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RESEARCH ARTICLE

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A survey of preferences for respiratory support in the intensive care unit for patients with acute hypoxaemic respiratory failure

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Abstract

Background: When caring for mechanically ventilated adults with acute hypoxaemic respiratory failure (AHRF), clinicians are faced with an uncertain choice between ventilator modes allowing for spontaneous breaths or ventilation fully controlled by the ventilator. The preferences of clinicians managing such patients, and what motivates their choice of ventilator mode, are largely unknown. To better understand how clinicians' preferences may impact the choice of ventilatory support for patients with AHRF, we issued a survey to an international network of intensive care unit (ICU) researchers.

Methods: We distributed an online survey with 32 broadly similar and interlinked questions on how clinicians prioritise spontaneous or controlled ventilation in

A full list of SVALBARD investigators and their affiliations is provided in Appendix A1.

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invasively ventilated patients with AHRF of different severity, and which factors determine their choice.

Results: The survey was distributed to 1337 recipients in 12 countries. Of these, 415 (31%) completed the survey either fully (52%) or partially (48%). Most respondents were identified as medical specialists (87%) or physicians in training (11%). Modes allowing for spontaneous ventilation were considered preferable in mild AHRF, with controlled ventilation considered as progressively more important in moderate and severe AHRF. Among respondents there was strong support (90%) for a randomised clinical trial comparing spontaneous with controlled ventilation in patients with moderate AHRF.

Conclusions: The responses from this international survey suggest that there is clinical equipoise for the preferred ventilator mode in patients with AHRF of moderate severity. We found strong support for a randomised trial comparing modes of ventilation in patients with moderate AHRF.

KEYWORDS
acute hypoxaemic respiratory failure, acute respiratory distress syndrome, controlled ventilation, invasive mechanical ventilation, spontaneous ventilation, survey

Editorial Comment

When patients require ventilatory support for acute critical illness with hypoxemia, there are alternatives for the type of positive pressure ventilator modes. This study presents findings about preferences for modes of ventilatory support among intensive care unit (ICU) clinicians from a range of countries. In this sample, there are a range of preferences demonstrated for ventilatory modes including, for example, spontaneous versus controlled ventilation.

1 | INTRODUCTION

Mechanical ventilation is a mainstay in the management of patients with severe acute hypoxaemic respiratory failure (AHRF), a common cause of admission to the intensive care unit (ICU) that may progress to acute respiratory distress syndrome (ARDS).[1,2] The Scandinavian Society of Anaesthesiology and Intensive Care Medicine has previously published guidelines for the management of patients with ARDS,[3] and similar multi-societal transatlantic guidelines were published in 2017, 2019 and 2023.[4–7]

However, clinicians frequently fail to recognise the onset of ARDS, resulting in significant delays in initiating protocolized care, with potentially adverse consequences for patient management.[2,8,9] But the observational nature of such data should caution us against making firm causal inferences and[2,8,9] current guidelines do not provide evidence-based recommendations for several clinically relevant questions, including choice of ventilator mode (e.g., volume- or pressure-controlled ventilation), and modes allowing spontaneous (triggered) ventilation, due to a paucity of high-quality evidence.[10]

The issue of spontaneous versus controlled mechanical ventilation in ARDS has recently been highlighted as a research priority,[10] as no published large randomised clinical trial (RCT) exists to inform this choice. The desirable and undesirable effects of either strategy are largely unknown.[11–13] Experimental studies highlight the potential for harm from spontaneous or triggered breathing caused by increased transpulmonary pressures that may cause pulmonary oedema in the injured lung and contribute to further lung injury.[13,14] However, in the Large Observational Study to Understand the Global Impact of Severe Acute Respiratory Failure (LUNG SAFE) cohort, mechanical ventilation (MV) that allowed for spontaneous breathing, was associated with more ventilator-free days and shorter stay in the ICU.[11] Of note, more than half of all patients with ARDS were allowed spontaneous breaths in the latter study.[15] In a Nordic sub-set of the LUNG SAFE data, 35% of invasively ventilated patients with AHRF were allowed spontaneous breathing from Day 1, increasing to 62% at Day 5.[12] These findings may reflect clinicians' inclination towards less use of sedatives, in accordance with recently updated guidelines for the prevention and management of pain, agitation/sedation, delirium, immobility, and sleep disruption in adult patients in the ICU.[15]

Hence, experimental and observational studies reveal an uncertain balance of benefits and harms of controlled and spontaneous breathing modes in mechanically ventilated patients with AHRF, with the additional observation of substantial practice variation among clinicians responsible for the care of these patients.

To better understand how clinicians' preferences may impact the choice of ventilatory support for patients with AHRF we issued a

survey via the network of ICU researchers associated with the Collaboration for Research in Intensive Care (CRIC).[16] We hypothesised that the severity of AHRF was an important determinant of clinicians' preferences for spontaneous or controlled ventilation in patients managed with invasive MV and that the severity of AHRF would affect clinicians' willingness to enrol patients in an RCT.

2 | METHODS

2.1 | Organisation and design

The Spontaneous Versus controlled mechanicAL Breathing in patients with ARDS (SVALBARD) project aims to provide high-quality evidence to support clinical decision-making for the provision of MV in patients with ARDS. Specifically, we seek to understand the benefits and harms of spontaneous breathing in invasively ventilated patients. The project is closely associated with CRIC.

