera, and light source, allows for real-time, direct visualization of the airways (2).

In recent years, there has been a significant increase in the use of this diagnostic and therapeutic technique by intensive care physicians in intensive care units.

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Here are some examples of its common applications.

Fiber-optic bronchoscopy is commonly used both to clear bronchial secretions and restore airway patency and to obtain microbiological samples for the diagnosis and management of nosocomial and community-acquired pneumonia (3).

The use of bronchoscopy is also essential during percutaneous tracheostomy performed in the intensive care unit, as it provides real-time intraluminal guidance, facilitates correct puncture site identification, and reduces the risk of posterior tracheal wall injury and malposition (4).

In the operating room, the anesthesiologist's use of the bronchoscope is essential for managing difficult airways, as well as, for example, for positioning devices that allow single-lung ventilation in surgeries where it is required (5).

Reusable bronchoscopes are generally used for these procedures. They are cleaned, sterilized, or disinfected after use, then dried, packaged, and stored in a clean environment (6).

The main limitation of these bronchoscopes is their extremely fragile structure, featuring a long, narrow working channel that, in addition to the access ports, makes cleaning and disinfection particularly difficult and predisposes them to damage (7).

Therefore, there is, on the one hand, a potential risk of contamination and infection, as complete sterilization after use is never guaranteed, and on the other, the possibility of breakage or injury due to the mechanical stress to which they are subjected, particularly during difficult intubation maneuvers and when verifying the correct positioning of a double-lumen tracheobronchial tube (8,9).

In recent decades, single-use endoscopic instruments have been introduced with the aim of overcoming logistical and organizational problems related to the need for timely and constant availability of bronchoscopes, but above all, to minimize the risk of transmitting hospital-acquired infections. The latest generation disposable endoscopes can offer a good level of reliability with regard to all the fundamental characteristics of a bronchoscope: good endoscopic vision, good maneuverability, good suction capacity and adequate sterility (10,11).

The situations in which the use of a disposable bronchoscope may be considered the best option include conditions with a high risk of microbial contamination, scenarios with an increased risk of damage or existing defects in reusable devices, and settings in which the use of a conventional reusable bronchoscope is challenging. However, despite these theoretical indications, it remains unclear how clinicians actually perceive the differences between disposable and reusable bronchoscopes in everyday practice. This survey was therefore designed to explore these perceptions and to assess whether, in their experience, one of the two devices offers superior performance or advantages.

Materials and Methods

This single-center survey-based, cross-sectional observational study was conducted within the Emergency-Acceptance, Critical Care, and Trauma Department of the Policlinico Umberto I University Hospital in Rome.

The study analyzes the perceptions of staff (physicians and nurses) and management (hospital pharmacists, clinical engineers, and health authority employees) regarding the organizational impact, quality, and performance of using single-use bronchoscopes versus reusable bronchoscopes during procedures performed within the aforementioned department.

These three professional groups were selected because they represent the stakeholders most directly involved in bronchoscope use: staff during procedures, management for the procurement of single-use and reusable devices, and the reprocessing and maintenance of reusable devices.

The analysis considered single-use endoscopes (Ambu Scope 4 Broncho ®) and reusable endoscopes (various brands and models), both currently available to the medical staff in the Emergency Department, Critical Care Areas, and Trauma.

Participants were eligible if they met the following criteria. Physicians and nurses had to belong to Anesthesia/Resuscitation, Intensive Care, or Critical Care Units and be directly involved in bronchoscopy procedures. They were required to have used at least two disposable and two reusable bronchoscopes in the previous six months, provide informed consent, and complete the questionnaire. Management participants had to be involved in procurement, budgeting, maintenance, or reprocessing of bronchoscopes within the previous 12 months, possess knowledge of repair workflows and operating costs, provide consent, and complete the questionnaire. Exclusion criteria included incomplete questionnaires (more than 10% missing responses or omission of key sections) and refusal or withdrawal of consent.

