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Flexible Bronchoscopy in the Intensive Care Unit – the FLEXICARE survey

Christoph Fisser[1,2*], Nina Sicker[2*], Claudia Crimi[3,4], Christian Karagiannidis[5], Joao Carlos Winck[6,7], Marieke Duiverman[8,9], Ariana Azevedo[10], Ana Cysneiros[10,11○], Ignacio Martin-Loeches[12○]

* contributed equally

○ contributed equally

Corresponding author: Prof. Christoph Fisser, MD. University Hospital Regensburg, Department of Internal Medicine II; Center for Pneumology, Donaustauf Hospital, Donaustauf, Germany, Ludwigstraße 68, 93093 Donaustauf, Germany.

Email: Christoph.Fisser@klinik.uni-regensburg.de

[1] Department of Internal Medicine II, University Hospital Regensburg, Regensburg, Germany

[2] Center for Pneumology, Donaustauf Hospital, Donaustauf, Germany

[3] Department of Clinical and Experimental Medicine, University of Catania, Catania, Italy

[4] Respiratory Medicine Unit, Policlinico "G. Rodolico-San Marco" University Hospital, Catania, Italy

[5] Department of Pneumology and Critical Care Medicine, ARDS and ECMO Centre, Cologne-Merheim Hospital, 51109 Cologne, Germany

[6] UniC, Cardiovascular R&D Centre, Faculty of Medicine, University of Porto, Porto, Portugal

[7] Instituto CUF, Porto, Portugal

[8] Groningen Research Institute for Asthma and COPD, University of Groningen, University Medical Center Groningen, Groningen, The Netherlands

[9] Department of Pulmonary Diseases and Home Mechanical Ventilation, University of Groningen, University Medical Center Groningen, Groningen, The Netherlands

[10] Unidade de Urgência Médica, Hospital de São José, Centro Hospitalar Universitário Lisboa Central, 1169-050 Lisbon, Portugal

[11] ULS São José, Hospital São José, UUM. Lisboa Portugal, Nova Medical School

[12] James's Hospital, Dublin, Ireland; Trinity College Dublin, Dublin, Ireland

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ABSTRACT

Background: Flexible bronchoscopy (FB) is a key diagnostic and therapeutic procedure in the intensive care unit (ICU). However, significant heterogeneity exists regarding indications, peri-procedural management, training, and safety practices across ICUs. Data on real-world practices remain limited.

Methods: An international, online cross-sectional survey was conducted by the European Respiratory Society's Acute Critical Care Group between May and December 2023. The questionnaire, designed according to CROSS and ACCADEMY standards, targeted healthcare professionals performing FB in ICUs. It addressed procedural protocols, sedation, ventilation strategies, complications, microbiologic sampling, tracheostomy practices, and training. Only fully completed responses were included in the analysis.

Results: Data from 266 respondents across 73 countries were analyzed. Training in FB varied widely: 41% reported no formal training, and only 61% had access to a 24/7 bronchoscopy service. Sedation practices were heterogeneous. Ventilator settings were adjusted differently based on ICU certification, with ICU-certified physicians more likely to reduce PEEP during FB (55% vs. 42%; p=0.031). Bronchoalveolar lavage (BAL) was the most common sampling method, with a median saline volume of 60–120 mL and a recovery rate of 48±18%. Microbiological findings led to therapeutic changes in 48±21% of cases. FB guidance during percutaneous tracheostomy was applied in only 56% of cases.

Conclusion: Substantial variability exists in FB practices across ICUs, particularly in training, sedation, ventilation adjustments, and microbiologic sampling. Despite frequent therapeutic consequences, standardized approaches are lacking. These

findings underscore the need for international consensus guidelines and structured training programs to harmonize FB practices in critical care settings.

ABBREVIATIONS LIST

BAL Bronchoalveolar lavage

ECMO extracorporeal membrane oxygenation

ERS European Respiratory Society

FB flexible bronchoscopy

ICU intensive care units

Introduction:

Flexible bronchoscopy (FB) is an essential tool in the management of critically ill patients in the intensive care unit (ICU), used primarily for diagnostic and supportive therapeutic purposes [1, 2]. Its widespread applications include airway inspection, secretion management, bronchoalveolar lavage, and guidance in procedures such as tracheostomy placement or difficult airway management.

Despite its widespread use in ICU settings, clinical practice varies considerably across institutions and countries, particularly regarding procedural indications, ventilator settings, sedation strategies, and training requirements. Most existing guidelines, recommendations and studies focus on bronchoscopy in ambulatory or non-critically ill inpatient populations, offering limited insight into ICU-specific practices [1–7]. Consequently, key questions remain concerning clinical decision-making, procedural protocols, safety measures, microbiologic sampling and the extent of standardized training across the heterogeneous landscape of ICUs.

To address this gap, we conducted an international, observational survey under the auspices of the European Respiratory Society (ERS). The aim of this survey was to assess procedural details of FB, peri-procedural preparation, sedation and monitoring strategies, complication management, microbiologic assessment and training structures.

Methods

Survey design

The acute critical group of the ERS conducted an international structured cross-sectional internet-based survey to investigate current real-world clinical practice of flexible bronchoscopy (FB) in the intensive care unit (ICU) setting, taking into account diverse social, geographical and economic settings. The survey design and reporting adhered to the principles of the Checklist for Reporting of Survey Studies (CROSS) [8] (Table S1) as well as the recommendations of the Academy of Critical Care: Development, Evaluation and Methodology Group [9].

Survey items were formulated by the assembly 2.1 of the ERS through an evidence-based process that combined a focused literature review with expert consensus. The panel included interdisciplinary clinicians with established expertise in FB on ICU, certified in at least one of the following specialties: intensive care medicine, pulmonology or infectious diseases. The questionnaire was pretested for content validity and clarity. Feedback from the pilot testing was incorporated to revise and finalize the survey instrument by the survey design team (CF, TC, IML). The final version comprised a combination of closed- and open-ended questions, enabling the collection of both quantitative and qualitative data.