We conducted a cross-sectional online survey, using the web application SurveyMonkey (Momentive Inc., San Mateo, CA, USA). The survey was developed, tested and approved by a working group (TNA, TLK, MHM, AP, BSR and JHL) following a meeting of CRIC collaborators in Copenhagen, Denmark, in September 2022. The final survey was issued on 1 January 2023, and the database was closed on 31 January 2023. Two reminders were issued via e-mail before closing the database.

At each participating centre, one co-worker was responsible for distributing the survey and reminders to colleagues identified as clinical decision-makers (mostly ICU physicians) managing patients with AHRF. It was not possible to make multiple entries from the same IP address. Other than this, we did not check for multiple participation.

TABLE 1 Participants.

	Co-workers	Recipients	Respondents (%)	Proportion (%)
Norway	26	451	151 (33.5)	36.39
Denmark	13	441[a]	119 (27.0)	28.67
Sweden	6	188	34 (18.1)	8.19
Poland	2	48	23 (47.9)	5.54
Switzerland	3	79	22 (27.8)	5.30
Finland	1	23	20 (87.0)	4.82
Iceland	1	46	17 (37.0)	4.10
Netherlands	1	25	15 (60.0)	3.61
Germany	2	16	5 (31.3)	1.20
Australia	1	20	5 (25.0)	1.20
United Kingdom	-	-	3	0.72
Belgium	-	-	1	0.24
Sum	56	1337	415 (31.0)	100.00

Note: The survey was distributed to 56 local co-workers in 10 countries. These selected recipients (1337) were classified as clinical decision makers (day or night) who personally care for patients with acute hypoxaemic respiratory failure. Respondents (415) are those who completed the survey fully or partially. The proportion denotes the percentage of participants by country of employment (as reported anonymously by the participant).
[a]Includes 160 intensive care unit nurses.

TABLE 2 Respondents' characteristics.

	MD in training	MD specialist	Other professions[a]	SDIC/EDIC
Norway	20	131	0	28
Denmark	23	86	8	29
Sweden	1	33	0	16
Finland	0	20	0	9
Iceland	0	17	0	6
Other[b]	3	72	1	16
Total (%)	47 (11.3)	359 (86.5)	9 (2.2)	104 (25.1)

Abbreviations: EDIC, European Diploma of Intensive Care; MD, medical doctor; SDIC, Scandinavian Diploma of Intensive Care.
[a]Nurse, 8; medical student, 1.
[b]Poland, Switzerland, Netherlands, Germany, Australia, United Kingdom, Belgium.

The collected data were stored on a secure server at Oslo University Hospital. We did not seek ethics approval as no patient data were collected, and all responses were anonymous. Participation was voluntary, and no financial support was provided. We considered participants' activation of the survey link and full or partial completion of the survey as provision of informed consent. This manuscript was prepared with reference to the Consensus-Based Checklist for Reporting of Survey Studies (CROSS).[17] The completed checklist is available in the Supporting Information.

2.2 | Survey description

The survey consisted of 32 questions. Participants were asked to identify the country of their current employment and their training status (e.g., specialist or in-training). To identify all patients of interest we used the more inclusive term AHRF instead of ARDS. Queries were designed to explore clinical decision-makers' preferences for mechanical respiratory support in patients with AHRF according to the severity of hypoxemia. We explicitly excluded considerations for patients with known chronic lung diseases and cardiopulmonary oedema. We asked participants about the respiratory support method of choice (i.e., invasive vs. non-invasive); ventilator mode (i.e., controlled vs. spontaneous or triggered ventilation); which clinical observations might impact decision-makers' choice of respiratory support method and mode (e.g., apparent work of breathing, PaO_2); use of therapeutic adjuncts (e.g., neuromuscular blockers [NMBAs], prone positioning) and monitoring methods; and clinicians' preferences for, and rating of the importance of, controlled versus spontaneous ventilation. Finally, we queried participants about their interest in enrolling patients with AHRF in an RCT, their preferred comparisons and outcomes, and their knowledge of current guidelines. A full list of queries is provided in the Supporting Information.