A systematically developed, context-specific in-house questionnaire was used, designed to capture organizational, technological, and clinical variables specific to bronchoscope use in emergency and critical care settings. A generic or externally validated tool was not suitable because it would not have allowed an accurate assessment of context-dependent workflow implications, device characteristics, and operational considerations relevant to bronchoscope technology adoption in the study environment.

A total of 150 questionnaires were distributed, 50 for each professional category (physicians, nurses, and management), with an overall response rate of 87.3%. Questionnaires were administered to physicians and nurses immediately after procedures involving bronchoscope use, and to management personnel during routine work activities. No additional demographic variables (such as age, sex, or years of professional experience) were collected. This decision was aligned with the study's inclusion criteria, which already required participation from professional categories with sufficient and specific expertise to reliably answer the questionnaire. Because all respondents belonged to predefined clinical and managerial groups directly involved in bronchoscopy-related procedures or processes, demographic stratification was not expected to provide additional explanatory value for the study outcomes. Data were collected from July to October 2024, and only fully completed questionnaires were included in the final analysis. For each item, participants could select "Single-use bronchoscope," "Equivalent," or "Reusable bronchoscope." A 5-point Likert scale was also used (1 = very poor, 2 = poor, 3 = neutral, 4 = good, 5 = very good). Physicians and nurses were surveyed on device characteristics, safety regarding prevention of cross-infection, ease of use for training residents, and organizational impact. Management personnel evaluated procurement aspects, costs, and organizational implications.

Ethics Committee approval was not required. According to institutional policy, anonymous surveys that do not collect sensitive or identifiable information and pose minimal risk are exempt from full Ethics Committee review. All participants provided informed consent prior to questionnaire completion.

Results

A total of 150 questionnaires were distributed, and 131 were included in the final analysis (overall response rate: 87.3%). The clinical staff (physicians and nurses) performed a comparable number of bronchoscopy-related procedures with both systems, with 80-84% reporting 1-10 single-use procedures per week and 75-88% reporting 1-10 reusable procedures per week. To address the variability of this range, a sensitivity analysis was conducted by collapsing procedural exposure into two categories: low experience (1-5 procedures/

week) and high experience (≥5 procedures/week). For single-use bronchoscopes, low-experience operators represented 68% of nurses and 64% of physicians, while high-experience operators accounted for 32% and 36%, respectively. For reusable bronchoscopes, low-experience operators represented 35% of nurses and 70% of physicians, whereas high-experience operators accounted for 65% and 30%. No differences were observed between these exposure groups in any of the evaluated domains, indicating that operator expertise did not influence the overall direction or magnitude of the findings. Regarding image quality, 64% (95% CI 49-78) preferred single-use devices, and 66% (95% CI 52-80) rated the image quality of disposable bronchoscopes as good or very good (scores 4-5). Single-use bronchoscopes were also rated superior in terms of handling and portability: 68% (95% CI 54-82) reported easier handling, and 70% (95% CI 57-84) considered disposable devices more portable. Probe flexibility was perceived as better in single-use devices by 61% of physicians, with 69% rating this characteristic between 4 and 5. Concerning suction performance, 45% (95% CI 31-60) reported no relevant differences between single-use and reusable bronchoscopes with the same channel diameter. Sample collection performance showed similar patterns, with 39% considering the devices comparable and 45% expressing a slight preference for single-use bronchoscopes. Ease of exporting images and videos was considered superior in disposable systems by 70% (95% CI 57-84), with 69% rating this function between 4 and 5. The plug-and-play usability of single-use devices received high appreciation, with 90% (95% CI 81-99) assigning a score between 4 and 5. (Figs 1 and 2)

