Journal of Cardiothoracic and Vascular Anesthesia 000 (2026) 1–9

Contents lists available at ScienceDirect

Journal of Cardiothoracic and Vascular Anesthesia

journal homepage: www.jcvaonline.com

Original Article

Postoperative Respiratory Support After Cardiac Surgery: The BREASE ARC International Survey

Axel Hirwe, MD[*,†,1], Nicolas Nesseler, MD, PhD[‡], Gudrun Kunst, MD, PhD[§,‖], Fabio Sangalli, MD[¶], Adrien Bouglé, MD, PhD[*,†], Pauline Dureau, MD[*,†,**]

[*]Sorbonne University, GRC 29 Clinical Research Group in Anesthesiology, Critical Care and Perioperative Medicine, ARPE, Paris, France

[†]Department of Anesthesiology and Critical Care, AP-HP, Pitié Salpêtrière Hospital, DMU DREAM, Paris, France

[‡]Department of Anesthesia and Critical Care, Pontchaillou, University Hospital of Rennes, Univ Rennes, CHU Rennes, CIC 1414 (Centre d'Investigation Clinique de Rennes), Inra, Inserm, Institut NUMECAN – UMR_A 1341, Rennes, France

[§]Department of Anesthetics and Pain Therapy, King's College Hospital NHS FT, Denmark Hill, London, United Kingdom

[‖]School of Cardiovascular and Metabolic Medicine & Sciences, King's College London British Heart Foundation Centre of Excellence, James Black Centre, London, United Kingdom

[¶]Department of Anesthesia and Intensive Care, ASST Brianza, University of Milano-Bicocca, Vimercate, Italy

[**]INSERM, Pierre Louis Institute of Epidemiology and Public Health, Sorbonne University, AP-HP, Pitié Salpêtrière Hospital, Department of Public Health, AP-HP Center for Pharmacoepidemiology (Cephepi), Paris, France

Objective: To describe current clinician-reported postextubation noninvasive respiratory strategies after cardiac surgery with a focus on variability across centers and emerging combined strategies.
Design: Cross-sectional 25-item survey with descriptive analysis.
Setting: Cardiac surgery units across Europe, North Africa, the Middle East, and South America.
Participants: Ninety-two clinicians from European and French cardiothoracic anesthesia societies; 86% worked in cardiac-dedicated ICUs, 73% had >5 years of experience.
Interventions: No clinical interventions were undertaken. Respondents reported institutional protocols and individual postextubation respiratory support practices.
Measurements and main results: Institutional protocols were reported by 40% of respondents. Noninvasive respiratory support was used prophylactically by 77% of them, most often in high-risk patients (62%). Obesity (93%), severe chronic obstructive pulmonary disease ($FEV_1 \leq 50\%$, 93%), and obstructive sleep apnea (78%) were the main risk factors used for stratification. High-flow nasal oxygen (HFNO) and noninvasive ventilation (NIV) were available in almost all units. Combination HFNO-NIV was the most frequently selected prophylactic strategy (37%) and the dominant option for established postextubation respiratory failure (54%). The duration of prophylaxis varied widely, reflecting marked heterogeneity in practice. Decisions were influenced by training and experience (63%), protocol availability, and equipment constraints.
Conclusion: Postextubation respiratory practices after cardiac surgery are highly variable, with increasing adoption of combined HFNO-NIV strategies. The absence of standardized pathways contributes to inconsistency in patient selection, timing, and duration. These findings highlight the need for harmonized postoperative respiratory protocols and pragmatic multicenter trials to define optimal respiratory support strategies in cardiac surgical patients.

Key Words: cardiac surgery; acute respiratory failure; noninvasive ventilation; high-flow nasal oxygen; postextubation care; prophylactic respiratory support

[1]*Address correspondence to:* Axel Hirwe, MD, Assistance Publique-Hôpitaux de Paris (AP-HP), Département d'anesthésie et réanimation, Institut de Cardiologie, Hôpital La Pitié-Salpêtrière, 47-83 Boulevard de l'Hôpital, 75013, Paris, France; Tel.: +33 1 84828355.
E-mail address: axel.hirwe@aphp.fr (A. Hirwe).

https://doi.org/10.1053/j.jvca.2026.04.023

POSTOPERATIVE ACUTE RESPIRATORY FAILURE (ARF) is a common and serious complication following adult cardiac surgery, resulting from postoperative respiratory mechanics impairment, fluid shifts, diaphragmatic dysfunction, pain-related hypoventilation, and patient-related comorbidities.[1-5] ARF is associated with increased morbidity, prolonged intensive care unit (ICU) stays, higher reintubation rates, and substantial healthcare costs.[1,6-8] Despite improvements in perioperative care, a significant postextubation risk persists in high-risk cardiac surgical patients.[9-11]

Noninvasive respiratory support options include conventional oxygen therapy, continuous positive airway pressure (CPAP), noninvasive ventilation (NIV), and high-flow nasal oxygen (HFNO). Their relative benefits depend on clinical phenotype (hypoxic *v* hypercapnic) and timing of application (prophylactic *v* therapeutic). CPAP and NIV have been shown to reduce postoperative pulmonary complications.[12-16] However, research on their effects on reintubation remains inconsistent, particularly when baseline failure rates are low, and evidence synthesis is limited by heterogeneous protocols, settings, and outcome definitions.[12,17] Moreover, most available data are derived from general ICU populations, whereas cardiac surgical patients remain underrepresented in clinical trials despite distinct postoperative constraints.[18-20]