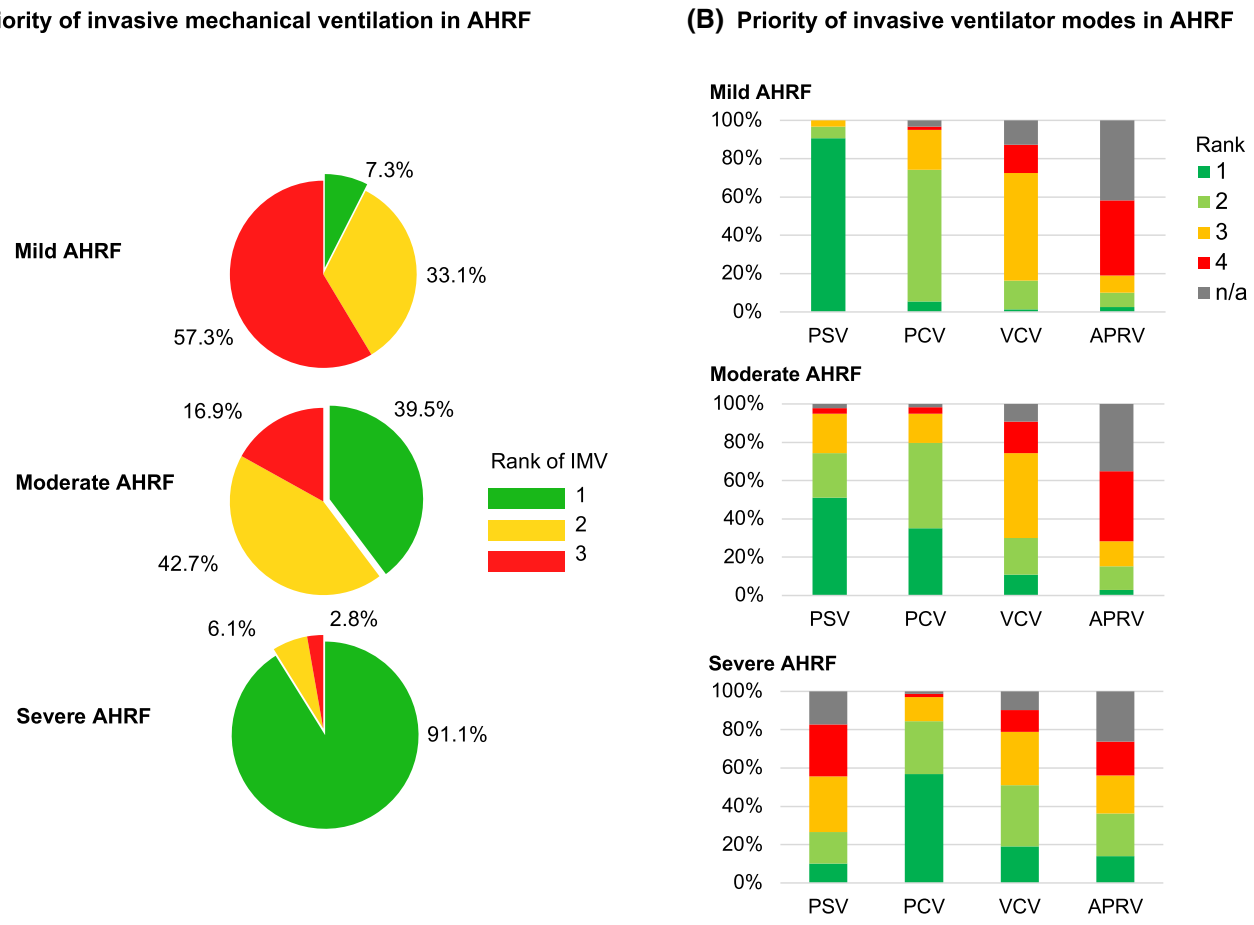

FIGURE 1 Priority of invasive ventilation and ventilator modes in AHRF. (A) Respondents' were asked to prioritise between IMV, non-invasive positive pressure ventilation and continuous positive airway pressure for given degrees of AHRF. The sector diagrams indicate the ranking of IMV in mild, moderate and severe AHRF ($n = 249$). Green, highest rank for IMV (most important); yellow, second rank; red, third rank (least important). (B) Respondents were asked to assign priority ranks to given ventilator modes in patients requiring IMV for mild, moderate and severe AHRF ($n = 238$). Greens, highest rank (first or second) (most important); yellow, middle rank; red, lowest rank (least important). AHRF, acute hypoxaemic respiratory failure; defined as mild (a ratio of the partial pressure of arterial oxygen and the fraction of inspired oxygen (PaO_2/FiO_2) of 26.6–40 kPa; 200–300 mmHg), moderate (PaO_2/FiO_2 13.3–26.6 kPa; 100–200 mmHg) or severe (PaO_2/FiO_2 < 13.3 kPa; <100 mmHg); APRV, airway pressure release ventilation; IMV, invasive mechanical ventilation; PCV, pressure control ventilation; PSV, pressure support ventilation; VCV, volume-controlled ventilation.

2.3 | Definitions

AHRF was defined as mild (a ratio of the partial pressure of arterial oxygen and the fraction of inspired oxygen (PaO_2/FiO_2) of 26.6–40 kPa; 200–300 mmHg), moderate (PaO_2/FiO_2 13.3–26.6 kPa; 100–200 mmHg) or severe (PaO_2/FiO_2 <13.3 kPa; <100 mmHg).

2.4 | Statistics

We present results graphically and as descriptive statistics, with continuous variables as medians with interquartile ranges (IQRs), and categorical variables as numbers and percentages. We did not impute missing data. We used STATA (version 17.0, StataCorp LLC, College Station, TX, USA) and Microsoft Excel (Microsoft Corp., Redmond, WA, USA) for analyses. We did not perform any sample size estimation.

3 | RESULTS

3.1 | Respondents

Local co-workers distributed the survey link to 1337 recipients in 12 countries. Of these, 416 (31%) completed the survey either fully (52%) or partially (48%). One respondent, who did not personally care for patients with AHRF, was excluded. Thus, the overall response rate was 31%. Most respondents were employed in the Nordic countries, but a substantial number of contributions were from other nations (Table 1).