The questionnaire consisted of eleven sections, addressing demographics, FB practice, indications and contraindications, procedural details (diagnostic and therapeutic), peri-procedural preparation, sedation and monitoring, ventilator settings, complications, tracheostomy and training resulting in 52 questions. The finalized questionnaire (Table S2) received endorsement by the ERS.

Survey dissemination

The target population comprised healthcare professionals involved in performing FB on ICU with a focus on ERS members due to the background of the survey initiative. No restrictions were placed regarding hospital size, geographic region or socioeconomic setting to minimize selection biases.

The online survey was disseminated via the ERS from May 2023 to December 2023 using Microsoft Forms© (Microsoft, Redmond, WA). Invitations were distributed electronically via email and the assembly 2 newsletter. Additionally, assembly heads and secretaries of each ERS assembly were asked to forward the invitation for broader dissemination. Reminder emails were sent every other month. Participations was voluntary and respondents were informed about the study's objectives, estimated completion time and data confidentiality prior to the beginning the survey. Informed consent was obtained electronically through an acknowledgment checkbox at the beginning of the survey. To ensure anonymity, no personally identifiable information was collected. Reasons for non-participation were not documented. The study adhered to ethical standards as outlined in the Declaration of Helsinki. Formal ethical approval was not required due to the anonymous nature of data collection. Voluntary completion of the survey was considered equivalent to informed consent.

Statistics

Quantitative data are expressed as mean (standard deviation) and were compared with the T-test. Categorical variables were analyzed with the Chi-squared test of independence if expected cell counts were 5 or more. Correlations models were used to assess associations. Analyses by continent were limited to regions with more than 10 responses. All reported *p* values were two-sided, and a *p* value of ≤ 0.05 was considered statistically significant. To ensure data quality and minimize bias due to

missing data, only fully completed questionnaires were included in the analysis. Data entry and calculation were done using IBM SPSS Statistics version 29.0 (IBM, Armonk, NY) and Microsoft® Excel für Mac 16.93.1 (Microsoft, Redmond, WA).

Results

General data

Complete data sets were available for 266 participants from five continents and 73 countries (Figure 1). The majority of responses originated from Europe (66%) with the highest proportion from Germany (16%), Portugal (14%), Italy (13%), Greece (6%) and the Netherlands (5%). The study population consisted predominantly of male respondents (64%), most of whom were consultants between 35 and 44 years, certified in pulmonary medicine and employed at university hospitals (Table 1).

Training in FB in the ICU setting varied considerably: 41% of respondents reported no formal training. Among those who had received training, 47% underwent training periods of up to six months. In addition, 41% had received specific training in the administration of sedation and/or analgesia during FB. Bronchoscopy skills were most commonly acquired through peer-to-peer learning (65%) and supervision by senior colleagues (60%). Formal education formats such as workshops (51%), conferences (46%), and literature (44%) were also frequently reported. Notably, 52 % of respondents stated that video-bronchoscopy for intubation was used for educational reasons.

Bronchoscopy Practice

Most participants (73%) reported routinely obtaining patient consent prior to performing FB. Among patients without naso-gastric feeding, 64% were fasted for at least four hours before the procedure. Pre-procedural imaging was considered necessary by

90% of respondents, and laboratory tests (e.g., platelet count) were routinely conducted (Table 2).

FB was generally conducted under sedation (99%), most respondents (58%) maintained to the current sedation regime. Sedation methods included propofol (55%), benzodiazepines (50%), and dexmedetomidine (11%), often in combination with topical anesthesia (69%). Sedation was primarily administered by physicians (58%) or trained assistants (34%). All patients were monitored using pulse oximetry (100%), ECG (90%), and blood pressure measurement (88%), while capnography was less frequently used (19%).

Half of participants performed FB 1–2 times per week, 24% conducted the procedure daily. Physicians certified in pulmonary medicine performed FB significantly more frequently than non-certified colleagues (>1-2 times a week: 52% vs. 37%; $p<0.001$). Among physicians certified in intensive care medicine, 25% reported performing FB on a daily basis, 47% on a weekly basis (1–2 times per week), 21% on a monthly basis (1–2 times per month), and 7% less frequently than once per month. A 24/7 bronchoscopy on-call service was available to 61% of participants.

Preferred ventilator modes during FB were equally divided between pressure-controlled (34%) and volume-controlled ventilation (34%), the rest used mostly a mixed mode (21%), 9% used pressure support and 2% volume support. Most respondents (94%) reported escalating ventilator settings (e.g. set FiO2 to 100%) during FB. Interestingly, physicians certified in intensive care more often reduced positive end-expiratory pressure during FB to prevent hyperinflation and barotrauma compared to non-ICU-certified respondents (55% vs. 42%; $p=0.031$). A similar trend was observed among female compared to male participants (59% vs. 42%; $p=0.024$).

Health cost and equipment Usage and Economy

Participants most frequently reported using reusable fiberoptic bronchoscope (60%) for FB followed by video bronchoscopes (57%) and single-use bronchoscopes (46%). Personal protective equipment was reportedly available to nearly all respondents (Table S3-7). Declining to perform FB due to economic constraints was relatively uncommon overall (11%) but occurred significantly more often in Asia compared to Europe (25% vs. 5%, $p<0.001$). Data from other continents were not analyzed due to limited responses (<10 participants). In addition, single-use bronchoscopes were less frequently used in Asia than in Europe (23% vs. 56%, $p<0.001$).

Indications for flexible bronchoscopy on ICU and sample collection

Diagnostic bronchoscopy in the ICU was most commonly performed for microbiological sampling (Figure 2A). For this purpose, BAL was the preferred technique in 43% of cases, followed by suctioning with saline instillation (40%), suctioning without saline (11%) or tracheal suctioning alone (7%). The volume of saline for BAL ranged from 60 to 120 mL in 53% of cases, with a median recovery of 48±18%. Differential cell counts were performed by 62% of participants. Notably, microbiological findings obtained through FB led to modifications in the therapeutic regimen in 48±21% of cases. Therapeutic indications for FB included secretion management, relief of airway obstruction and difficult airway management (Figure 2B).