A previous European survey conducted more than a decade ago reported widespread use of NIV after cardiac surgery. Since then, the landscape of noninvasive respiratory support has evolved, with the introduction of HFNO and the emergence of combined HFNO-NIV strategies, creating a need for updated data on how these approaches are used and organized in routine cardiac surgical ICU practice. Although HFNO, CPAP, and NIV are widely used in clinical practice, real-world postextubation strategies remain poorly described. The absence of standardized postoperative respiratory pathways likely contributes to substantial variability in international practice and may hinder the effective implementation of available evidence. Given the growing availability of HFNO and its increasing integration into periextubation care, the current authors expected that combined or sequential HFNO-NIV strategies would now be commonly used in routine practice after cardiac surgery, despite limited direct evidence in this setting.

The Best REspirAtory StratEgy for Acute Respiratory failure after Cardiac surgery (BREASE ARC) survey was therefore designed to: (1) assess the availability and declared use of different noninvasive respiratory support modalities; (2) examine reported practices regarding patient selection, timing, and duration; and (3) identify the main organizational factors and perceived barriers to implementation. By characterizing current practices and potential sources of heterogeneity, this survey was designed to inform the development of standardized, evidence-based postextubation strategies in cardiac surgical ICUs.

Materials and Methods

Study Design

The BREASE ARC study is an international, cross-sectional, online survey targeting clinicians involved in the perioperative management of adult cardiac surgical patients.

Survey Development and Content

Two scientific societies supported the survey: the European Association of Cardiothoracic Anesthesiology and Intensive Care (EACTAIC) and the French Anesthesia and Critical Care Heart-Thorax-Vessels Association (ARCOTHOVA), the national society for cardiothoracic anesthesia and critical care. A panel of experts in anesthesiology, intensive care, and cardiac surgery developed, reviewed, and validated the survey instrument and study protocol. An expert-driven process involving iterative revisions was used to ensure clarity, clinical relevance, and content validity. The final 25-item questionnaire combined single-choice, multiple-choice, and open-ended questions to allow for both quantitative and qualitative input. The items covered: (1) institutional and demographic characteristics, (2) prophylactic respiratory strategies after extubation, and (3) therapeutic approaches for postextubation ARF, including the use of combined HFNO-NIV strategies (ie, the use of both modalities within the same postextubation management strategy). The full survey is available in Supplementary Material 1. A pilot test of the questionnaire among anesthesiologists assessed readability and technical functionality before dissemination.

Data Collection and Distribution

From October 1 to December 15, 2024, the survey was disseminated via EACTAIC and ARCOTHOVA communication channels. At the time of distribution, EACTAIC included 523 members in good standing, while ARCOTHOVA comprised approximately 1,500 to 2,000 members across specialties, with likely overlap between the two societies. A reminder was posted mid-survey period on both societies' professional websites. Responses were collected online using Google Forms (Google LLC, Mountain View, CA, USA).

Inclusion and Exclusion Criteria

Only responses from board-certified anesthesiologists or intensivists who were actively involved in perioperative cardiac surgical care and who practiced in ICUs with cardiac surgery programs were included in the analysis. Incomplete responses and multiple submissions were excluded. All submitted questionnaires meeting these eligibility criteria were included in the analysis.

Data Analysis

The primary endpoints were: (1) institutional and respondent characteristics; (2) prophylactic respiratory strategies after extubation, including the availability and use of noninvasive respiratory support modalities; and (3) therapeutic approaches for postextubation ARF. All analyses were performed at the clinician level. Secondary endpoints included perceived barriers to implementation and factors influencing clinical decision-making.

All responses were extracted and anonymized by the study coordinator (A.H.) prior to analysis. Descriptive statistics were used, with categorical variables summarized as counts and percentages. Free-text responses were analyzed using a thematic approach and are reported in aggregated form.

Given the exploratory nature of the survey and the absence of prespecified comparative hypotheses, no inferential statistical analyses were performed. The study was intentionally designed as a descriptive analysis. The primary analysis was conducted at the clinician level to reflect individual reported practices. When more than one clinician from the same center completed the survey, all responses were retained for the primary clinician-level analysis. To assess the robustness of the findings, a center-level sensitivity analysis was conducted after deduplication, retaining a single response per center. When multiple responses were received from the same center, a single response was retained using a predefined hierarchy: (1) the most complete questionnaire, (2) the response from the clinician with the longest reported experience in this type of ICU setting, and (3) the earliest submission timestamp.

Ethical Considerations

This study consisted of an anonymized, voluntary survey of healthcare professionals without the collection of patient-level data. In accordance with applicable regulations for such studies, formal ethics committee approval was not required. The study complied with the Declaration of Helsinki. The purpose of the survey was outlined in the introduction, and completion was considered implied consent. No incentives were offered, and no patient-level data were collected.