Most respondents (87%) were identified as medical specialists and 25% reported to hold either a Scandinavian Diploma of Intensive Care Medicine (SDIC) or a European Diploma of Intensive Care (EDIC) (Table 2). A minority (11%) were identified as physicians in training. In Denmark, local co-workers distributed the query to 160 ICU nurses, of whom only 8 responded. A majority of respondents (66%) reported that their department had a local guideline for the provision of respiratory support in AHRF. Similarly, respondents reported knowledge of some (76%), all (15%), or none (9%) of the published guidelines on the management of MV in ARDS,[3–6] and management of sedation in the ICU (57%).[15] Respondents with SDIC or EDIC reported awareness of the 'Clinical Practice Guidelines for the Prevention and Management of Pain, Agitation/Sedation, Delirium, Immobility, and Sleep Disruption in Adult Patients in the ICU (PADIS guidelines)'[15] significantly more often than medical specialists without SDIC/EDIC and non-specialists (72% vs. 52% and 35%, respectively).

3.2 | Completeness

On average, respondents completed 68% of all queries. Respondents spent on average 17 min on the survey, and those who fully completed the survey spent on average 31 min.

3.3 | Response to queries

3.3.1 | Preferred techniques and modes of respiratory support for a patient with AHRF

Respondents ranked non-invasive techniques of respiratory support (continuous positive airway pressure [CPAP] or non-invasive ventilation [NIV]) as more important than invasive MV in mild AHRF. In moderate AHRF, responses were equivocal, and in severe AHRF, invasive MV was ranked first (Figure 1A). In invasively ventilated patients, pressure support ventilation was ranked first in mild and moderate

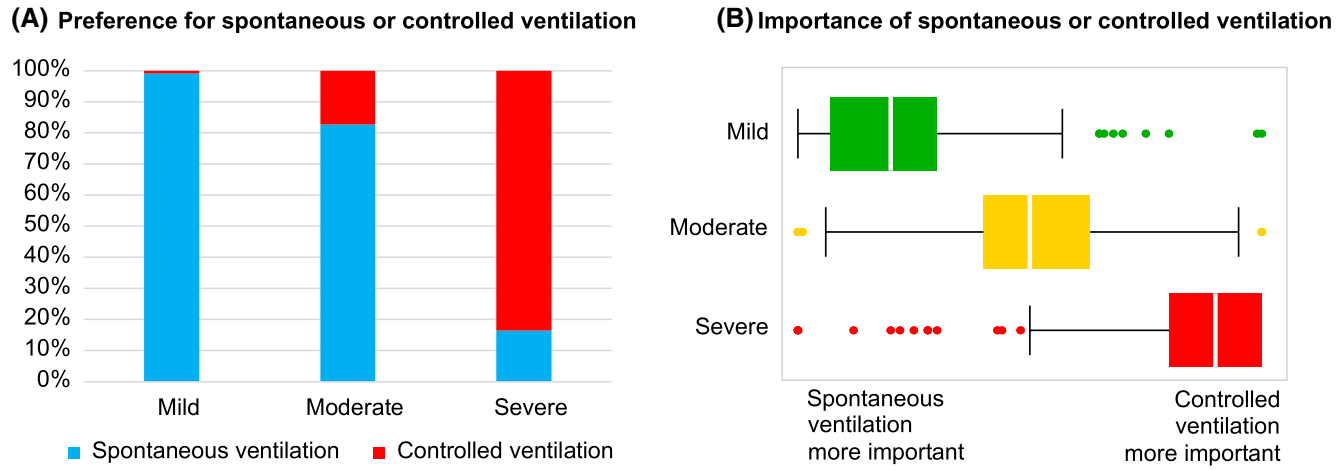

FIGURE 2 Spontaneous or controlled ventilation. (A) Preference for spontaneous or controlled ventilation in patients with mild, moderate or severe AHRF ($n = 238$). Binary choice. (B) Importance of spontaneous or controlled ventilation in patients with mild, moderate or severe AHRF ($n = 213$). Sliding scale (1–100) from 'spontaneous ventilation most important' to 'controlled ventilation most important'. Boxplots indicate medians and interquartile ranges (IQRs, boxes) and whiskers indicate upper and lower adjacent values (1.5× IQR, as defined by Tukey[20]). AHRF, acute hypoxaemic respiratory failure; defined as mild (a ratio of the partial pressure of arterial oxygen and the fraction of inspired oxygen (PaO_2/FiO_2) of 26.6–40 kPa; 200–300 mmHg), moderate (PaO_2/FiO_2 13.3–26.6 kPa; 100–200 mmHg) or severe (PaO_2/FiO_2 <13.3 kPa; <100 mmHg).

