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REVIEW

Best Evidence Summary of Nursing Management for Perioperative Patients with Hypoxemia

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Objective: To identify, evaluate, and synthesize the best available evidence regarding the perioperative management of hypoxemia, providing a comprehensive clinical reference for healthcare professionals.

Methods: Following the "6S" evidence-based resource pyramid model, a systematic search was performed across international and domestic databases and professional society websites. The search encompassed clinical decision support tools, guidelines, evidence summaries, systematic reviews, expert consensuses, and randomized controlled trials (RCTs) published from database inception through November 2025. Two researchers independently performed quality assessment and evidence extraction for the included literature.

Results: Twenty articles were included, comprising 2 clinical decisions, 1 guideline, 1 expert consensus, 10 systematic reviews, and 6 RCTs. A total of 38 pieces of evidence were synthesized across eight key dimensions: initial assessment and management, oxygenation monitoring and target-directed management, risk assessment for high-risk populations, intraoperative etiology and ventilation management, selection of non-invasive respiratory support, perioperative high-flow nasal cannula (HFNC) therapy, nursing management in the PACU, and comprehensive interventions (including positioning and pharmacotherapy).

Conclusion: This study summarizes the best evidence for the nursing management of perioperative hypoxemia, covering the entire process from risk assessment and intraoperative intervention to PACU care. These findings provide a standardized, evidence-based framework for healthcare professionals. When implementing these strategies, clinical context and individual patient characteristics should be considered to standardize hypoxemia management, reduce the risk of perioperative complications, and optimize patient outcomes.

Keywords: perioperative period, hypoxemia, evidence summary, evidence-based nursing

Hypoxemia is one of the most prevalent and severe perioperative complications, directly correlating with increased morbidity, mortality, and poor clinical outcomes.[1] Under the influence of anesthetic agents, surgical trauma, and positional changes, patients are susceptible to ventilation/perfusion mismatch, atelectasis, and hypoventilation, leading to the onset of hypoxemia.[2] Literature indicates[3] that perioperative hypoxemia significantly increases postoperative respiratory complications, prolongs the duration of mechanical ventilation and hospital stays, and in severe cases, progresses to acute respiratory failure, adversely affecting recovery and long-term prognosis.

Perioperative hypoxemia is characterized by its stage-specific and multifactorial nature, occurring across induction, intraoperative maintenance, and the early recovery phase in the PACU.[4] Advanced age, obesity, and pre-existing cardiopulmonary diseases identify patients at high risk.[5] Within this continuum, nursing staff play a pivotal role as key implementers of continuous care. Their responsibilities—including perioperative risk assessment, high-fidelity oxygenation monitoring, early detection of hypoxic events, and the implementation of respiratory support interventions—are essential for mitigating risks and ensuring surgical safety.[6]

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Currently, several international guidelines and expert consensuses provide recommendations on oxygenation monitoring and respiratory support.[7,8] However, significant limitations remain within the existing evidence framework. First, current guidelines are predominantly led by anesthesiology or critical care medicine, with recommendations often emphasizing pharmacological interventions or advanced ventilatory support; they lack a systematic synthesis of nurse-led "soft interventions", such as positioning management, early airway maintenance, and dynamic risk assessment. Second, clinical consensuses across different disciplines exhibit discrepancies regarding the application timing of specific interventions (e.g., High-Flow Nasal Oxygen) during various perioperative stages. Such "disciplinary silos" and "evidence fragmentation" make it challenging for nursing staff to access standardized, full-process care pathways when navigating complex, cross-departmental clinical scenarios. Consequently, this study employs an evidence-based approach to systematically integrate the best available evidence for perioperative hypoxemia management. By summarizing assessment, monitoring, and interventional strategies, we aim to provide an evidence-based foundation for standardized nursing protocols, ultimately enhancing patient safety and postoperative recovery.