Results

Among the 92 completed questionnaires, responses originated from 80 distinct cardiac surgical centers across 13 countries. No submitted questionnaires were excluded, as all responses were complete and no multiple submissions were identified. In a center-level sensitivity analysis restricted to one response per center, the distribution of the main practice variables remained similar to that observed in the full clinician-level dataset (Supplementary Table 2).

Respondents were primarily based in Italy and France, though contributions also came from the Middle East, North Africa, and South America. Most were affiliated with tertiary (university) hospitals (79%, n = 73), followed by private hospitals (13%, n = 12), nonuniversity public hospitals (7%, n = 6), and other institutions (1%, n = 1) (Supplementary Table 1). The vast majority of respondents were anesthesiologist-intensivists (90/92, 97.8%).

ICU Setting, Experience, and Activity

Most clinicians (86%, n = 79) worked in cardiac-dedicated ICUs, whereas 14% (n = 13) practiced in general mixed or mixed surgical ICUs. Overall ICU experience was substantial, with 92% (n = 85) reporting at least 2 years in their current setting, including 73% (n = 67) with more than 5 years (Supplementary Table 1).

Nearly half of respondents worked in high-volume cardiac surgery units, with 45% (n = 43) reporting ≥600 cardiac procedures with cardiopulmonary bypass annually, including 24% (n = 22) reporting >1,000 procedures. Likewise, 64% (n = 59) worked in ICUs with ≥600 admissions per year, including 37% (n = 34) reporting >1,000 admissions (Supplementary Table 1).

Prophylactic Noninvasive Respiratory Support After Extubation

The respiratory support modalities that were available are detailed in Table 1. HFNO and NIV were available in almost all participating units (92%, n = 84; Table 1).

Prophylactic postextubation support was used by 78% (n = 72) of respondents, most often selectively in patients considered at high risk. Among clinicians applying prophylaxis, NIV (alone or combined) was reported by 70% (n = 64) of respondents, followed by HFNO (alone or combined) by 51% (n = 47). CPAP was selected less frequently (13%, n = 12), primarily alongside NIV in bilevel PAP mode. The practice dispersion of these modalities across systematic, selective, and absent prophylactic use is shown in Fig 1. In selective prophylactic settings, the combined HFNO-NIV approach was the most frequently used strategy (n = 35, 38%; Fig 1).

The criteria used to identify high-risk patients relied on clinical factors or a risk score in 67% of cases (n = 54), with obesity and chronic obstructive pulmonary disease being the most frequent factors (both 93%; see Table 1).

The duration of prophylactic noninvasive respiratory support also varied across centers. Fifty-five percent (n = 50) used prophylactic noninvasive respiratory support for less than 48 hours, while one-third continued it until clinical stabilization (Fig 2). Decisions regarding initiation and continuation were most influenced by clinician expertise and training (62%), followed by the presence of institutional protocols and the availability of equipment (Supplementary Fig 1). Protocol standardization (60%) and staff training (46%) were identified as the main areas likely to improve implementation (Supplementary Fig 2).

Therapeutic Use for Postextubation ARF

In established postextubation ARF, HFNO was the most frequently used modality (65%, n = 59), most often in

Table 1
Prophylactic Postextubation Respiratory Support Strategies and Risk Assessment Criteria

Items	n (%)
Respiratory support modalities available	n = 92
HFNO alone	0 (0)
NIV alone	5 (5)
CPAP alone	3 (3)
HFNO + NIV	84 (92)
Prophylactic postextubation respiratory support	n = 92
Systematic use	14 (15)
In high-risk patients	58 (63)
No prophylactic use	20 (22)
Criteria used to define high-risk patients	n = 80*
In presence of 2 or more risk factors	51 (64)
With the ARISCAT risk score	2 (2)
With the LAS VEGAS risk score	1 (1)
No definition of high-risk patients	26 (33)
Risk factors considered for postoperative pulmonary complications	n = 91
COPD	85 (93)
Obesity	85 (93)
Obstructive sleep apnea	72 (79)
Cumulative smoking >20 cigarettes/d for at least 20 y	53 (58)
Emergency surgery	36 (40)
Age, y	37 (41)
Cachexia	24 (26)

* High-risk definition items were answered only by respondents reporting selective prophylactic use.
Abbreviations: ARISCAT, Assess Respiratory Risk in Surgical Patients in Catalonia; COPD, chronic obstructive pulmonary disease; CPAP, continuous positive airway pressure; HFNO, high-flow nasal oxygen; LAS VEGAS, local assessment of ventilatory management during general anesthesia for surgery; NIV, noninvasive ventilation.

combination with NIV. NIV alone was used in 16% (n = 14) of patients, while CPAP alone remained marginal (4%, n = 4; Supplementary Fig 3).

NIV settings were adjusted according to clinical response by 63% of clinicians; a quarter reported adherence to predefined protocols, and 11% made adjustments only in case of deterioration (Table 2). Regarding the perceived clinical benefits of NIV, 50% of clinicians reported reduced reintubation rates, and 41% noted shorter hospital or ICU lengths of stay. Only a small minority (2%) associated NIV with a reduced incidence of postoperative pneumonia (Fig 3).