Contraindications and Complications

SpO2 <88% under full extracorporeal membrane oxygenation (ECMO) support was considered a contraindication for FB by 47% of participants. Hemodynamic instability was regarded as a barrier by 40%, followed by the risk of barotrauma (32%). Notably, patient discomfort was only cited as a relevant contraindication by 20% of respondents.

Complications related to FB were systematically assessed by 83% of participants. The most frequently reported adverse events included respiratory deterioration (SpO2 <88%), minor bleeding (<100 ml) and bronchospasm. In contrast, arrhythmias, hemodynamic instability, and major bleeding were observed less frequently (Figure 3).

Tracheostomy

Less than half of the respondents (46%) reported performing percutaneous dilatational tracheostomy (PDT). Physicians certified in intensive care conducted the procedure more frequently than non-certified colleagues (67% vs. 29%, p<0.001). The most commonly used technique for PDT was the cone-shaped dilatator system, applied by 34%. Notably, FB guidance during PDT was employed in only 56%, with no significant variation across continents. The most frequently complications during PDT included bleeding, respiratory worsening and fracture of tracheal cartilage (Figure 4).

Discussion

This international survey provides a novel insight into current practice of FB in ICU worldwide. Practice of FB varied substantially across countries, particularly with respect to formal training, sedation protocols, and the presence of 24/7 on-call bronchoscopy services. Second, ventilatory settings during FB, especially PEEP adjustments differed markedly between ICU-certified and non-certified physicians. Gender-based differences were also observed with female physicians reducing the PEEP significantly more likely during FB. Third, while microbiological sampling was a key indication for FB, the methods ranged from simple suctioning to BAL, with the instillation of 60-120 mL saline. Importantly, FB findings led to therapeutic changes in nearly half of the cases. Fourth, although PDT is often recommended to be performed under bronchoscopy guidance, this was only the case in nearly 50% of respondents.

Despite FB being performed in 11% of mechanical ventilated patients [10], FB is often performed without standardized protocols or high-level evidence [1]. Indeed, more than 2 out of 5 respondents reported no formal training for FB when managing patients in ICU. This is in line with a recent study showing that program directors reported substantial barriers to establishing structured educational formats for teaching [11]. This lack of training may also explain the limited availability of on-call bronchoscopy services. A recent German survey reported similar findings, with 69% of secondary care hospitals offering such services [7]. The lack of structured training underscores the urgent need for innovative educational strategies. Simulation-based training offers a standardized, safe, and reproducible environment to acquire and refine bronchoscopy skills, with recent systematic reviews confirming its effectiveness [12]. Beyond conventional simulation, artificial intelligence–guided supervision has emerged as a promising approach, with recent randomized data suggesting that AI-

supported bronchoscopy training may outperform instruction by human experts [13]. Incorporating such approaches into critical care training curricula could help address the current gaps in formal education and ultimately improve both trainee competence and patient.

The structure of critical care training differs internationally, being a primary specialty in some countries, and a subspecialty (e.g., pulmonary medicine) in others [14]. In the current survey nearly 50% of the respondents were certified in intensive care medicine. These physicians were more likely to adjust PEEP during FB, eventually aiming to reduce the risk of auto-PEEP and barotrauma. The development of auto-PEEP during FB in mechanically ventilated patients have been reported more than two decades ago [15, 16] which may cause barotrauma [17]. In addition, a significant proportion of respondents did not change sedation during FB which may be either in contrast to bronchoscopy guidelines that recommend adequate sedation [1, 18] or in contrast to recommended light over deep sedation on ICU [19]. However, this may reflect the discrepancy between available recommendations and real-world practice. Another notable finding is the increasing adoption of single-use bronchoscopes, driven by their convenience and reduced risk of cross-contamination. However, this trend must be carefully balanced against their potential environmental impact, as widespread use may contribute to medical waste and raises questions of sustainability. Importantly, the greenhouse gas emissions appear to depend on the frequency of bronchoscope use (either single or reusable). In addition, some studies indicate an advantage and others a disadvantage for single-use instruments in terms of the carbon footprint. This highlights that the environmental debate is complex, context-dependent, and requires further high-quality research. Hospitals and clinicians should therefore consider both infection control and sustainability aspects when selecting bronchoscopes [20, 21]

Percutaneous dilatational tracheostomy remains an important intervention for patients requiring prolonged mechanical ventilation or difficult weaning. Guidelines recommend the use of bronchoscopy guidance for accurate placement and prevention of complications [22]. In this survey however, this was only performed by nearly 50% of the respondents. This is remarkable since PDT is recommended under bronchoscopic guidance [23] and correct placement can be easily identified with bronchoscopy which greatly decreases complications [24].

Known complications of FB include hypoxemia, hypotension, pneumomediastinum, and pneumothorax - particularly in patients with underlying critical illness [25]. While hemodynamical instability and barotrauma were frequently cited as contraindications, such complications were rarely observed in practice. Nonetheless, if they do occur, they may lead to severe clinical deterioration in critical ill patients on ICU.

Diagnostic FB was most frequently performed for microbiological sampling. Inparticular in immunocompromised patients, FB including BAL plays a pivotal role in diagnosing pulmonary infections [26–28] and guiding antibiotic stewardship. Substantial changes have been reported in the last two decades in Europe, with a higher rate of bronchoscopy procedures performed for the diagnosis of lower respiratory tract infections in invasive mechanically ventilated patients [29, 30]. In nearly 50% of cases, the microbiological results prompted changes in clinical management. Previous studies in patients with respiratory failure have reported diagnostic yields ranging from 13 to 59% [31–35].

This underscores the clinical value of FB, provided the potential benefits outweigh the risks. In this survey in ICU-patients the main aliquot range for BAL was between 60 to 120 mL and the recovery rate 48±18%, comparable to non-ICU settings where 100–300 mL is standard [36–38]. Similarly, data from Germany have shown a median

instillation of 100 ml saline [38] with 50% recovery rates, exceeding the often recommended threshold of 30% in non-ICU populations [37, 39]. However, BAL can temporarily worsen gas exchange [40–42], with PaO2/FiO2 ratios decreasing in mechanically ventilated patients by up to 86 mmHg independent of instillation volume [40–42].