Materials and Methods

Identification of the Clinical Question

The evidence-based questions were structured using the PIPOST[9] model as follows: Population (P): Patients in the perioperative period; Intervention (I): Comprehensive management strategies for perioperative hypoxemia, including risk assessment, early identification, oxygenation monitoring, oxygen therapy, respiratory support, and associated nursing interventions; Professionals (P): Clinical healthcare providers, specifically anesthesiologists and perioperative nurses; Outcomes (O): Incidence of hypoxemia, oxygenation parameters (eg, SpO_2, PaO_2), incidence of respiratory complications, rate of unplanned airway interventions, patient safety, and clinical prognosis; Setting (S): Perioperative clinical environments, including operating rooms, post-anesthesia care units (PACU), intensive care units (ICU), and surgical wards; Type of Evidence (T): Clinical practice guidelines, evidence summaries, systematic reviews, expert consensuses, and randomized controlled trials (RCTs).

Search Strategy

A systematic literature search was conducted following the "6S" hierarchy of evidence-based resources.[10] Evidence-based clinical decision support tools included UpToDate and BMJ Best Practice. Guidelines and evidence summaries were retrieved from the Joanna Briggs Institute (JBI) Evidence-Based Practice Database, the Guidelines International Network (GIN), the National Institute for Health and Care Excellence (NICE), the Scottish Intercollegiate Guidelines Network (SIGN), the Registered Nurses' Association of Ontario (RNAO), and the Chinese Society of Anesthesiology (CSA). Electronic databases searched included PubMed, Embase, the Cochrane Library, CINAHL, SpringerLink, ScienceDirect, the Chinese Biomedical Literature Database (CBM), CNKI, Wanfang Data, and Medlive. Additionally, a manual search of references from relevant studies was performed using the "snowballing" method. The search encompassed clinical decisions, guidelines, evidence summaries, systematic reviews, expert consensuses, and randomized controlled trials (RCTs) published from database inception through November 2025. The search utilized a combination of Medical Subject Headings (MeSH) and free-text terms. English keywords included: "perioperative period", "anesthesia period", "intraoperative", "postoperative", "post-anesthesia care unit/PACU", "hypoxemia", "hypoxia", "low oxygen saturation", "nursing management", "oxygen therapy", "respiratory support", and "monitoring". Equivalent Chinese search terms were applied in domestic databases.

Inclusion and Exclusion Criteria

The inclusion criteria were defined as follows: Population: Adult patients (18≥years old) in the perioperative period; Content: Studies focusing on risk assessment, early identification, oxygenation monitoring, oxygen therapy, respiratory support management, or targeted nursing interventions for perioperative hypoxemia; Study Type: Clinical practice guidelines, evidence summaries, systematic reviews, meta-analyses, expert consensuses, and randomized controlled trials (RCTs); Language: Literature published in either English or Chinese. The exclusion criteria were: Data Quality:

Studies with incomplete information or inaccessible full texts; Redundancy/Type: Duplicate publications, simplified interpretations of existing guidelines/consensuses, or direct translations of previously published evidence.

Literature Quality Evaluation

The quality of the included guidelines was appraised using the Appraisal of Guidelines for Research and Evaluation II (AGREE II) instrument.[11] Expert consensuses, systematic reviews, and randomized controlled trials (RCTs) were evaluated using the Joanna Briggs Institute (JBI) Critical Appraisal Tools (2016).[12–14] For evidence summaries, quality was assessed by tracing the original source literature and applying the corresponding JBI appraisal criteria based on the specific study design. Clinical decision-making tools were considered high-quality evidence and were included in their entirety.