Institutional Protocols

Fewer than half of respondents (40%, n = 37) reported having an institutional postextubation protocol, while 53% (n = 49) reported a written protocol not routinely applied, and 7% (n = 6) reported no protocol. Exploratory descriptive analyses, based on the availability of institutional protocols and clinicians' experience, showed broadly similar patterns of practice, with only minor variations in the distribution of strategies (Supplementary Tables 3 and 4).

Discussion

This international survey provides an overview of current practices for preventing and managing postoperative ARF after cardiac surgery. The current findings reveal that postextubation respiratory support is no longer limited to isolated use of NIV but increasingly incorporates HFNO and combined HFNO-NIV strategies in both prophylactic and curative settings. At the same time, substantial heterogeneity persists across participating units. Less than half of respondents reported having an established institutional protocol; implementation remains inconsistent, and many decisions are still driven by individual experience and local resources rather than by unified, evidence-based pathways.

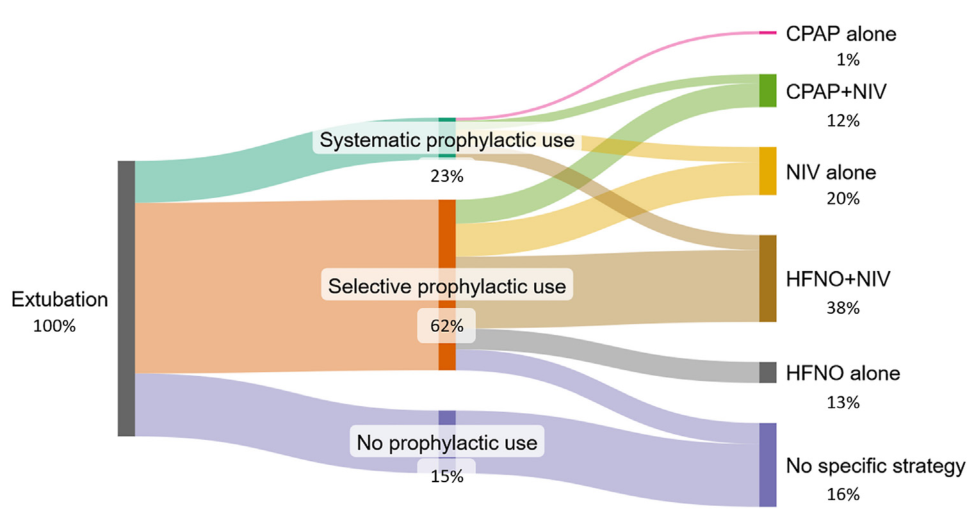

Fig 1. Prophylactic noninvasive respiratory support strategies after extubation in cardiac surgery (n = 92). Sankey diagram illustrating the distribution of clinicians by prophylactic postextubation strategy (systematic, selective, or none) and the corresponding noninvasive respiratory support modalities used. The width of each flow is proportional to the percentage of respondents selecting each option. CPAP, continuous positive airway pressure; HFNO, high-flow nasal oxygen; NIV, noninvasive ventilation.

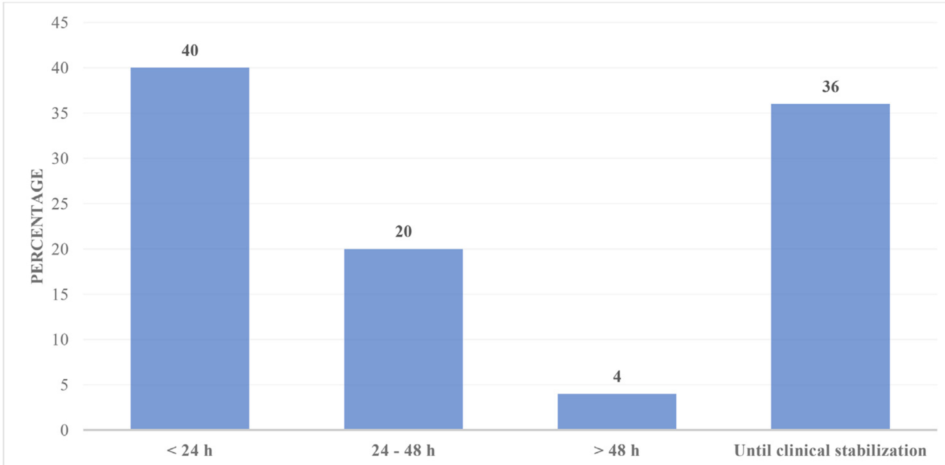

Fig 2. Reported duration of prophylactic noninvasive respiratory support after extubation. Percentages are calculated from respondents who reported using prophylactic noninvasive respiratory support after extubation (n = 83).

Positioning Within Existing Evidence

A previous European survey conducted in 2013 reported that although NIV was widely used after cardiac surgery, 80% of cardiac surgery units lacked formal protocols, and the perceived success rate was below 50% in most patients.[21] A decade later, NIV continues to dominate practice, with 97% of respondents in the current survey reporting its use. This sustained predominance may reflect clinicians' perception of greater efficacy, an assumption supported by mechanistic evidence showing that NIV reduces inspiratory effort more effectively than HFNO in high-risk postextubation patients.[22] Concurrently, the proportion of centers lacking a formal protocol remains substantial, though this represents an improvement from the 80% reported in 2013. As detailed in Supplementary Table 5, the main evolution lies not in NIV use itself, but in its integration into multimodal strategies including HFNO.