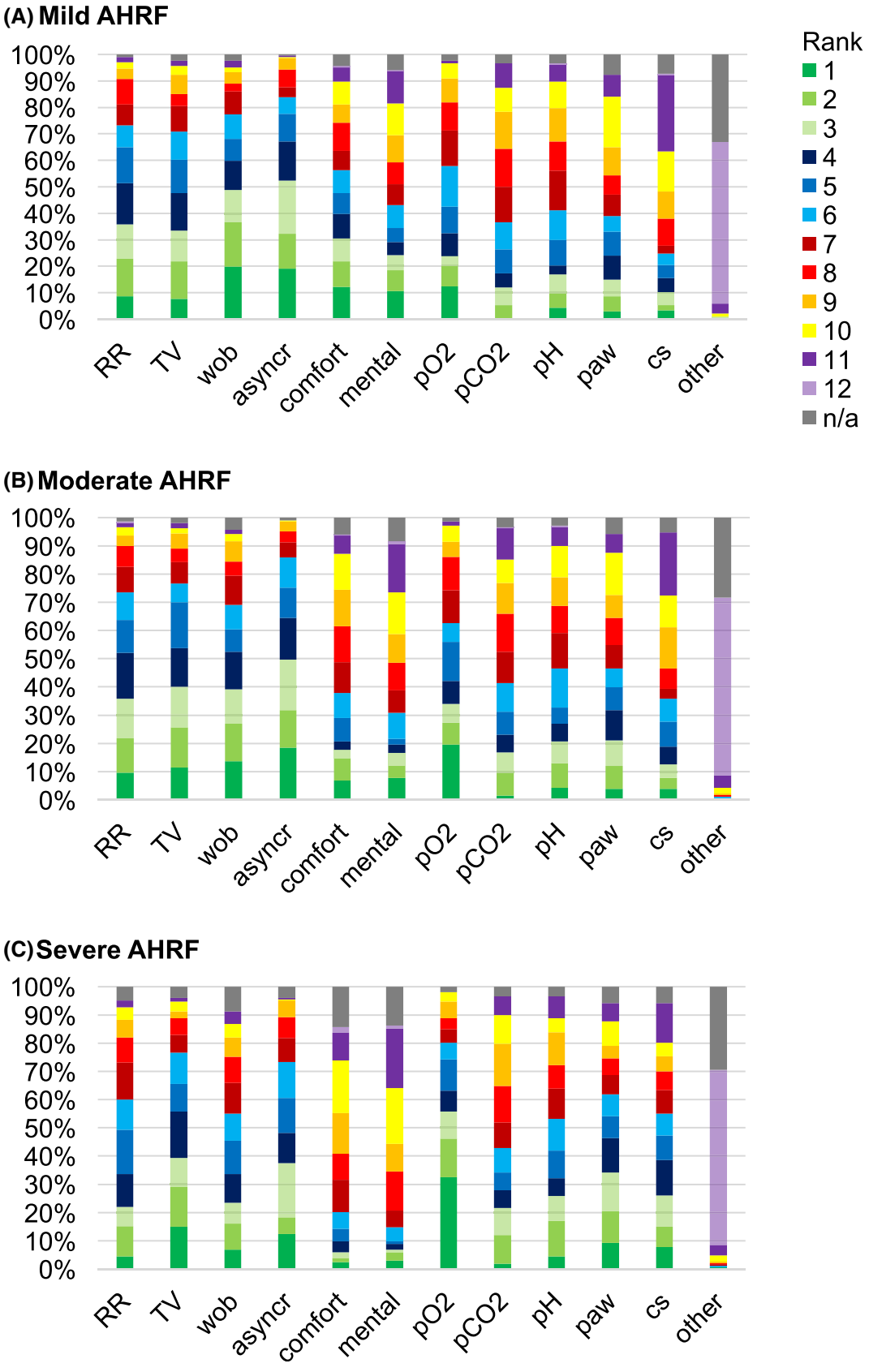

FIGURE 3 Legend on next page.

AHRF, and pressure control ventilation was ranked first in severe AHRF (Figure 1B). Volume-controlled ventilation was ranked last in all severities of AHRF.

3.3.2 | Preference for spontaneous (triggered) ventilation or controlled ventilation in AHRF

When presented with a binary choice, most respondents preferred ventilator modes allowing for spontaneous breathing (i.e., triggered by the patient) over modes fully controlled by the ventilator in patients with mild or moderate AHRF. In severe AHRF, most respondents (84%) preferred controlled ventilation (Figure 2A). When asked to indicate the importance of either mode on a sliding scale from 1 to 100 (i.e., any point between 'spontaneous ventilation more important' and 'low tidal volume ventilation [protective ventilation] more important'), the responses were more nuanced, with respondents being equivocal in patients with moderate AHRF and clearly preferring spontaneous ventilation in mild AHRF and controlled ventilation in severe AHRF (Figure 2B).