Evidence Extraction and Integration

Two researchers trained in evidence-based nursing independently extracted data from the included literature, including the study type, title, source, original evidence statements, and recommendation grades. Any discrepancies during the extraction process were resolved through discussion or consultation with a third researcher specialized in anesthesia or perioperative nursing to reach a consensus. An expert panel—comprising anesthesiologists, perioperative nurses, and evidence-based nursing specialists—was convened to review and synthesize the extracted evidence. The synthesis followed these methodological principles: (1) Complementarity: Evidence with complementary findings was comprehensively integrated. (2) Consistency: Where conclusions were consistent or similar, evidence characterized by clearer expression, logical rigor, and superior clinical feasibility was prioritized. (3) Conflict Resolution: In cases of conflicting results, the original studies were traced and analyzed to identify potential reasons for discrepancies before a final judgment was made. Priority was given to evidence with higher methodological quality and more recent publication dates, ultimately culminating in the best evidence summary for the management of perioperative hypoxemia.

Evidence Grading System

Evidence levels were assigned according to the Joanna Briggs Institute (JBI) Levels of Evidence (2014 edition).[15] The grading hierarchy is defined as follows: Level 1: Randomized controlled trials or experimental studies; Level 2: Quasi-experimental studies; Level 3: Observational-analytical studies; Level 4: Observational-descriptive studies; Level 5: Expert opinion and bench research/basic science.

Results

Study Selection and Basic Characteristics

A total of 2165 articles were initially identified, with 1542 remaining after the removal of duplicates. Following a preliminary screening of titles and abstracts, 1399 articles were excluded. The remaining 143 articles underwent full-text review. During this stage, we excluded 45 articles for irrelevant content, 68 for ineligible study designs, 4 for inaccessible full texts, and 6 for being published in languages other than Chinese or English. Ultimately, 20 articles were included in the final analysis, comprising 2 clinical decision support tools, 1 guideline, 1 expert consensus, 10 systematic reviews, and 6 randomized controlled trials (RCTs). The characteristics of these studies are summarized in Table 1.

Quality Appraisal of Included Literature

Guidelines and Expert Consensus

The included guideline[7] was categorized as Grade A, with standardized percentage scores across all domains exceeding 60.00%. For the expert consensus,[8] item 3 (“Is there an explicit statement of the point of view?”) was assessed as “No”, and item 4 (“Is the method used to reach the consensus clearly stated?”) was “Unclear”; all other items were appraised as “Yes”.

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Table 1 Basic Characteristics of Included Literature (n=20)

Included Literature	Publication Date (Year)	Source	Type	Topic
Shweta et al[16]	2025	Up To Date	Clinical Decision	Making Assessment and Stability Management of Hypoxemia
Shaun et al[17]	2024	Up To Date	Clinical Decision	Making Assessment of Hypoxemia and High-Risk Factors
Leone et al[7]	2020	PubMed	Guidelines	Oxygenation monitoring, non-invasive ventilation
Chinese Society of Anesthesiology, Chinese Medical Association[8]	2020	Wanfang Medical	Expert Consensus	Oxygenation Monitoring
Spence et al[18]	2020	PubMed	Systematic review	Perioperative application of high-flow nasal oxygen
Tan et al[19]	2025	PubMed	Systematic review	Effect of nasal high flow oxygen therapy
Zhou et al[20]	2022	PubMed	Systematic review	Application of nasal high flow oxygen therapy
Zhao et al[21]	2025	PubMed	Systematic review	Effect of nasal high flow oxygen therapy
Hung et al[22]	2022	PubMed	Systematic review	Effectiveness of Nasal High Flow Oxygen Therapy
Bizuneh et al[5]	2025	PubMed	Systematic review	Risk assessment in high-risk populations
Xiang Yuping et al[23]	2023	CNKI	Systematic review	Risk Factors of Hypoxemia
Jiang Hui et al[24]	2022	CNKI	Systematic review	Prone Position Ventilation Management
Yu Jintian et al[25]	2019	CNKI	Systematic review	High-risk Population of Hypoxemia
Zeng Ling et al[26]	2020	CNKI	Systematic review	Risk Factors of Hypoxemia
Bao Chunrong et al[27]	2021	CNKI	RCT	Intervention for severe hypoxemia
Yang Pan et al[28]	2019	CNKI	RCT	Hypoxemia Interventions
Dong Chenyang et al[29]	2016	CNKI	RCT	Prone position ventilation
Zheng et al[30]	2022	PubMed	RCT	Use of nitric oxide expanders
Liao et al[31]	2021	PubMed	RCT	Hypoxemia medication
Sun Fang et al[32]	2018	CNKI	RCT	Adjustment of mechanical ventilation parameters