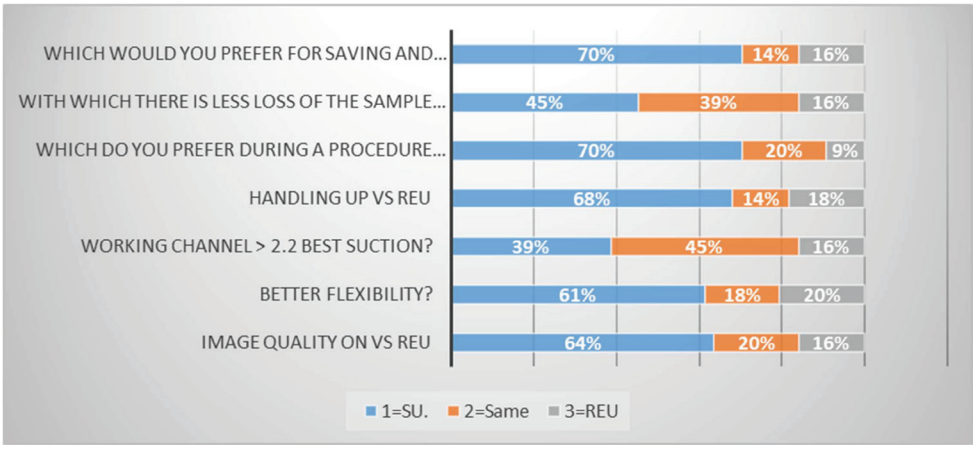

FIGURA 1 - Device Features (Doctors) SU: single-use, REU: reusable.

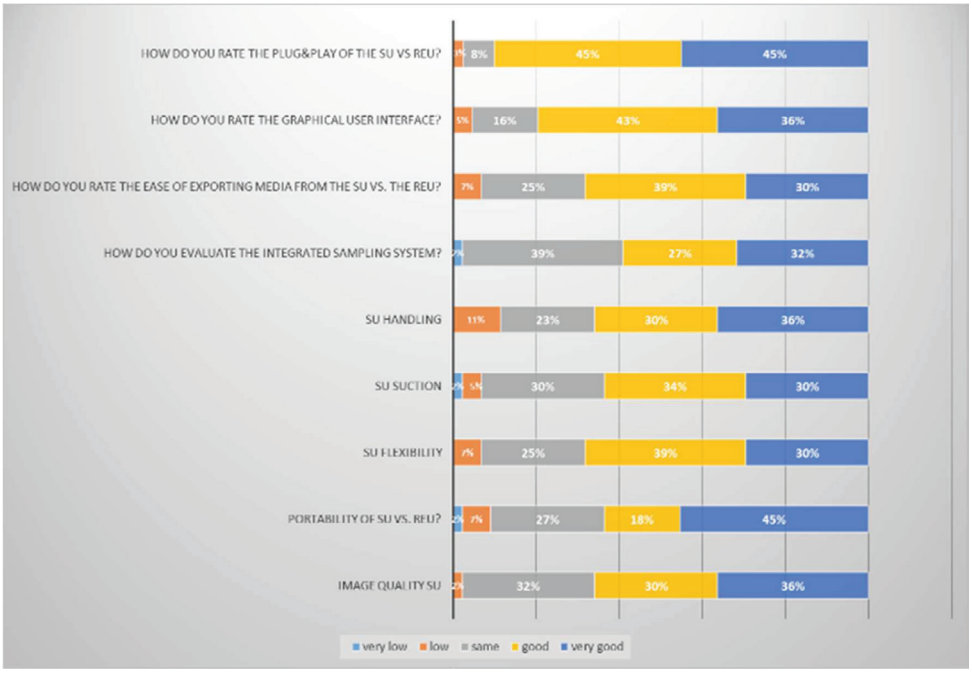

FIGURA 2 - Quality and Impact of Single-Use Products.

Infections

Figures 3 and 4 show the responses of clinicians and nurses who expressed their views on the topic of infections in the survey. They reported a higher perceived exposure to infectious risks when using reusable bronchoscopes (59% and 75%, respectively; 95% CI 45-74 and 62-88). Consequently, 77% (95% CI 65-90) considered single-use devices to require a lower level of vigilance during procedures. The potential benefit of single-use bronchoscopes in preventing healthcare-associated infections was highly rated, with 80% of clinicians (95% CI 68-91) and 75% of nurses scoring this aspect between 4 and 5. Reprocessing effectiveness was considered suboptimal for reusable devices: 59% of physicians (95% CI 45-74) and 71% of nurses (95% CI 56-84) expressed concerns about the risk of contamination related to reprocessing cycles. Overall perceived safety of single-use bronchoscopes was high, with 61% (95% CI 47-76) rating them between 4 and 5.