The findings of this analysis must be interpreted in the light of the following limitations. First, the number of respondents per country was insufficient to allow for country-specific comparisons. Second, due to the design of the survey, differentiation between invasively and non-invasively ventilated patients were not possible. Third, the dissemination via the ERS may have biased participation toward respiratory specialists.

Conclusion

Substantial variability exists in FB practices across ICUs, particularly in training, sedation, ventilation adjustments, and microbiologic sampling. Despite leading to changes in management, standardized approaches are lacking. Notably, a considerable proportion of physicians perform FB without formal training, and on-call bronchoscopy services are not universally available. ICU-certified physicians were more likely to adjust ventilator settings during FB, particularly by reducing PEEP to avoid barotrauma. Despite these variations, FB frequently led to clinically relevant changes in management, underlining its diagnostic and therapeutic value in critically ill patients. These findings underscore the need for international consensus guidelines and structured training programs to harmonize FB practices in critical care settings.

Conflict of interest: All authors have nothing to disclose.

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Table 1: Baseline characteristics

Participants	n=266	Junior Clinician N=59	Senior Clinician N=207
Job position			
Medical chief	61 (23%)	0	61 (29%)
Consultant	146 (55%)	0	146 (71%)
Junior clinician	59 (22%)	59 (100%)	0
Board Certification			
Pulmonary	223 (84%)	30 (51%)	193 (93%)
Intensive Care Medicine	122 (46%)	11 (19%)	111 (54%)
Age			
25-34	52 (20%)	35 (59%)	17 (8%)
25-44	113 (43%)	20 (34%)	93 (45%)
45-54	53 (20%)	1 (2%)	52 (25%)
55-64	37 (14%)	3 (5%)	34 (16%)
65-74	11 (4%)	0	11 (5%)
Female	94 (35%)	32 (54%)	62 (30%)
Hospital setting			
Non-university	78 (29%)	14 (24%)	64 (31%)
Private institution	21 (8%)	1 (2%)	20 (10%)
University Hospital	167 (63%)	44 (75%)	123 (59%)

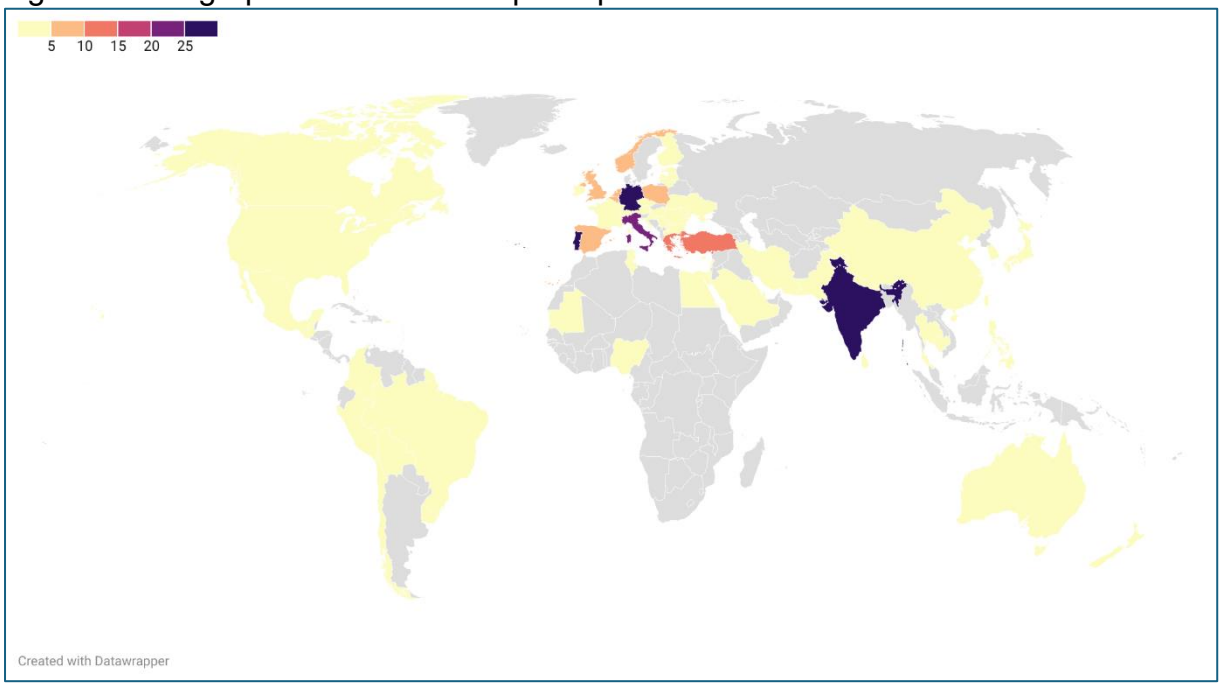
Data are expressed as number of patients (%). Values are rounded. Senior clinician includes consultants and medical chiefs.