Systematic Reviews

Of the 10 systematic reviews included, five[18–20,24,25] met all quality criteria ("Yes"). Among the others, two[21,26] were rated "No" for item 10 ("Are the recommendations for policy and/or practice supported by the reported data?"); one[22] was rated "Unclear" for item 8 ("Was the method of data synthesis appropriate?"); one[5] was rated "Unclear" for item 7

("Were appropriate measures taken to minimize error during data extraction?"); and one[23] was rated "No" for item 4 ("Were the search strategy and databases used appropriate?"). All remaining items for these reviews were rated "Yes".

Randomized Controlled Trials

Six RCTs were evaluated. Three[27,28,30] were rated "Unclear" for item 8 ("Was follow-up complete, and if not, were strategies used to address incomplete follow-up?"); two[29,32] were rated "Unclear" for item 6 ("Were outcomes assessors blind to treatment assignment?"); and one[31] satisfied all quality appraisal items ("Yes").

Summary of Evidence

The best evidence for perioperative patient hypoxemia management identified from the included studies is summarized in Table 2. The evidence covers key aspects including risk assessment, early identification, intraoperative monitoring, airway management, oxygen therapy, postoperative observation, and multidisciplinary interventions.

Discussion

Early Identification, Continuous Assessment, and Stratified Intervention in Perioperative Hypoxemia Management

The findings of this study underscore that the effective management of perioperative hypoxemia hinges on early recognition and prompt intervention. This process necessitates continuous assessment and dynamic management across the preoperative, intraoperative, and postoperative phases. Although the evidence synthesized here originates from diverse sources—including clinical decision tools,[16,17] a guideline,[7] an expert consensus,[8] and systematic reviews[5,23,25,26] with varying levels of certainty—there is a clear consensus: timely assessment and early intervention are paramount in mitigating adverse outcomes associated with hypoxemia. Evidence items 1–3 suggest that for patients with suspected or confirmed perioperative hypoxemia, a systematic assessment should be initiated immediately, prioritizing the stabilization of vital signs and tailored treatments based on clinical manifestations and underlying etiologies.[16,17] This highlights that nursing staff are not merely responsible for routine monitoring; they play a critical role in risk identification and the clinical judgment of physiological shifts. Consistent with prior research, proactive intervention effectively reduces the duration of hypoxemic episodes and lowers the risk of associated complications.[33,34] Regarding monitoring, evidence items 4–8 emphasize pulse oximetry (SpO_2) as the primary indicator for perioperative oxygenation. When necessary, this should be supplemented by arterial blood gas analysis and the PaO_2/FiO_2 ratio for a more comprehensive evaluation. Furthermore, clinicians must account for the potential impact of body temperature, anemia, and metabolic status on oxygenation readings.[7,8,16] For patients receiving non-invasive respiratory support, continuous multi-parameter monitoring and regular blood gas assessments are particularly vital.[7] This suggests that perioperative hypoxemia management requires a goal-directed strategy combined with dynamic adjustments. Consequently, in clinical practice, nursing protocols should transition toward a model of continuous assessment and stratified management. By dynamically adjusting monitoring frequency and intervention intensity based on the patient's perioperative stage and risk profile, nursing staff can significantly enhance the safety and efficacy of hypoxemia management.