Training

Single-use bronchoscopes were perceived as easier to use and more suitable for training by 80% of physicians (95% CI 68-91) and 100% of nurses. The majority rated them highly for training inexperienced operators (79% and 93%, respectively; scores 4-5).

Organizational Impact

As illustrated in Figure 5, 61% of physicians (95% CI 47-76) and 98% of nurses (95% CI 93-100) reported that single-use bronchoscopes required less coordination among team members. Reusable devices were perceived as more prone to

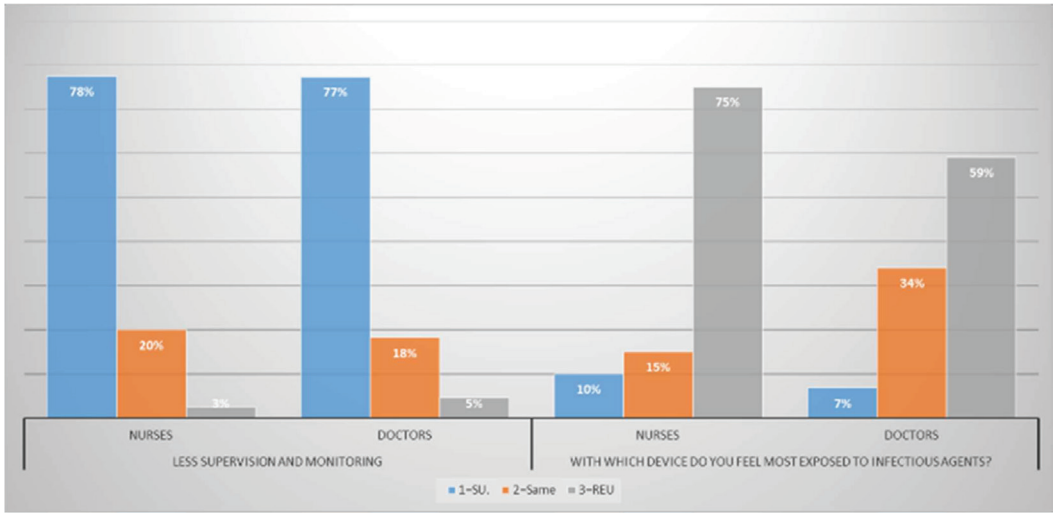

FIGURA 3 - Infections
SU: single-use, REU: reusable.