Table 2: Peri-procedural data of flexible bronchoscopy

Participants	Total n=266	Junior Clinician N=59	Senior Clinician N=207
Informed consent	194 (73%)	37 (63%)	157 (76%)
Fasting before FB in those without naso-gastric feeding at least 4 hours	171 (64%)	36 (61%)	135 (65%)
Pre-FB			
Imaging	240 (90%)	53 (90%)	187 (90%)
Platelet count	227 (82%)	51 (86%)	168 (81%)
Monitoring			
Pulse oximetry	265 (100%)	59 (100%)	206 (100%)
ECG	120 (45%)	22 (37%)	98 (47%)
Blood pressure	234 (88%)	52 (88%)	182 (88%)
Capnography	51 (19%)	17 (29%)	34 (16%)
Sedation			
Propofol	146 (55%)	31 (53%)	115 (56%)
Benzodiazepine	134 (50%)	27 (46%)	107 (52%)
Dexmedetomidine	30 (11%)	2 (3%)	28 (14%)
Topical anesthesia	184 (69%)	35 (59%)	149 (72%)
Bronchoscopy performances			
1-2 times per week	50 (19%)	26 (44%)	34 (16%)

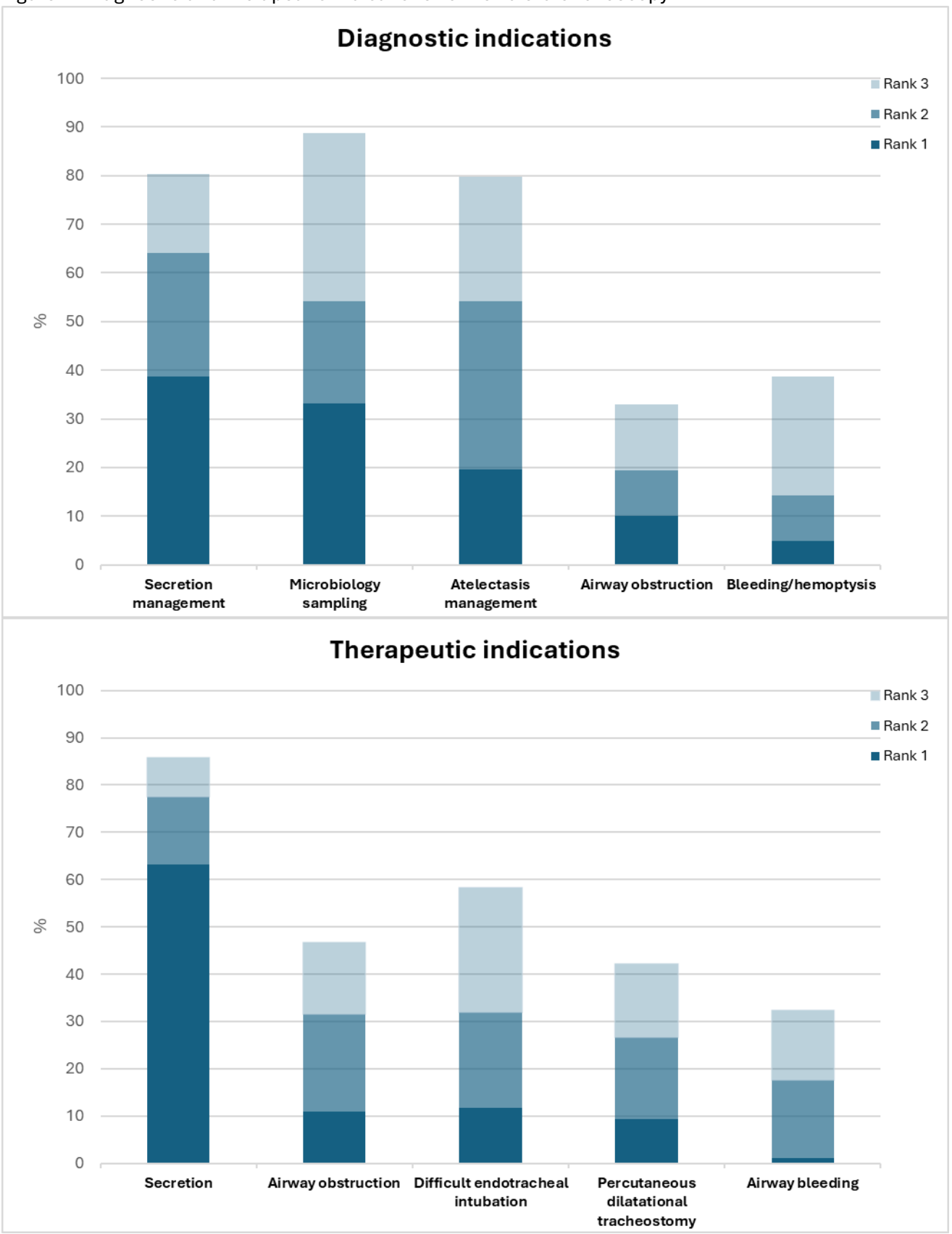
Data are expressed as number of patients (%). Values are rounded. Senior clinician includes consultants and medical chiefs. FB: flexible bronchoscopy; ECG: electrocardiogram.

Figure 1: Geographic distribution of participants



The scale depicts the number of responses ranging from 1-5 (yellow) to >25 (dark blue).