Identification of High-Risk Populations and Etiology-Oriented Perioperative Ventilation Management

Beyond continuous monitoring, clarifying the clinical characteristics of high-risk populations and the underlying causes of hypoxemia is a prerequisite for implementing precision ventilation management. Perioperative hypoxemia is closely linked to pre-existing comorbidities, surgical characteristics, and intraoperative pathophysiological shifts.[35] High-risk patients typically exhibit diminished ventilatory reserve or impaired gas exchange efficiency. For instance, those with chronic respiratory diseases often present with carbon dioxide retention, impaired secretion clearance, and altered thoracic compliance. Similarly, obese patients are highly susceptible to oxygenation failure due to decreased chest and abdominal wall compliance, alongside a significant reduction in functional residual capacity (FRC).[36] Furthermore, patients undergoing emergency or cardiac surgeries face heightened risks due to the severity of illness, surgical trauma, the effects of cardiopulmonary bypass, and

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Table 2 Summary of the Best Evidence for Perioperative Patient Hypoxemia Management

Evidence Theme	Evidence Description	Evidence Level (Grade)
Initial assessment and handling	1. For patients suspected of or already experiencing hypoxemia, immediate assessment of airway patency, breathing pattern, pulse rate, blood pressure, and body temperature should be conducted. In case of any abnormal indicator, priority should be given to stabilizing vital signs[16]	5A
	2. For all patients with hypoxemia, initiate empirical treatment targeting suspected underlying causes[16]	5A
	3. It is necessary to promptly identify and treat the underlying causes of hypoxemia to maintain adequate tissue oxygenation and minimize perioperative complications[17]	5A
Oxygenation monitoring and target management	4. Use SpO_2 as the primary oxygenation monitoring indicator, and when necessary, combine it with blood gas analysis and PaO_2/FiO_2 assessment. At the same time, pay attention to the impact of factors such as patient's body temperature, anemia, metabolic diseases, and internal acid-base balance on oxygenation[8]	5B
	5. Peripheral oxygen saturation (SpO2) is commonly used to monitor oxygenation status. We typically set the SpO2 target within the range of 90%-96%, with individualized targets set for specific populations[16]	5A
	6. During non-invasive positive pressure ventilation for patients with perioperative hypoxemia, continuous physiological monitoring should be performed, including pulse oximetry, non-invasive or invasive blood pressure measurement, respiratory rate, and electrocardiogram. Arterial blood gas analysis should be assessed one hour after the start of treatment, and rechecked at least every six hours for the first 24 hours. Once the patient's respiratory and oxygenation status stabilize, the frequency can be adjusted to once daily until the end of treatment[7]	1A
	7. During non-invasive positive pressure ventilation treatment for patients with hypoxemia in the perioperative period, pulmonary imaging examination should be considered[7]	1A
	8. When using closed non-invasive positive pressure ventilation technology, monitoring of flow and pressure ventilation waveforms should be increased[7]	1A
Risk assessment for high-risk groups	9. Patients with chronic restrictive respiratory diseases need to be evaluated for manifestations such as hypercapnia, increased respiratory work, or difficulty in clearing pulmonary secretions. Additionally, attention should be paid to BMI, presence of external chest wall deformities, pulmonary auscultation findings (such as the presence of moist rales), and pulse oximetry values during rest and exercise[17]	5B
	10. When assessing high-risk groups, it is advisable to use the intended surgical position[17]	5B
	11. Emergency surgery patients are a high-risk group[5]	3A
	12. Age, body mass index, preoperative oxygenation index ≤300 mm Hg, preoperative white blood cell count, perioperative blood transfusion, and cardiopulmonary bypass time are high-risk factors for postoperative hypoxemia after TAAD surgery[23]	4A
	13. Risk factors for hypoxemia can be used to identify patients at high risk of postoperative hypoxemia[23,25,26]	4A
Intraoperative etiology management and ventilation management	14. Hypoxemia during general anesthesia is often caused by V/Q mismatch. The sudden hypoxemia resulting from V/Q mismatch is mostly due to atelectasis, which can lead to intrapulmonary shunt, making increasing FiO2 ineffective. At this time, it is usually recommended to increase PEEP up to 10–12 cmH2O to improve oxygenation[17]	5B
	15. During general anesthesia and mechanical ventilation, surgical positioning has significant physiological effects on ventilation, pulmonary perfusion, and intrathoracic pressure. These physiological effects are usually more pronounced in patients with restrictive lung diseases, leading to insufficient tissue perfusion. Changing the position during surgery or alerting the surgical team to the possibility of direct or indirect compression of the lungs can help improve oxygenation[17]	5B
	16. Investigate and address causes of ventilation insufficiency such as mucus embolism and tracheal tube displacement[17]	5B
	17. For severe cases, inhaled pulmonary vasodilators (such as nitric oxide or epoprostenol) may be considered to improve V/Q mismatch[17]	5B