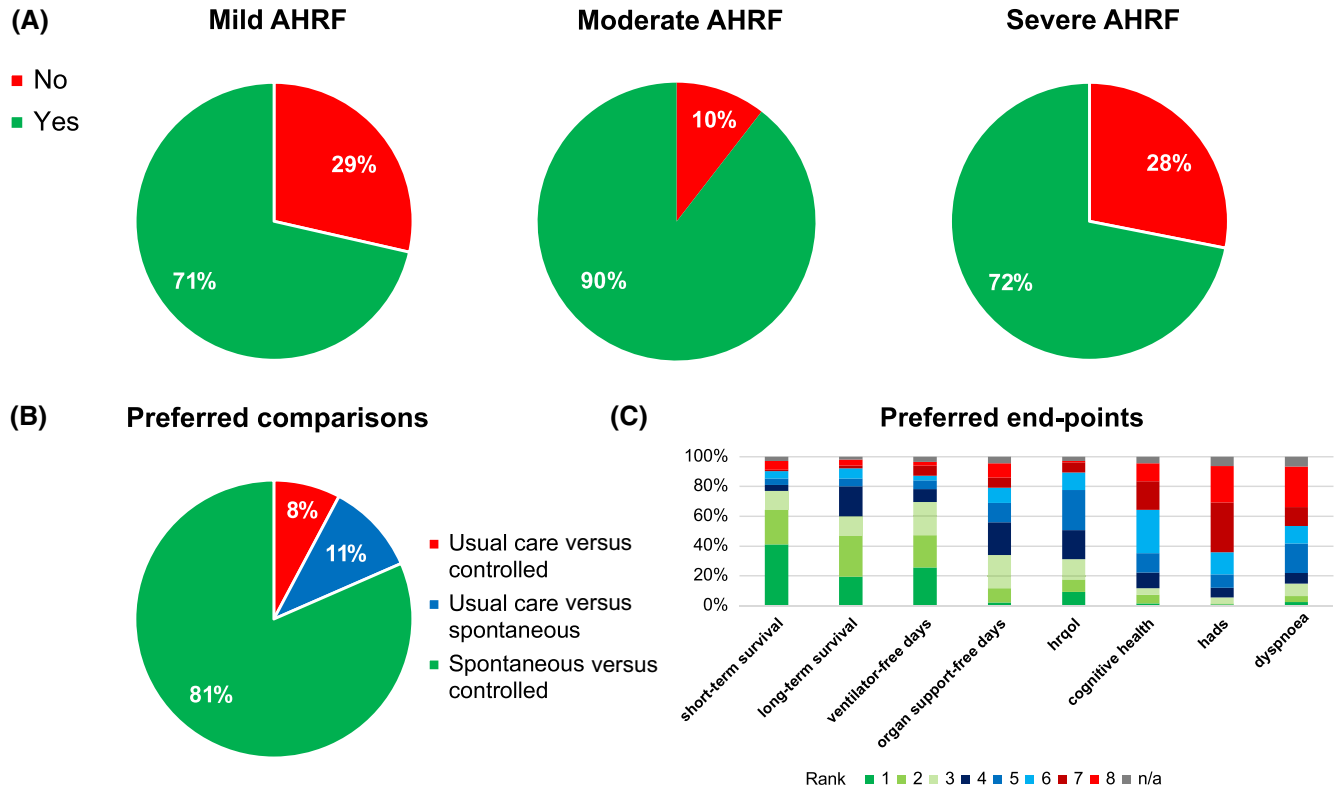

FIGURE 4 Support for trial enrolment of patients with AHRF. (A) Proportion of respondents ($n = 211$) who would include patients in a randomised trial comparing spontaneous and controlled ventilation in mild, moderate or severe AHRF. (B) Preference for comparisons in a trial of ventilator modes in patients with AHRF ($n = 207$). (C) Proportions of respondents' ranking of potential endpoints in a trial of ventilator modes in patients with AHRF ($n = 210$). Greens, highest rank (first, second or third; blues, middle rank (fourth, fifth or sixth); reds, lowest rank (seventh, or eighth); grey, not ranked. AHRF, acute hypoxaemic respiratory failure; defined as mild (a ratio of the partial pressure of arterial oxygen and the fraction of inspired oxygen (PaO_2/FiO_2) of 26.6–40 kPa; 200–300 mmHg), moderate (PaO_2/FiO_2 13.3–26.6 kPa; 100–200 mmHg) or severe (PaO_2/FiO_2 <13.3 kPa; <100 mmHg); short-term survival (e.g., ICU-, hospital-, or 30–90 day survival); long-term survival (e.g., 12-month survival); days alive without mechanical ventilation (within a period of e.g. 90 days); days alive without any organ support (within a period of e.g. 90 days); hrqol, health-related quality of life at, for example, 6 or 12 months; cognitive health at, for example, 6 or 12 months; hads; symptoms of anxiety, depression and post-traumatic stress at 6 or 12 months; dyspnoea at 6 or 12 months.

FIGURE 3 Determinants for choice of spontaneous versus controlled ventilation. Participants' ($n = 213$) ranking of the importance of observations and tests in determining their choice of spontaneous versus controlled ventilation in IMV of patients with (A) mild, (B) moderate or (C) severe AHRF. Green colours indicate proportion of high ranks (first, second or third); blue colours indicate proportion of middle ranks (fourth, fifth and sixth); red colours indicate proportion of low ranks (seventh, eighth, ninth or 10th) and purple colours indicate lowest rank (11th and 12th); grey indicates an item not chosen by the respondent. AHRF, acute hypoxaemic respiratory failure; defined as mild (a ratio of the partial pressure of arterial oxygen and the fraction of inspired oxygen (PaO_2/FiO_2) of 26.6–40 kPa; 200–300 mmHg), moderate (PaO_2/FiO_2 13.3–26.6 kPa; 100–200 mmHg) or severe (PaO_2/FiO_2 <13.3 kPa; <100 mmHg); cs, respiratory system compliance; paw, any ventilator pressures; RR, respiratory rate; TV, tidal volume; wob, the patient's work of breathing (perceived effort by the patient).

3.3.3 | Determinants of respiratory support and ventilator modes

Determinants for selecting non-invasive or invasive techniques of respiratory support in mild and moderate AHRF were patients' apparent work of breathing, followed by patients' mental alertness, and respiratory rate (Figure S1a,b). In severe AHRF, patients' PaO_2 ranked first, followed by patients' apparent work of breathing and respiratory rate (Figure S1c).

When participants were asked to rank determinants for choosing between spontaneous or controlled ventilation in patients with mild and moderate AHRF, patients' apparent work of breathing and patient-ventilator synchrony were given the highest rankings, followed by respiratory rate, and tidal volume (Figure 3A,B). In patients with severe AHRF, patients' PaO_2 was ranked as the most important determinant for the clinicians' choice, followed by tidal volume, and patient-ventilator synchrony (Figure 3C).