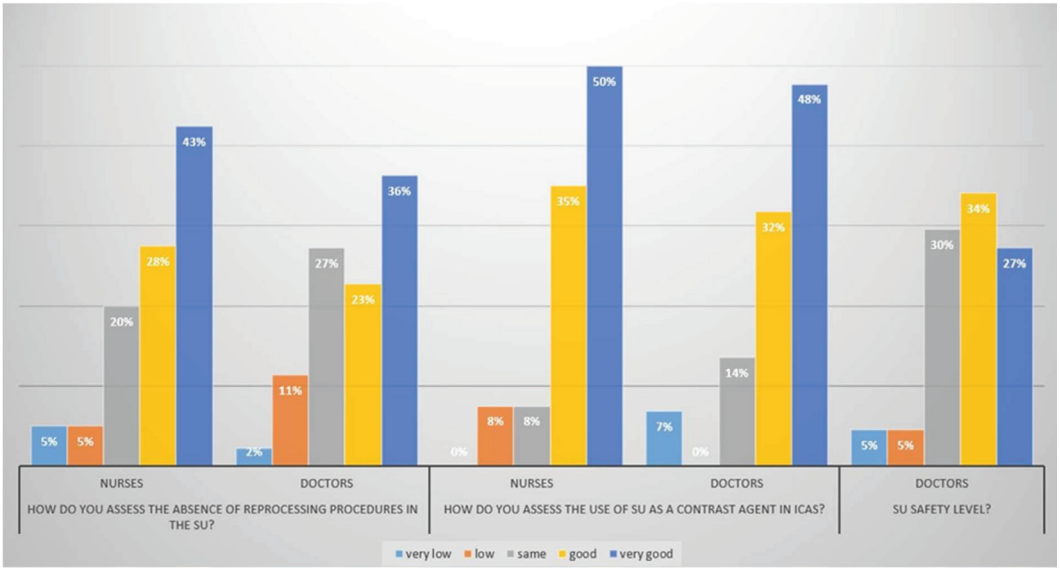

FIGURA 4 - Infections.

wear or damage by 77% of physicians (95% CI 65-90), while nurses considered the two categories comparable.

Regarding procurement times, 57% (95% CI 42-71) considered reusable devices faster to obtain, likely due to administrative delays associated with tender processes for disposable devices.

Overall satisfaction (OS) with single-use bronchoscopes was 75% (95% CI 62-88).

Administrative and Hospital Management

A total of 47 management questionnaires were analyzed (94% response rate). As shown in Figure 6, management personnel reported fewer communication and coordination needs when using single-use bronchoscopes (74%, 95% CI 62-87). Reusable devices were considered more prone to breakage (68%, 95% CI 55-81) and associated with higher logistical burdens.

Single-use systems were also perceived as having greater cost transparency (68%, 95% CI 55-81) and the lowest budget impact (57%, 95% CI 43-72).

Discussion

This study provides a comprehensive assessment of clinicians' and management personnel's perceptions regarding single-use and reusable bronchoscopes in a large hospital. The findings highlight a consistent preference for single-use bronchoscopes across multiple domains, including image quality, device handling, portability, workflow simplicity, infection prevention, staff safety, and training suitability.

From a clinical perspective, image quality and handling emerged as the most influential features guiding device selection. This is consistent with recent evaluations showing that single-use flexible bronchoscopes achieved high ratings for image clarity, brightness and maneuverability (12).

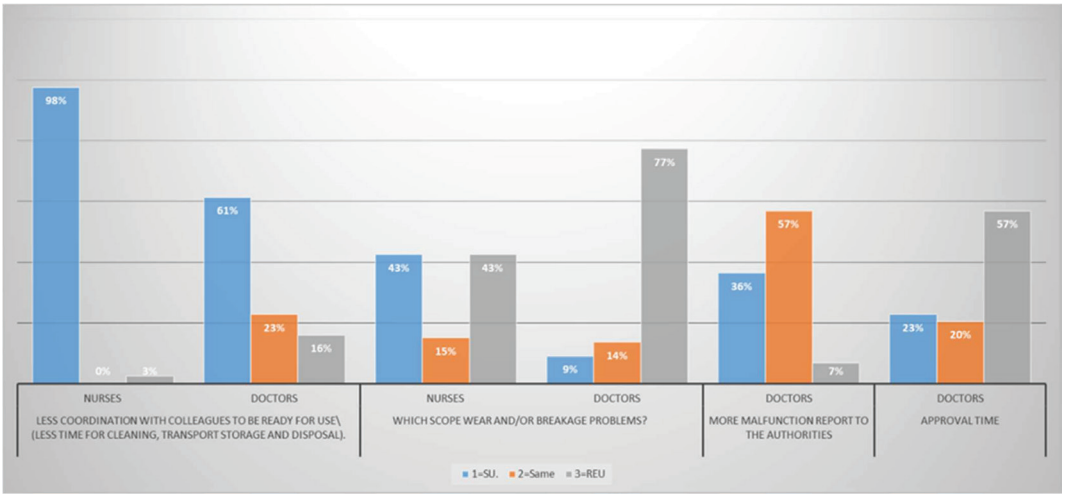

FIGURA 5 - Endoscope management and procurement. SU: single-use, REU: reusable.