	18. For patients with acute hypoxic respiratory failure who have a low demand for oxygen supplementation, nasal catheter low-flow oxygen therapy can be the first choice[16]	5A
	19. Obese patients are prone to develop hypoxemia during the perioperative period, and it is recommended that the FiO2 during general anesthesia surgery for obese patients should not exceed 80%[8]	5B
Selection of non-invasive respiratory support technology	20. In patients with perioperative hypoxemia, non-invasive positive pressure ventilation or continuous positive airway pressure ventilation is superior to conventional oxygen therapy[7]	1A
	21. After cardiac surgery, patients should prioritize non-invasive positive pressure ventilation to reduce the risk of atelectasis[7]	1A
	22. Non-invasive positive pressure ventilation or continuous positive airway pressure is recommended for patients after upper abdominal surgery[7]	1A
	23. For patients at risk of acute respiratory failure after extubation, non-invasive respiratory support should be initiated immediately[7]	1A
	24. Patients requiring advanced respiratory support may opt for humidified high flow nasal cannula (HFNC) and noninvasive ventilation (NIV)[16]	5A
Perioperative application of high-flow nasal oxygen	25. It is recommended that patients with hypoxemia after cardiac surgery and those with perioperative hypoxemia who have low tolerance to non-invasive respiratory support techniques may consider using high-flow nasal cannula[7]	1A
	26. High-flow nasal oxygen therapy can reduce the risk of perioperative desaturation, increase the lowest SpO, and prolong the safe apnea time[17,18,21]	1A
	27. High-flow nasal oxygen therapy can be applied to patients who are at risk of hypoxemia, are expected to have difficulty with intubation, experience apnea during airway surgery, and have difficulty with extubation after surgery[21,22]	1B
	28. For patients at risk of hypoxemia or with difficult airways, high-flow nasal oxygen can be used during anesthesia induction[18]	1A
	29. High-flow nasal oxygen therapy can reduce the incidence of perioperative hypoxemia in obese patients and increase the lowest SpO_2[18,20]	2A
Nursing management of hypoxemia in PACU	30. Adequate analgesia should be ensured during the PACU stage, and atelectasis should be prevented[17]	5B
	31. Use high-flow nasal oxygen or non-invasive ventilation as needed based on oxygenation status[17]	5B
	32. During the use of non-invasive positive pressure ventilation, continuous monitoring of SpO_2, blood pressure, respiratory rate, and electrocardiogram should be performed[7]	1A
	33. In the early stages of treatment, regular arterial blood gas analysis should be performed, and the treatment plan should be dynamically adjusted accordingly[8]	5B
Body position, medication, and comprehensive nursing intervention	34. Prone positioning ventilation can improve oxygenation in patients with hypoxemia after cardiac surgery and shorten the duration of mechanical ventilation[24,29]	2A
	35. Inhaling vasodilators such as nitric oxide can improve severe hypoxemia[27,30]	2C
	36. The use of etoricoxib can reduce inflammation and lower the incidence of hypoxia[31]	1C
	37. Adjusting PEEP based on esophageal pressure monitoring can help improve oxygenation and reduce lung driving pressure[32]	2C
	38. Implementing integrated medical and nursing care and targeted nursing interventions can promote patient recovery[28]	1C

Abbreviations: FiO_2, Fractional Inspired Oxygen Concentration; TAAD, Type A Aortic Dissection; V/Q, Ventilation/Perfusion Ratio; PEEP, Positive End-Expiratory Pressure; HFNC, High Flow Nasal Cannula; NIV, Non-Invasive Ventilation; PACU, Post-Anesthesia Care Unit.