Recent comparative studies have shown inconsistent clinical results between HFNO and NIV. While NIV consistently reduces inspiratory effort more effectively than HFNO in high-risk postextubation patients, suggesting a potential physiological advantage in selected populations,[22] clinical trials comparing HFNO and NIV after cardiothoracic surgery have not consistently favored either modality.[18,23-25] HFNO may help prevent escalation of respiratory support and reduce reintubation rates, particularly in obese or high-risk patients,[7,23-25] but results remain heterogeneous across studies. To our knowledge, this is the first international survey to document such widespread adoption of HFNO in the specific context of cardiac surgery, marking a notable evolution compared with earlier literature.

The combined or sequential use of HFNO and NIV is increasingly reported in practice, yet few studies have directly evaluated these approaches, leaving a persistent gap in the literature. Two recent 2025 clinical studies support these patterns: pre- and postoperative NIV reduced pulmonary complications compared with standard oxygen therapy,[16] and CPAP reduced early reintubations in high-risk postoperative patients.[15] However, these and earlier trials are characterized by substantial heterogeneity in prophylactic versus therapeutic intent, timing of initiation, duration and intensity of support, and in the choice and definition of primary endpoints (reintubation, treatment failure composites, postoperative pulmonary complications, or length of stay). This heterogeneity limits comparability across studies and complicates translation into standardized pathways.

Table 2
Postoperative Use of Noninvasive Ventilation After Extubation

	n (%), n = 92
Frequency of use	
Rarely (<10%)	26 (28)
Occasionally (≈10%-40%)	37 (40)
Frequently (>40%)	29 (32)
Adjustment of parameters	
No adjustment	1 (1)
Occasional adjustment in case of clinical deterioration	23 (25)
Regular adjustments according to a predefined protocol	10 (11)
Adjustments frequently based on clinical response	58 (63)

NOTE. Data are expressed as number of respondents (percentage).

Clinical Interpretation of Observed Patterns

HFNO was widely used in this cohort (65%), marking a notable evolution since prior surveys, although it may be the modality with the weakest level of cardiac-surgery-specific evidence compared with NIV and CPAP. As these data are survey-based, the findings reflect reported practices and clinicians' perceptions rather than measured clinical outcomes. Rather than replacing NIV, HFNO appears to be integrated into pragmatic hybrid strategies, consistent with evidence showing reduced treatment failure when HFNO is alternated with scheduled NIV sessions in high-risk extubation trials.[18] These combined strategies may reflect pragmatic attempts to balance physiological efficacy with patient comfort and

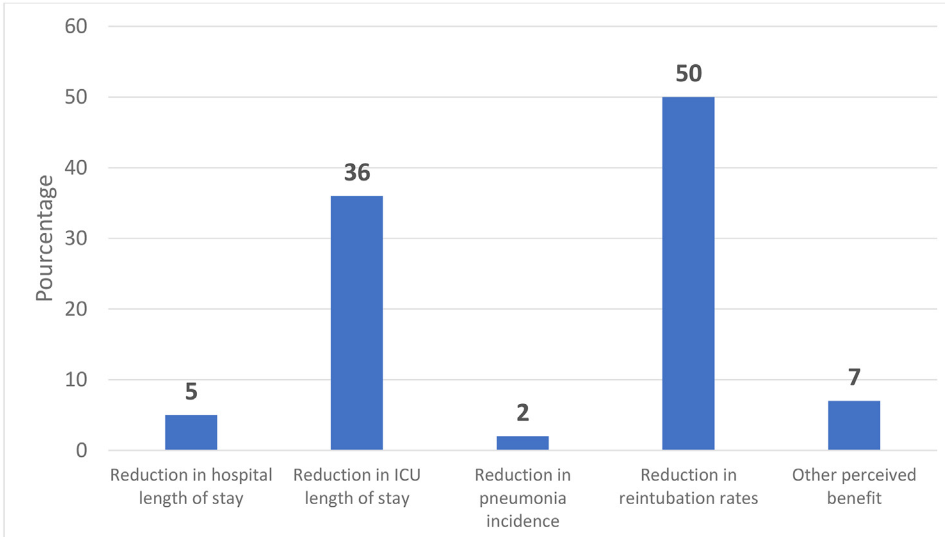

Fig 3. Clinicians' perceived benefits of noninvasive ventilation after extubation. Percentages represent the proportion of respondents reporting each perceived benefit. ICU, intensive care unit.

organizational constraints. The relatively high use of HFNO in this cohort may partly reflect the geographic distribution of respondents, with many originating from France and Italy, where HFNO is widely used. However, this remains speculative as no country-level analysis was performed.

In contrast, CPAP remained the least commonly used modality, reported by fewer than 15% of respondents. This limited diffusion may reflect the relative scarcity of contemporary comparative evidence, patient tolerance issues, and technical constraints in postoperative settings. While CPAP has demonstrated benefits in reducing atelectasis and postoperative pulmonary complications,[14] its role within multimodal postoperative strategies remains ill-defined. Moreover, distinctions between prophylactic and therapeutic applications across postoperative risk strata remain insufficiently explored.