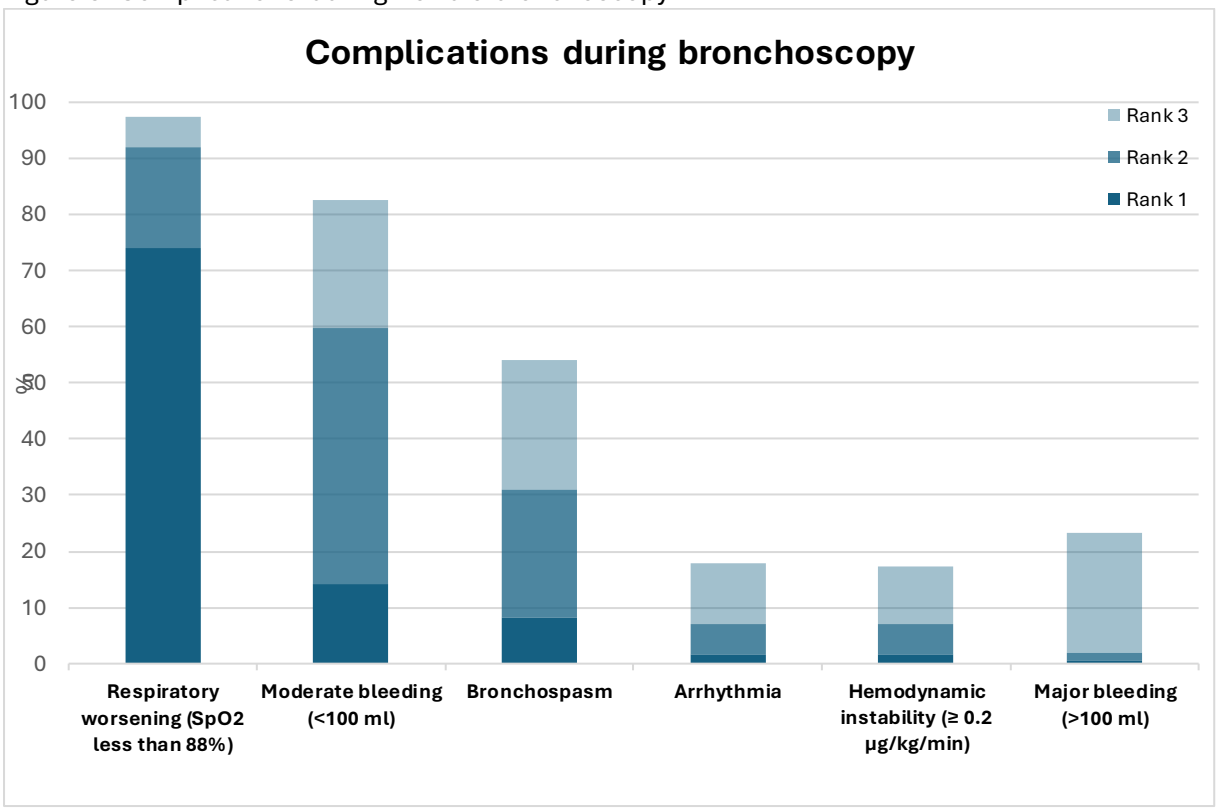
Figure 2: Diagnostic and therapeutic indications for flexible bronchoscopy



Bar chart representing diagnostic (A) and therapeutic (B) indications for flexible bronchoscopy. Respondents were able to select 3 answers from the options provided, which they most important/applicable and prioritize them among themselves (rank 1-3). Instillation of

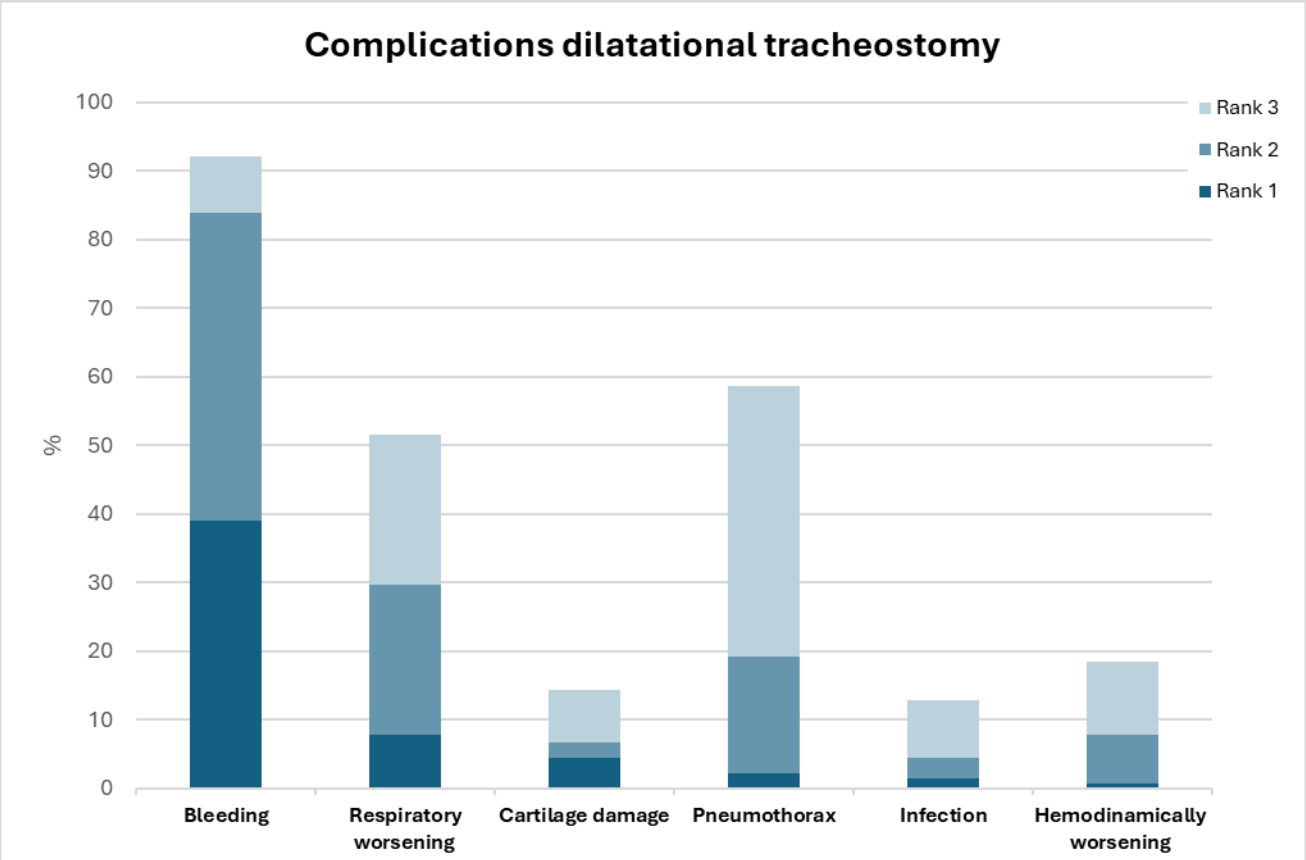
therapeutic agents, stent placement, and foreign body extraction were rarely reported as therapeutic interventions and are therefore not represented in the figure.

Figure 3: Complications during flexible bronchoscopy



Bar chart representing complications during flexible bronchoscopy. Respondents were able to select 3 answers from the options provided, which they most important/applicable and prioritize them among themselves (rank 1-3).