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systemic inflammatory responses.[37] Research[38] confirms that the onset of hypoxemia is a multifactorial process involving patient-specific, anesthetic, and surgical variables. Evidence items 9–13 suggest that pre-anesthetic assessment should not only focus on medical history, body mass index (BMI), and pulmonary physical signs, but also place particular emphasis on measuring baseline oxygenation levels in a resting state on room air.[5,17,23] Baseline SpO_2 reflects the patient's underlying pulmonary gas exchange function and, more importantly, serves as a comparative reference for interpreting postoperative changes in oxygenation. For patients with a low baseline, even a slight decline in postoperative values may indicate a severe pathological evolution. Consequently, incorporating preoperative baseline values into risk stratification models enables nursing staff to identify early signs of hypoxemia dynamically and objectively. Regarding etiological treatment and ventilation, evidence items 14–19 emphasize that hypoxemia is frequently driven by ventilation-perfusion (V/Q) mismatch, alveolar collapse (atelectasis), and suboptimal airway management. Under general anesthesia, oxygenation can be optimized by judiciously adjusting positive end-expiratory pressure (PEEP), avoiding chest/abdominal compression, and promptly troubleshooting airway obstruction or tube displacement.[16,17] For patients refractory to conventional strategies, this evidence supports the consideration of inhaled bronchodilators or high-flow nasal cannula (HFNC) therapy under close surveillance. These findings indicate that perioperative hypoxemia is rarely the result of a single factor. Its prevention and control must rely on early risk identification, etiology-driven analysis, and individualized ventilation adjustments. Nursing staff play a pivotal role in managing high-risk cohorts through position optimization and the early detection of ventilatory abnormalities. Their systematic, proactive interventions are instrumental in reducing the incidence and severity of perioperative hypoxemia.

Risk-Stratified Selection of Oxygen Therapy and Non-Invasive Respiratory Support

Evidence from items 20–29 elucidates the rational application of high-flow nasal cannula (HFNC) and non-invasive ventilation (NIV) as escalations from conventional oxygen therapy, aimed at optimizing oxygenation and mitigating respiratory complications. In patients at risk of respiratory insufficiency or those experiencing hypoxemia post-extubation, the timely initiation of non-invasive support can significantly improve oxygenation parameters and reduce the rate of reintubation.[7,16] Studies[39] demonstrate that NIV can rapidly increase alveolar ventilation and gas exchange efficiency, thereby correcting hypoxemia. HFNC provides stable, high-concentration oxygen while reducing inspiratory resistance and enhancing patient comfort, which helps prevent perioperative desaturation events.[18–22] Research by Li et al[40] indicates that HFNC generates a gas oscillation effect through high-flow rates, creating a modest positive end-expiratory pressure (PEEP) effect within the airway. This mechanism facilitates the flushing of physiological dead space, thereby accelerating CO_2 clearance. Furthermore, while delivering precise FiO_2, this technique preserves spontaneous breathing, minimizes the hemodynamic interference often associated with traditional positive pressure ventilation, and maintains local oxygen concentrations. By reducing upper airway resistance, HFNC lowers the risk of intraoperative hypoxemia. These findings suggest that perioperative management should not rely on a single oxygen delivery method. Instead, support strategies must be dynamically adjusted according to the patient's evolving clinical status. Nursing staff must meticulously monitor respiratory rate, oxygenation indices, and patient tolerance, maintaining high vigilance for early signs of non-invasive support failure. Consequently, the nursing management of perioperative hypoxemia should prioritize the rational selection and standardized implementation of oxygen therapy. Ensuring optimal oxygenation must be balanced with patient comfort and safety. Within a multidisciplinary framework, nursing staff should provide continuous assessment and individualized management to enhance the overall efficacy of perioperative respiratory care.