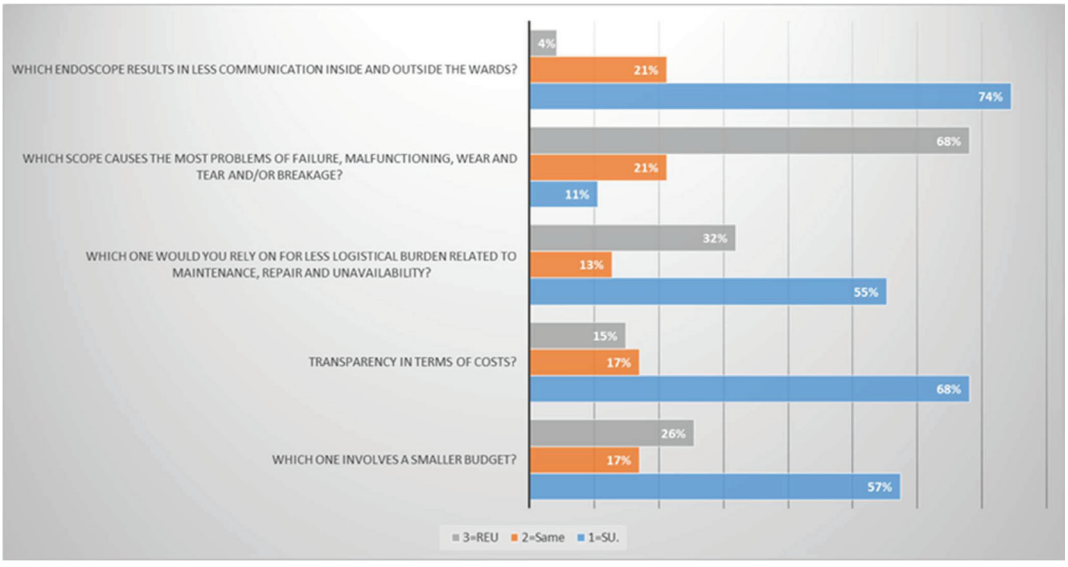

FIGURA 6 - Administrative and hospital management results.
SU: single-use, REU: reusable.

Moreover, the fact that each use is performed with a new instrument, thus avoiding cumulative wear and degradation as seen in reusable bronchoscopes, may further explain the favorable perception of disposable devices. Additional advantages, such as probe flexibility and ease of image/video exportation, contribute particularly in emergency settings where rapid deployment is crucial (13).

Infection prevention was a major determining factor. Despite advances in reprocessing technology, reusable bronchoscopes remain associated with concerns about incomplete decontamination, biofilm persistence, and potential cross-contamination—issues widely documented in current literature. (14) The perception that single-use devices significantly reduce infection-related risks is therefore consistent with existing evidence, especially for vulnerable and immunocompromised patients. The high safety scores assigned to disposable devices reflect these considerations (15).

Training also strongly favored single-use bronchoscopes. Disposable devices were considered more intuitive and safer for inexperienced operators, aligning with the clinical need to protect reusable equipment from damage while ensuring effective on-the-job training for residents and nurses. This finding is particularly relevant given the increasing procedural responsibilities of anesthesiologists and critical care staff.

Organizational considerations further reinforced the preference for single-use bronchoscopes. Clinical staff noted that single-use devices reduce coordination requirements, eliminate downtime due to reprocessing or unavailability, and offer predictable performance. Management personnel emphasized cost transparency, lower repair and maintenance burdens, and simplified logistics. Although procurement of disposable devices may require longer administrative processing times, this did not outweigh the perceived benefits related to operational efficiency. Overall satisfaction was high across all professional groups, suggesting that single-use bronchoscopes provide a significant perceived improvement in workflow reliability and patient safety in emergency and critical care environments.