3.3.4 | Adjuncts

Respondents expressed support for both ventilation in the prone position and NMBA in severe AHRF. In moderate AHRF responses were equivocal, and very few respondents supported the use of either therapy in mild AHRF (Figure S1a,b). The median oxygenation threshold (PaO_2/FiO_2) for initiating prone positioning was 18 kPa (IQR 13; 20) (135 mmHg, IQR 97; 150) (Figure S2c). In mild AHRF, 36.9% would choose controlled ventilation if patients were in prone position (Figure S2d). In moderate and severe AHRF, 69.3% and 84.9% of respondents, respectively, would choose controlled ventilation in the prone position.

3.3.5 | Interest in trial enrolment of patients with AHRF and outcomes of interest

Respondents expressed interest in enrolling patients with AHRF in an RCT comparing ventilator modes, with 90% supporting a trial in patients with moderate AHRF and more than 70% supporting a trial enrolling patients with mild and severe AHRF (Figure 4A). More than 80% of respondents favoured a direct comparison between spontaneous and controlled ventilation (Figure 4B). Short- (90 days or less) and long-term (1 year or more) survival, and ventilator-free days were ranked first among potential outcome measures (Figure 4C). Respondents generally ranked patient-reported outcome measures (e.g., quality-of-life measures, cognitive health etc.) lower than survival and ventilator-free days.

4 | DISCUSSION

The purpose of this survey was to collect information on clinicians' preferences for respiratory support and choice of ventilator modes in mechanically ventilated patients with AHRF. We also sought to understand which considerations determined their choice. We explicitly stated that our main focus was on the uncertainties that clinicians encounter when deciding between spontaneous or controlled invasive MV, and we informed participants that the responses to our survey would aid the design of an RCT to provide more solid evidence on this topic.

We therefore deliberately avoided detailed queries about the use of different modes of non-invasive oxygen supplementation, for example, standard versus high-flow oxygen therapy, helmet versus mask-ventilation etc., and only asked participants to rank the importance of non-invasive mechanical support (CPAP or NIV) or invasive MV in AHRF of different severity.

Also, we deliberately avoided differentiating between a plethora of intermediate ventilator modes found on modern ICU ventilators, allowing for both controlled and supported ventilation. Although many clinicians are used to toggle between a variety of modes, our aim was to understand their fundamental preferences and which factors determine their choice.

We therefore based our queries on a recurring theme; 'how do clinicians prioritise between spontaneous *versus* controlled ventilation?' Thus, we presented participants with broadly similar and interlinked problems to allow for more nuanced responses.

Our hypothesis was that clinicians' preferences for spontaneous or controlled ventilation in patients managed with invasive MV were determined by the severity of AHRF and that the severity of AHRF would affect clinicians' willingness to enrol patients in an RCT. This was based on observations in the LUNG SAFE study, where spontaneous breathing was present in 67% of patients with mild ARDS, 58% of patients with moderate ARDS and 46% of patients with severe ARDS.[11]

Respondents expressed strong support for an RCT comparing spontaneous and controlled ventilation. Support for such a trial appeared to be greatest if the trial population was limited to patients with moderate AHRF. This conclusion was supported by respondents being comfortable with spontaneous ventilation in mild AHRF, and strongly preferred controlled ventilation in patients with severe AHRF. Respondents were much more equivocal in moderate AHRF. Thus, even with sparse evidence from clinical trials to support either spontaneous or controlled ventilation in AHRF of increasing severity,[1] true equipoise, reflecting both clinicians' preferences and current evidence, for either ventilator mode appears to be limited to patients with moderate AHRF. Respondents' rankings of determinants for selection of both the method of respiratory support and ventilator modes in MV lend support to this: in severe AHRF, patients' oxygenation ranked first, indicating that choice of support modes is determined by a physiological target, and in mild AHRF invasive MV was ranked as a low priority.

Furthermore, respondents clearly ranked short- and long-term mortality, and 'ventilator-free days' as more important than patient-reported outcome measures (e.g., quality-of-life measures, cognitive health etc.). Also, respondents ranked patients' comfort and mental alertness lower than physiological parameters as determinants of the

choice of method of respiratory support and modes of MV. These findings are at odds with the broad interest in these topics in current literature, and the potential benefits of improved sedation practices and ventilator management on mental alertness and early rehabilitation.[18,19] However, respondents also indicated only moderate awareness of the PADIS guidelines, and this may potentially reflect that the management of pain and sedation is given less priority than we imagined.[15]

Routine use of prone ventilation and NMBA as adjuncts were supported in severe AHRF and to some extent in moderate AHRF. These findings were strengthened by respondents' indication of a threshold for the institution of prone ventilation at a median PaO_2/FiO_2 of 18 kPa (135 mmHg). Most respondents would choose controlled ventilation in patients with AHRF managed in the prone position, further strengthening our impression that randomisation to either spontaneous or controlled ventilation in severe AHRF would be difficult.

4.1 | Strengths and limitations

This survey collected responses from a broad range of academic and non-academic ICUs in 12 countries. We sought participation from colleagues with personal experience in caring for patients with AHRF and with clinical decision-making capacity. Therefore, we believe that our findings may reflect current variations in attitudes and practices in our network. On the other hand, a response rate of 31% is a limitation of our survey and may have resulted in a biased response. Physicians in training and nurses were poorly represented. In Denmark, 160 ICU nurses received the survey but only 8 nurses responded, probably because the survey's title indicated that it was intended for physicians and nurses did not identify as clinical decision-makers. We chose not to exclude nurse respondents because their responses were broadly aligned with others'. Nonetheless, the overall response rate dictates a cautious interpretation of our results.