Figure 4: Complications during percutaneous dilatational tracheostomy



Bar chart representing complications during percutaneous dilatational tracheostomy. Respondents were able to select 3 answers from the options provided, which they most important/applicable and prioritize them among themselves (rank 1-3).

Supplemental material:

This appendix has been provided by the authors to give readers additional information about the study.

Supplement to:
Flexible Bronchoscopy on Intensive Care Unit – the FLEXICARE survey

Table S1: Checklist for Reporting Of Survey Studies (CROSS)

Section/topic	Item	Item description	Reported on page #
Title and abstract			
Title and abstract	1a	State the word "survey" along with a commonly used term in title or abstract to introduce the study's design.	3
	1b	Provide an informative summary in the abstract, covering background, objectives, methods, findings/results, interpretation/discussion, and conclusions.	3
Introduction			
Background	2	Provide a background about the rationale of study, what has been previously done, and why this survey is needed.	6
Purpose/aim	3	Identify specific purposes, aims, goals, or objectives of the study.	6
Methods			
Study design	4	Specify the study design in the methods section with a commonly used term (e.g., cross-sectional or longitudinal).	7
Data collection methods	5a	Describe the questionnaire (e.g., number of sections, number of questions, number and names of instruments used).	7-8
	5b	Describe all questionnaire instruments that were used in the survey to measure particular concepts. Report target population, reported validity and reliability information, scoring/classification procedure, and reference links (if any).	7-8
	5c	Provide information on pretesting of the questionnaire, if performed (in the article or in an online supplement). Report the method of pretesting, number of times questionnaire was pre-tested, number and demographics of participants used for pretesting, and the level of similarity of demographics between pre-testing participants and sample population.	7

	5d	Questionnaire if possible, should be fully provided (in the article, or as appendices or as an online supplement).	Online supplement
Sample characteristics	6a	Describe the study population (i.e., background, locations, eligibility criteria for participant inclusion in survey, exclusion criteria).	7-8
	6b	Describe the sampling techniques used (e.g., single stage or multistage sampling, simple random sampling, stratified sampling, cluster sampling, convenience sampling). Specify the locations of sample participants whenever clustered sampling was applied.	8-9
	6c	Provide information on sample size, along with details of sample size calculation.	N/A
	6d	Describe how representative the sample is of the study population (or target population if possible), particularly for population-based surveys.	10
Survey administration	7a	Provide information on modes of questionnaire administration, including the type and number of contacts, the location where the survey was conducted (e.g., outpatient room or by use of online tools, such as SurveyMonkey).	8
	7b	Provide information of survey's time frame, such as periods of recruitment, exposure, and follow-up days.	8
	7c	Provide information on the entry process: –>For non-web-based surveys, provide approaches to minimize human error in data entry. –>For web-based surveys, provide approaches to prevent "multiple participation" of participants. 17	9
Study preparation	8	Describe any preparation process before conducting the survey (e.g., interviewers' training process, advertising the survey).	N/A
Ethical considerations	9a	Provide information on ethical approval for the survey if obtained, including informed consent, institutional review board [IRB] approval, Helsinki declaration, and good clinical practice [GCP] declaration (as appropriate).	8
	9b	Provide information about survey anonymity and confidentiality and describe what mechanisms were used to protect unauthorized access.	8
Statistical analysis	10a	Describe statistical methods and analytical approach. Report the statistical software that was used for data analysis.	8-9
	10b	Report any modification of variables used in the analysis, along with reference (if available).	N/A
	10c	Report details about how missing data was handled. Include rate of missing items, missing data mechanism (i.e., missing completely at random [MCAR], missing at random [MAR] or missing not at random	9

		[MNAR]) and methods used to deal with missing data (e.g., multiple imputation).	
	10d	State how non-response error was addressed.	9
	10e	For longitudinal surveys, state how loss to follow-up was addressed.	N/A
	10f	Indicate whether any methods such as weighting of items or propensity scores have been used to adjust for non-representativeness of the sample.	N/A
	10g	Describe any sensitivity analysis conducted.	N/A
Results			
Respondent characteristics	11a	Report numbers of individuals at each stage of the study. Consider using a flow diagram, if possible.	10-13
	11b	Provide reasons for non-participation at each stage, if possible.	9
	11c	Report response rate, present the definition of response rate or the formula used to calculate response rate.	16
	11d	Provide information to define how unique visitors are determined. Report number of unique visitors along with relevant proportions (e.g., view proportion, participation proportion, completion proportion).	N/A
Descriptive results	12	Provide characteristics of study participants, as well as information on potential confounders and assessed outcomes.	10
Main findings	13a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates along with 95% confidence intervals and p-values.	N/A
	13b	For multivariable analysis, provide information on the model building process, model fit statistics, and model assumptions (as appropriate).	N/A
	13c	Provide details about any sensitivity analysis performed. If there are considerable amount of missing data, report sensitivity analyses comparing the results of complete cases with that of the imputed dataset (if possible).	N/A
Discussion			
Limitations	14	Discuss the limitations of the study, considering sources of potential biases and imprecisions, such as non-representativeness of sample, study design, important uncontrolled confounders.	16
Interpretations	15	Give a cautious overall interpretation of results, based on potential biases and imprecisions and suggest areas for future research.	17
Generalizability	16	Discuss the external validity of the results.	17
Other sections			

Role of funding source	17	State whether any funding organization has had any roles in the survey's design, implementation, and analysis.	2
Conflict of interest	18	Declare any potential conflict of interest.	2
Acknowledgements	19	Provide names of organizations/persons that are acknowledged along with their contribution to the research.	2

Table S2: Questionnaire

1. General demographic data

1.1. Where are you based?
1.2. What is your job?
1.3. Are you certified in pulmonary diseases?
1.4. Are you certified in intensive care medicine?
1.5. What is your age?
1.6. What is your gender?
1.7. What is your hospital setting? (University Hospital, non-university Hospital, Private institution, medical office)

2. General bronchoscopy data

2.1. How often do you perform bronchoscopy?
2.2. What is your favorite way of access?
2.3. Who supports you while performing flexible bronchoscopy?
2.4. Who mainly does the flexible bronchoscopy on your ICU?
2.5. Do you have an on-call service available 24/7, 7 days a week to perform flexible bronchoscopy on ICU?
2.6. What kind of personal protective equipment do you use during bronchoscopy?
2.7. Which kind of bronchoscopes do you use on the intensive care unit?
2.8. In your country/hospital setting, do you decline performing bronchoscopy for economic reasons?