The current survey indicates that decisions are often influenced by clinical factors such as obesity, chronic obstructive pulmonary disease, and sleep apnea. These risk factors are consistent with populations shown to benefit most in subgroup analyses.[7,26]

Implications for Clinical Practice

The marked heterogeneity in modality selection, timing, and monitoring highlights the absence of standardized, evidence-based pathways for postoperative respiratory support.[17,27] The frequent use of combined HFNO-NIV strategies suggests an attempt to balance physiological efficacy with patient tolerance, yet substantial uncertainty persists regarding optimal duration, initial intensity, monitoring, and weaning protocols. Inconsistent outcome definitions across trials (including reintubation, postoperative pulmonary complications, length of stay, and mortality) further complicate guideline development.[17,27,28]

The current findings confirm that, despite consistent evidence favoring positive-pressure modalities over standard oxygen, their use in cardiac surgical ICUs remains highly variable.[14,17,28] The choice of modality often appears driven by local practice patterns or logistical constraints rather than by formalized risk stratification, despite evidence from a recent network meta-analysis identifying NIV as the most effective strategy for reducing postoperative pulmonary complications.[12] However, the certainty of evidence was low, and NIV did not significantly reduce reintubation rates or short-term mortality in this context. In parallel, a large multicenter randomized trial in high-risk cardiac surgical patients is currently evaluating prophylactic HFNO versus standard oxygen with patient-centered outcomes as coprimary endpoints,[29] and its results are expected to further clarify the role of HFNO in this setting.

In clinical practice, these observations argue for:

(1) systematic preoperative identification of high-risk patients (eg, obesity, chronic obstructive pulmonary disease, sleep apnea, reduced ventricular function, prolonged cardiopulmonary bypass);
(2) integration of postextubation noninvasive support within a comprehensive perioperative respiratory bundle, including lung-protective ventilation, early mobilization and chest physiotherapy, structured oral care and secretion management, and multimodal or regional analgesia to minimize opioid-induced hypoventilation; and
(3) development of simple, algorithm-based protocols to guide modality selection (HFNO, NIV, CPAP, or combined strategies) according to dominant postoperative phenotypes (eg, hypoxemic or atelectatic *v* hypercapnic or mixed presentations).

Strengths and Limitations

To our knowledge, this is the most recent international survey dedicated to clinician practices in the prevention and management of ARF after cardiac surgery, and the first to report detailed data on HFNO use. Responses were obtained from 92 clinicians representing 80 cardiac surgery units with heterogeneous surgical activity, spanning low- to high-volume centers. The high level of ICU experience among respondents supports the clinical relevance of the findings. The study design and reporting were aligned, where applicable, with current recommendations for survey-based research and reporting.[30]

Several limitations should be acknowledged. Participation was voluntary, which may have introduced selection bias, as clinicians or units with established protocols or greater research engagement may have been more likely to respond. The geographical distribution reflects the survey dissemination channels, with a predominance of Western European centers. Given the dissemination strategy, a precise response rate could not be determined. The number of potentially reached clinicians is based on the approximate society membership at the time of distribution and may overestimate the number of individuals directly concerned with the survey. In addition, overlap between societies further limits the accuracy of this estimate. This uncertainty introduces a risk of selection bias, with possible overrepresentation of clinicians more engaged in postoperative respiratory management. Data were self-reported and may not fully reflect actual bedside practice; the survey lacked technical granularity on interfaces, ventilatory modes, and specific settings. These results should therefore be interpreted as reflecting how clinicians report organizing respiratory support strategies after extubation, rather than how decisions are made in individual patient situations. Analyses were primarily conducted at the clinician level; although most centers contributed a single response, a minority were represented by more than one respondent, potentially introducing intracenter correlation. Reassuringly, center-level sensitivity analyses yielded similar distributions, supporting the robustness of the findings. Finally, the economic aspects of noninvasive respiratory support strategies, particularly combined or high-intensity approaches, were not assessed, and this may limit generalizability across healthcare systems.

Implications for Future Research

The heterogeneity observed in prophylactic and therapeutic strategies for noninvasive respiratory support underscores the current absence of standardized guidelines. Large, pragmatic, multicenter trials are therefore needed, not to compare devices in isolation, but to define optimal sequences or combinations of modalities according to postoperative phenotypes.

Based on the present survey, a focused and pragmatic research question emerges: Among high-risk cardiac surgical patients, does prophylactic HFNO alone provide protection against postextubation respiratory failure comparable with that of the increasingly adopted combined HFNO-NIV approach? While randomized trials in mixed ICU populations have compared HFNO with NIV or alternating strategies,[18] dedicated randomized trials specifically evaluating combined HFNO-NIV strategies in cardiac surgery remain lacking despite their widespread use in this cohort.

The current authors therefore propose a pragmatic, international randomized controlled trial in adult high-risk cardiac surgical patients to evaluate whether prophylactic HFNO alone provides similar protection against postextubation respiratory failure as combined HFNO-NIV strategies during the early postextubation period, with reintubation as a clinically relevant primary endpoint.