Nurse-Led Postural Management and Comprehensive Interventions for Improving Oxygenation

Regarding postural management and integrated nursing care, this study provides evidence that prone positioning significantly enhances oxygenation and shortens the duration of mechanical ventilation in patients experiencing hypoxemia after cardiac surgery.[24,29] Evidence suggests that strategic postural adjustment—an intervention readily implemented by nursing staff—is a feasible, cost-effective, and highly practical approach. It optimizes the ventilation-perfusion (V/Q) ratio and promotes alveolar recruitment, thereby effectively improving systemic oxygenation.[41] The Post-Anesthesia Care Unit (PACU) represents a high-risk setting, with the incidence of hypoxemia during recovery ranging from 16% to 50%.[42] The quality of nursing care in the PACU is intrinsically linked to perioperative patient safety. Evidence items 30–33 indicate that standardized protocols—including adequate analgesia to mitigate respiratory depression, proactive prevention of atelectasis, and the stratified application of high-flow nasal cannula (HFNC) or non-invasive positive pressure ventilation (NIPPV)—can markedly reduce hypoxemia risk and facilitate stable recovery. These findings underscore that hypoxemia management must be a nursing priority in the PACU, achievable through standardized, continuous monitoring and early intervention. In addition to postural changes, evidence items 35–38 demonstrate that the judicious use of pulmonary vasodilators, individualized PEEP titration based on monitoring data, and collaborative physician-nurse interventions further optimize oxygenation and recovery. This suggests that managing perioperative hypoxemia does not rely on a single modality but requires the systematic integration of postural management, respiratory support, and pharmacotherapy under nursing guidance. In conclusion, nurse-led postural management combined with a multimodal comprehensive intervention strategy is essential for ensuring patient safety and promoting early recovery. Its standardized implementation is of paramount significance for optimizing perioperative clinical outcomes.

Limitations

The findings of this study should be interpreted in light of several limitations. First, as the synthesized evidence primarily originates from systematic reviews and randomized controlled trials (RCTs) conducted in diverse global settings, the generalizability of specific interventions may vary across different surgical specialties and patient populations. Second, there remains a relative paucity of high-quality, large-scale original research specifically within the Chinese clinical context. Finally, the evidence included in this study exhibits a degree of heterogeneity in terms of geographic distribution, healthcare facility levels, and participant characteristics. This diversity may impact the generalizability of the clinical recommendations across specific local settings. Consequently, when translating this evidence into clinical practice, healthcare providers must exercise comprehensive judgment, taking into account specific clinical environments, individual patient characteristics, and available medical resources. Future research should focus on conducting high-quality, multicenter studies targeting distinct perioperative stages and specialized patient cohorts. Such efforts will further strengthen the evidence-based foundation for perioperative hypoxemia management and promote the rigorous application of these findings in clinical nursing practice.

Conclusions

This study systematically synthesizes the best available evidence for managing perioperative hypoxemia, encompassing risk assessment, oxygenation monitoring, stratified respiratory support, postural management, and multidisciplinary collaboration. This study emphasizes that nursing staff serve as the first line of defense in the prevention and control of perioperative hypoxemia. In clinical practice, nurses should establish a dynamic monitoring system rooted in “baseline oxygenation” and ensure the early capture of subtle signs of respiratory deterioration through continuous and rigorous observation. Furthermore, the pivotal role of nurses in proactive respiratory support interventions must be fully leveraged—including positioning optimization, airway secretion clearance, and meticulous management of respiratory equipment—to facilitate a strategic shift from reactive treatment to proactive prevention.

Data Sharing Statement

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Ethics Statement

This study is a summary of existing evidence and did not involve direct interventions with human participants or animals; therefore, formal ethical approval was not required. This study followed the reporting specifications for evidence summaries established by the Fudan University Center for Evidence-based Nursing. Registered Title: Summary of the best evidence for perioperative patient hypoxemia management. Registration Number: ES20269736.

Disclosure

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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