However, the study also underscores a number of aspects that warrant further evaluation, including long-term economic implications, the environmental burden of disposable instruments, and vulnerabilities associated with supply-chain disruptions. These dimensions are increasingly relevant for hospital decision-makers and should be addressed in future health technology assessments (16).

An additional aspect to consider concerns the environmental impact of single-use devices. While these instruments significantly reduce the risk of cross-infection and eliminate reprocessing-related costs, they generate substantial quantities of plastic and electronic waste. This waste is difficult to recycle and must be managed as infectious, hazardous healthcare waste, contributing to a non-negligible environmental footprint and imposing additional disposal costs on healthcare systems (17).

Furthermore, widespread adoption of disposable bronchoscopes introduces vulnerabilities related to supply-chain dependence. Procurement relies on external suppliers and international markets that may be subject to disruptions caused by geopolitical conflicts, pandemics, logistical crises, or administrative delays in tender processes. This dependency exposes anesthesia and intensive care units to the risk of sudden shortages, potentially compromising operational continuity during critical periods.

An effective strategy should therefore include an integrated procurement plan, safety stock policies, diversification of supply channels, and, where possible, the maintenance of reusable bronchoscopes as a backup resource to ensure continuity of care.

Beyond supply chain considerations, the transition to single-use devices (SUDs) also introduces significant logistical implications in terms of storage and inventory management. SUDs require a substantially greater physical storage footprint, as hospitals must maintain larger volumes of consumables and adequate safety stocks to mitigate potential supply disruptions (18). Additionally, the nature of inventory management shifts: the burden moves away from managing reprocessing schedules and tracking the number of reprocessing cycles per reusable device, and toward the strict monitoring of expiration dates (e.g., FIFO protocols) and increased working capital tied up in stock.

Tracking processes become simpler, as individual SUDs do not require maintenance or repair logs; however, the overall number of items to be tracked increases considerably. In essence, while SUDs eliminate the logistical complexity associated with reprocessing workflows, they simultaneously impose greater demands on physical storage space, inventory control, and supply-chain planning due to the high volume of consumables with limited shelf lives (19,20).

Limitations

This study presents several limitations that should be acknowledged.

First, it was designed as an observational, single-center, cross-sectional survey; thus, the findings represent perceptions at a single point in time and do not establish causal relationships between the type of bronchoscope used and clinical or organizational outcomes.

Second, the sample size was relatively small and limited to one institution, which may restrict the generalizability of the results to other hospital settings with different organizational structures or clinical workflows.

Third, data were collected through self-administered questionnaires, introducing potential response and social desirability bias, as participants may have provided answers consistent with expected norms or institutionally preferred views. In addition, the questionnaire was not formally validated, and responses relied on subjective Likert-type scales, potentially generating interindividual variability in interpretation and scoring.

Despite these limitations, the study offers valuable insight into healthcare professionals' and managers' perceptions of single-use bronchoscopes and provides a foundation for future multicenter research integrating both subjective and objective outcome measures.

Conclusions

The aim of this study was to evaluate, through a survey of healthcare professionals and management, their awareness of the differences in organizational impact, performance, and quality related to the use of single-use bronchoscopes compared to reusable ones. Analysis of the results demonstrated that the use of single-use bronchoscopes in anesthesia and intensive care is highly comparable in terms of clinical effectiveness to reusable ones, and that significant advantages in terms of costs and organizational impact were highlighted, positively impacting healthcare professionals' daily workflow.

Disclosures

Conflict of interest: The authors declare no conflict of interest.

Financial support: The authors declare that they have not received any financial support, grants, or funding from public, commercial, or not-for-profit sectors for the design, execution, analysis, or publication of this study.

Data availability statement: The questionnaire was used for data collection and was administered to physicians and nurses (at the end of the procedure) and to hospital administrators during their workday. Participation in the study was completely voluntary, and the questionnaires guaranteed anonymity: only completed questionnaires were included in the final analysis. All completed paper questionnaires are securely stored by Dr Pierfrancesco Tozzi in a locked office, with access limited to authorized personnel only, ensuring confidentiality and compliance with data protection standards.

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