Such a trial would specifically validate—within a cardiac surgery context—the combined HFNO-NIV strategies that are now widely implemented yet weakly supported by direct evidence and directly address the practice variability identified by the BREASE ARC survey.

Conclusion

The international BREASE ARC survey highlights substantial heterogeneity in the prophylactic and therapeutic use of noninvasive respiratory support after cardiac surgery, reflecting the absence of standardized postoperative pathways and a reliance on local practices. Although HFNO, CPAP, and NIV are widely available, the growing use of combined HFNO-NIV strategies contrasts with the limited comparative evidence currently available to guide their implementation. These findings underscore the urgent need for standardized postoperative respiratory support pathways and pragmatic multicenter trials designed to define evidence-based, phenotype-adapted strategies. In particular, the widespread implementation of combined HFNO-NIV strategies in cardiac surgery in the absence of dedicated randomized data represents a key, actionable evidence gap.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Availability of Data and Materials

The datasets supporting the conclusions in this article are available from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate

According to French regulatory guidelines for anonymized professional surveys, formal ethical approval was waived. Participation was voluntary and anonymous, and the study was conducted in accordance with the ethical standards of the Declaration of Helsinki.

Declaration of competing interest

The authors declare the following financial interests and/or personal relationships that may be considered potential competing interests: Gudrun Kunst reports a relationship with the National Institute for Health and Care Research, Senior Clinical Practitioner and Research Award, which includes funding grants (Grant No. NIHR306274). The other authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Axel Hirwe: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Nicolas Nesseler:** Writing – review & editing, Writing – original draft, Validation, Methodology, Conceptualization. **Gudrun Kunst:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Fabio Sangalli:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Conceptualization. **Adrien Bouglé:** Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Pauline Dureau:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Conceptualization.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1053/j.jvca.2026.04.023.

References

1 Beverly A, Brovman EY, Malapero RJ, et al. Unplanned reintubation following cardiac surgery: Incidence, timing, risk factors, and outcomes. J Cardiothorac Vasc Anesth 2016;30:1523–9. https://doi.org/10.1053/j.jvca.2016.05.033.

2 Groeneveld AJ, Jansen EK, Verheij J. Mechanisms of pulmonary dysfunction after on-pump and off-pump cardiac surgery: A prospective cohort study. J Cardiothorac Surg 2007;2:11. https://doi.org/10.1186/1749-8090-2-11.

3 Laghlam D, Lê MP, Srour A, et al. Diaphragm dysfunction after cardiac surgery: Reappraisal. J Cardiothorac Vasc Anesth 2021;35:3241–7. https://doi.org/10.1053/j.jvca.2021.02.023.

4 Mohamed MA, Cheng C, Wei X. Incidence of postoperative pulmonary complications in patients undergoing minimally invasive versus median sternotomy valve surgery: Propensity score matching. J Cardiothorac Surg 2021;16:287. https://doi.org/10.1186/s13019-021-01669-7.

5 Weissman C. Pulmonary complications after cardiac surgery. Semin Cardiothorac Vasc Anesth 2004;8:185–211. https://doi.org/10.1177/108925320400800303.

6 Wong WT, Lai VK, Chee YE, Lee A. Fast-track cardiac care for adult cardiac surgical patients. Cochrane Anaesthesia Group, editor, Cochrane Database Syst Rev 2016;9(9):CD003587. https://doi.org/10.1002/14651858.CD003587.pub3.

7 Zochios V, Collier T, Blaudszun G, et al. The effect of high-flow nasal oxygen on hospital length of stay in cardiac surgical patients at high risk for respiratory complications: A randomised controlled trial. Anaesthesia 2018;73:1478–88. https://doi.org/10.1111/anae.14345.

8 Fischer MO, Brotons F, Briant AR, et al. Postoperative pulmonary complications after cardiac surgery: The VENICE international cohort study. J Cardiothorac Vasc Anesth 2022;36:2344–51. https://doi.org/10.1053/j.jvca.2021.12.024.

9 Zhang Y, Chong JH, Harky A. Enhanced recovery after cardiac surgery and its impact on outcomes: A systematic review. Perfusion 2022;37:162–74. https://doi.org/10.1177/0267659121988957.

10 Rajaei S, Dabbagh A. Risk factors for postoperative respiratory mortality and morbidity in patients undergoing coronary artery bypass grafting. Anesth Pain Med 2012;2. https://doi.org/10.5812/aapm.5228;6-5.

11 Setlers K, Jurcenko A, Arklina B, et al. Identifying early risk factors for postoperative pulmonary complications in cardiac surgery patients. Medicina 2024;60:1398. https://doi.org/10.3390/medicina60091398.

12 Zhou X, Pan J, Wang H, et al. Prophylactic noninvasive respiratory support in the immediate postoperative period after cardiac surgery - A systematic review and network meta-analysis. BMC Pulm Med 2023;23:233. https://doi.org/10.1186/s12890-023-02525-1.