A proportion of respondents did not fully complete the survey. We believe this to be the result of two issues; firstly, some respondents noted in comments that they were disappointed that our survey did not address non-invasive methods more broadly; secondly, the response rate appeared to be negatively affected when participants were asked to rank multiple options. This proved to be time-consuming and technically challenging, with response rates dropping to around one-half of all respondents. Respondents who fully completed the survey spent more time than those who did not, perhaps indicating a differential degree of interest in the topic at hand. Such issues might have been mitigated had we sought external validation before issuing our survey.

5 | CONCLUSIONS

In this survey, respondents reported a clear preference for either non-invasive respiratory support or MV allowing for spontaneous ventilation in patients with mild AHRF, and a similarly strong preference for fully controlled ventilation in patients with severe AHRF. In patients with moderate AHRF, respondents had no clear preference for either spontaneous or controlled ventilation. These findings were strengthened by other findings, that is, the determinants of the methods of respiratory support and selection of ventilator modes, and the preference for adjunctive measures in severe AHRF. There was strong support for an RCT comparing spontaneous or controlled ventilation in patients with moderate AHRF.

AUTHOR CONTRIBUTIONS

Conceptualization; methodology; design; formal analysis and investigation; writing – original draft preparation; writing – review and editing: Tayyba N Aslam, Thomas L Klitgaard, Morten H Møller, Anders Perner, Bodil S Rasmussen, Jon H Laake. **Writing – original draft preparation; writing – review and editing:** Kristin Hofsø. **Funding acquisition:** Tayyba N Aslam, Jon H Laake. **Resources; supervision:** Jon H Laake. **Local co-ordination and data collection; writing – review and editing:** Christian AO Ahlstedt, Finn H Andersen, Michelle S Chew, Marie O Collet, Maria Cronhjort, Stine Estrup, Ole K Fossum, Shirin K Frisvold, Hans-Joerg Gillmann, Anders Granholm, Trine M Gundem, Kristin Hauss, Jacob Hollenberg, Maria E Huanca Condori, Johanna Hästbacka, Bror A Johnstad, Eric Keus, Maj-Brit N Kjær, Pål Klepstad, Mette Krag, Reidar Kvåle, Manu LNG Malbrain, Christian S Meyhoff, Matt Morgan, Anders Møller, Carmen A Pfortmueller, Lone M Poulsen, Andrew C Robertson, Joerg C Schefold, Olav L Schjørring, Martin Siegemund, Martin I Sigurdsson, Fredrik Sjövall, Kristian Strand, Thomas Stueber, Wojciech Szczeklik, Rebecka R Wahlin, Helge L Wangberg, Karl-Andre Wian, Sine Wichmann.

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CONFLICT OF INTEREST STATEMENT

Anders Granholm, Maj-Brit N. Kjær, Morten H. Møller and Anders Perner are affiliated with the Department of Intensive Care, Rigshospitalet, which receives support for research from the Novo Nordisk Foundation, Sygeforsikringen 'danmark', Beckett's Foundation and Pfizer and does contract research for AM-Pharma. Anders Perner has received an honorarium from Novartis for participation in an advisory board. Bodil S. Rasmussen, Olav L. Schjørring and Thomas L. Klitgaard are affiliated with the Department of Anaesthesia and Intensive Care, Aalborg University Hospital, which receives support from the Novo Nordisk Foundation and the Ministry of Higher Education and Science. Sine Wichmann is affiliated with the Department of Anaesthesia and Intensive Care, Nordsjællands Hospital, Denmark, which has received research funding from the Novo Nordisk Foundation, Sygeforsikringen 'danmark', Svend Andersens' Foundation and Ehrenreich Foundation. Christian S. Meyhoff has co-founded a start-up company, WARD24/7 ApS, with the aim of pursuing the regulatory and commercial activities of the WARD-project (Wireless Assessment of Respiratory and circulatory Distress, a project developing a clinical support system for continuous wireless monitoring of vital signs). WARD24/7 ApS has obtained licence agreement for any WARD-project software and patents. One patent has been filed: 'Wireless Assessment of Respiratory and circulatory Distress (WARD), EP 21184712.4 and EP 21205557.8'. These interests are unrelated to the current publication. Manu L. N. G. Malbrain is a professor of Critical Care Research at the First Department of Anaesthesiology and Intensive Therapy, Medical University of Lublin, Poland. He is co-founder, past-president and current treasurer of WSACS (The Abdominal Compartment Society, http://www.wsacs.org). He is a member of the medical advisory Board of Pulsion Medical Systems (now fully part of Getinge group), Serenno Medical, Potrero Medical, Sentinel Medical and Baxter. He consults for BBraun, Becton Dickinson, ConvaTec, Spiegelberg, Medtronic, MedCaptain, and Holtech Medical, and received speaker's fees from PeerVoice. He holds stock options for Serenno and Potrero. He is co-founder and president of the International Fluid Academy (IFA). The IFA (http://www.fluidacademy.org) is integrated within the not-for-profit charitable organisation iMERiT, International Medical Education and Research Initiative, under Belgian law. All other authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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APPENDIX A

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