3. Indication and contraindication for flexible bronchoscopy

3.1. What is the diagnostic main diagnostic indication for flexible bronchoscopy on your ICU?
3.2. What is the main therapeutic indication for flexible bronchoscopy on your ICU?
3.3. Are there any contraindications to perform flexible bronchoscopy in your ICU?

4. Diagnostic and therapeutic procedures
4.1. What amount of saline do you regularly use for a bronchioloalveolar lavage?
4.2. How much recovery do you regularly get?
4.3. Do you regularly conduct a differential cell count of your BAL?

5. Preparation, sedation and monitoring before and during bronchoscopy

5.1. Do you assess patient consent regularly before bronchoscopy on ICU?
5.2. In patients without naso-gastral feeding, are they fasted before bronchoscopy?
5.3. Which evaluations should be available before you do FB in ICU patients?
5.4. Which premedication and sedation do you usually use?
5.5. Who applies the sedation?
5.6. Which kind of monitoring do you provide during flexible bronchoscopy?

6. Bronchoscopy for intubation
6.1. Do you perform awake fiberoptic intubation for difficult airway?
6.2. Do you perform fiberoptic intubation while non-invasive ventilation?

6.3. Do you regularly check tube position by means of bronchoscopy in the case of respiratory worsening?

7. Ventilator

7.1. Which ventilation mode do you usually use during flexible bronchoscopy?
7.2. Do you escalate ventilator settings during bronchoscopy (e.g. set FiO2 to 100%)?
7.3. Do you reduce PEEP while performing bronchoscopy to avoid hyperinflation and barotrauma?
7.4. Do you perform bronchoscopy in patients requiring 100% of inspired oxygen under an adequate PEEP without extracorporeal membrane oxygenation support?

8. Bronchoscopy procedures

8.1. Do you prefer a large or small-sized bronchoscopy for secrete suctioning?
8.2. What kind of specimen do you regularly assess?
8.3. How do you collect respiratory secretion?
8.4. What kind of diagnostic do you conduct on bronchial secretion?
8.5. Do you systematically report mucosal status (color, vulnerability), bleeding status (requiring or not intervention), secretion status (location, quantity, appearance)?
8.6. How often does the microbiological result from bronchoscopy change your therapeutic regimen?

9. Complications

9.1. Do you systematically assess complications during and after flexible bronchoscopy?
9.2. What are the main complications during or after flexible bronchoscopy on ICU?
9.3. What kind of tools do you have available for bleeding complications?

10. Percutaneous tracheostomy

10.1. What kind of technique do you use for percutaneous tracheostomy?
10.2. How often do you perform percutaneous dilatational tracheostomy per year?
10.3. Do you use flexible bronchoscopy while performing percutaneous tracheostomy?
10.4. What are the main complications after dilatational bronchoscopy on your ICU?

11. Education of bronchoscopy on ICU

11.1. How long did you train for bronchoscopy?
11.2. Did you receive training for bronchoscopy in the ICU?
11.3. Did you receive a systematic training for sedation, analgesic for bronchoscopy on ICU?
11.4. How do you usually learn about flexible bronchoscopy?
11.5. Do you use fiberoptic/video-bronchoscopic intubation for educational reasons?

Table S3: Personal protective equipment (gloves) according to continent

Participants	Gloves YES N=263	Gloves NO N=3
Europe	175 (99%)	2 (1%)
North America	9 (100%)	0 (0%)
Asia	60 (98%)	1 (2%)
Australia	3 (100%)	0 (0%)
Africa	6 (100%)	0 (0%)
South America	10 (100%)	0 (0%)

Data are expressed as number of patients (%). Values are rounded. p-value 0.993 for overall comparison.

Table S4: Personal protective equipment (gown) according to continent

Participants	Gown YES N=214	Gown NO N=52
Europe	143 (81%)	34 (19%)
North America	5 (56%)	4 (44%)
Asia	53 (87%)	8 (13%)
Australia	3 (100%)	0 (0%)
Africa	4 (67%)	2 (33%)
South America	6 (60%)	4 (40%)

Data are expressed as number of patients (%). Values are rounded. p-value 0.098 for overall comparison.

Table S5: Personal protective equipment (mask) according to continent

Participants	Mask YES N=235	Mask NO N=31
Europe	19 (11%)	158 (89%)
North America	2 (22%)	7 (78%)
Asia	10 (16%)	51 (84%)
Australia	0 (0%)	3 (100%)
Africa	0 (0%)	6 (100%)
South America	0 (0%)	10 (100%)

Data are expressed as number of patients (%). Values are rounded. p-value 0.421 for overall comparison.

Table S6: Personal protective equipment (caps) according to continent

Participants	Caps YES N=139	Caps NO N=127
Europe	87 (49%)	90 (51%)
North America	4 (44%)	5 (56%)
Asia	38 (62%)	23 (38%)
Australia	1 (33%)	2 (67%)
Africa	5 (84%)	1 (17%)
South America	4 (40%)	6 (60%)

Data are expressed as number of patients (%). Values are rounded. p-value 0.242 for overall comparison.

Table S7: Personal protective equipment (glasses) according to continent

Participants	Glasses YES N=109	Glasses NO N=157
Europe	72 (41%)	105 (59%)
North America	6 (66%)	3 (33%)
Asia	20 (33%)	41 (66%)
Australia	3 (100%)	0 (0%)
Africa	2 (33%)	4 (66%)
South America	6 (60%)	4 (40%)

Data are expressed as number of patients (%). Values are rounded. p-value 0.072 for overall comparison.