13 Al Jaaly E, Fiorentino F, Reeves BC, et al. Effect of adding postoperative noninvasive ventilation to usual care to prevent pulmonary complications in patients undergoing coronary artery bypass grafting: A randomized controlled trial. J Thorac Cardiovasc Surg 2013;146:912–8. https://doi.org/10.1016/j.jtcvs.2013.03.014.

14 Zarbock A, Mueller E, Netzer S, et al. Prophylactic nasal continuous positive airway pressure following cardiac surgery protects from postoperative pulmonary complications. Chest 2009;135:1252–9. https://doi.org/10.1378/chest.08-1602.

15 Pasero D, Costamagna A, Filippini C, et al. Continuous positive airway pressure to prevent reintubation in patients recovering from cardiac surgery: A multicentre randomised clinical trial. Eur J Anaesthesiol 2025;42:958–65. https://doi.org/10.1097/EJA.0000000000002229.

16 Goret M, Pluchon K, Le Mao R, et al. Impact of noninvasive ventilation before and after cardiac surgery for preventing cardiac and pulmonary complications. CHEST 2025;167:1727–36. https://doi.org/10.1016/j.chest.2025.02.010.

17 Wu Q, Xiang G, Song J, et al. Effects of non-invasive ventilation in subjects undergoing cardiac surgery on length of hospital stay and cardiac-pulmonary complications: A systematic review and meta-analysis. J Thorac Dis 2020;12:1507–19. https://doi.org/10.21037/jtd.2020.02.30.

18 Thille AW, Muller G, Gacouin A, et al. Effect of postextubation high-flow nasal oxygen with noninvasive ventilation vs high-flow nasal oxygen alone on reintubation among patients at high risk of extubation failure: A randomized clinical trial. JAMA 2019;322:1465. https://doi.org/10.1001/jama.2019.14901.

19 Boscolo A, Pettenuzzo T, Sella N, et al. Noninvasive respiratory support after extubation: A systematic review and network meta-analysis. Eur Respir Rev 2023;32:220196. https://doi.org/10.1183/16000617.0196-2022.

20 Hernández G, Vaquero C, Colinas L, et al. Effect of postextubation high-flow nasal cannula vs noninvasive ventilation on reintubation and postextubation respiratory failure in high-risk patients: A randomized clinical trial. JAMA 2016;316:1565. https://doi.org/10.1001/jama.2016.14194.

21 Guarracino F, Cabrini L, Ferro B, et al. Noninvasive ventilation practice in cardiac surgery patients: Insights from a European survey. J Cardiothorac Vasc Anesth 2013;27:e63–5. https://doi.org/10.1053/j.jvca.2013.04.005.

22 Arrive F, Le Pape S, Bruhn A, et al. Physiological comparison of noninvasive ventilation and high-flow nasal oxygen on inspiratory efforts and tidal volumes after extubation: A randomized crossover trial. Crit Care 2025;29:185. https://doi.org/10.1186/s13054-025-05366-y.

23 Stéphan F, Barrucand B, Petit P, et al. High-flow nasal oxygen vs noninvasive positive airway pressure in hypoxemic patients after cardiothoracic surgery: A randomized clinical trial. JAMA 2015;313:2331. https://doi.org/10.1001/jama.2015.5213.

24 Wu X, Cao W, Zhang B, et al. Effect of high-flow nasal cannula oxygen therapy vs conventional oxygen therapy on adult postcardiothoracic operation: A meta-analysis. Medicine 2018;97:e12783. https://doi.org/10.1097/MD.0000000000012783.

25 Theologou S, Ischaki E, Zakynthinos SG, et al. High flow oxygen therapy at two initial flow settings versus conventional oxygen therapy in cardiac surgery patients with postextubation hypoxemia: A single-center, unblinded, randomized, controlled trial. JCM 2021;10:2079. https://doi.org/10.3390/jcm10102079.

26 Corley A, Bull T, Spooner AJ, et al. Direct extubation onto high-flow nasal cannulae post-cardiac surgery versus standard treatment in patients with a BMI ≥30: A randomised controlled trial. Intensive Care Med 2015;41:887–94. https://doi.org/10.1007/s00134-015-3765-6.

27 Zhou X, Pan J, Wang H, et al. Prophylactic noninvasive respiratory support in the immediate postoperative period after cardiac surgery - A systematic review and network meta-analysis. BMC Pulm Med 2023;23:233. https://doi.org/10.1186/s12890-023-02525-1.

28 Pieczkoski SM, Margarites AGF, Sbruzzi G. Noninvasive ventilation during immediate postoperative period in cardiac surgery patients: Systematic review and meta-analysis. Braz J Cardiovasc Surg 2017;32(4):301–11. https://doi.org/10.21470/1678-9741-2017-0032.

29 Earwaker M, Villar S, Fox-Rushby J, et al. Effect of high-flow nasal therapy on patient-centred outcomes in patients at high risk of postoperative pulmonary complications after cardiac surgery: A study protocol for a multicentre adaptive randomised controlled trial. Trials 2022;23:232. https://doi.org/10.1186/s13063-022-06180-5.

30 Augoustides JG. Survey studies: Optimizing this type of cross-sectional observational trial with respect to design, conduct, and reporting. J Cardiothorac Vasc Anesth 2026;40:782–4. https://doi.org/10.1053/j.jvca.2025.11.006.