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INPLASY

Evaluation of Respiratory Interventions on Pulmonary Function in Critical Care: A Systematic Review and Meta-Analysis

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ADMINISTRATIVE INFORMATION

Support - No funding was used in this study.

Review Stage at time of this submission - Completed but not published.

Conflicts of interest - None declared.

INPLASY registration number: INPLASY2024100041

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 10 October 2024 and was last updated on 10 October 2024.

INTRODUCTION

Review question / Objective The meta-analysis aims to evaluate the effectiveness of various respiratory interventions on pulmonary function and recovery outcomes in critically ill patients, with a specific focus on lung function.

Rationale The rationale for this study stems from the critical importance of pulmonary function in determining outcomes for patients in intensive care units (ICUs). Respiratory failure remains one of the leading causes of ICU admissions worldwide, particularly during crises like the COVID-19 pandemic, where respiratory interventions play a central role in patient management. The vulnerability of the lungs due to mechanical ventilation, systemic inflammation, and infections increases the need for effective respiratory interventions to prevent complications such as prolonged ventilator dependence and respiratory muscle weakness.

Recent advancements in non-invasive ventilation (NIV) and high-flow nasal cannula (HFNC) therapies have demonstrated benefits in reducing the need for invasive mechanical ventilation. Additionally, respiratory muscle training, which involves techniques like inspiratory and expiratory muscle exercises, has shown promise in improving respiratory function and rehabilitation outcomes in critically ill patients. However, despite emerging clinical practice and preliminary research, there is a lack of comprehensive systematic reviews evaluating the effectiveness of these interventions in ICU settings.

This study addresses the gap by systematically evaluating the impact of various respiratory interventions on pulmonary function in critically ill patients. The findings aim to provide evidence-based recommendations to optimize treatment strategies, improve patient outcomes, and reduce long-term complications associated with respiratory failure. Furthermore, this meta-analysis will explore the heterogeneity of outcomes across studies to assess the variability in treatment

responses and suggest personalized approaches for critical care.

Condition being studied The condition being studied in this systematic review and meta-analysis is respiratory failure in critically ill patients, specifically focusing on the impact of respiratory interventions on pulmonary function. Respiratory failure is a life-threatening condition where the lungs are unable to provide adequate oxygenation or remove carbon dioxide from the body, often requiring intensive care and mechanical ventilation. This condition is common in patients admitted to intensive care units (ICUs) due to underlying diseases such as acute respiratory distress syndrome (ARDS), chronic obstructive pulmonary disease (COPD), and complications from severe infections like pneumonia and COVID-19. The study aims to evaluate how different respiratory interventions can improve lung function and recovery outcomes in this high-risk patient population.

METHODS

Search strategy

Ovid MEDLINE(R) ALL

1 Respiratory Distress Syndrome, Adult/ 25810
2 Acute Lung Injury/ 9166
3 (((acute or adult or severe) and (respiratory adj1 distress)) or ards).mp. 53494
4 ((acute adj1 lung* adj1 injur*) or (shock adj1 lung*)).mp. 20433
5 exp Respiratory Insufficiency/ 69937
6 ((respirat* or ventilat*) adj3 (insufficienc* or failure or depression or disturbance or dysfunction)).mp. 88052
7 1 or 2 or 3 or 4 or 5 or 6 180712
8 (swallow* adj5 (exercise* or therap* or rehab* or train*)).mp. 1990
9 "swallow strengthening*".mp. 3
10 (swallow* adj5 man?euv*).mp. 232
11 ("thermal tactile stimulation*" or TTS).mp. 3807
12 ((fluid* or bolus* or boli) adj5 (viscos* or thick* or rheology*)).mp. 6374
13 (head?lift* or shaker* or CTAR* or "chin tuck against resistance*").mp. 4390
14 vitalstim*.mp. 22
15 "pharyn* electric* stimulation*".mp. 65
16 ((expiratory or respiratory) adj5 "muscle strength*").mp. 2247
17 EMST*.mp. 116
18 (("oral pressure*" or tongue*) adj5 (strengthen* or exercis*)).mp. 206
19 ("iowa oral performance instrument*" or IOPI*).mp. 208
20 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 19296
21 exp randomized controlled trial/ 618875
22 controlled clinical trial.pt. 95571
23 randomized.ab. 652643
24 placebo.ab. 249998
25 clinical trials as topic/ 202794
26 randomly.ab. 437525
27 trial.ti. 313471
28 21 or 22 or 23 or 24 or 25 or 26 or 27 1612936
29 exp animals/ not humans/ 5239184
30 28 not 29 1486055
31 7 and 20 and 30 65.

Participant or population The patient population targeted in this study consists of critically ill adults admitted to intensive care units (ICUs) with compromised pulmonary function. These patients may be suffering from conditions such as acute respiratory distress syndrome (ARDS), chronic obstructive pulmonary disease (COPD), or respiratory failure due to severe infections like pneumonia or COVID-19.

Intervention The interventions evaluated in this systematic review include various respiratory therapies aimed at improving pulmonary function in critically ill patients. These interventions consist of:
Non-invasive ventilation (NIV): Providing ventilatory support through methods that do not require endotracheal intubation.
High-flow nasal cannula (HFNC): Delivering heated and humidified oxygen at high flow rates to improve oxygenation.
Respiratory muscle training (RMT): Techniques such as inspiratory and expiratory muscle exercises to strengthen respiratory muscles and enhance lung function. These interventions are used to mitigate the effects of respiratory failure, reduce ventilator dependence, and improve recovery outcomes in ICU patients.

Comparator The comparator interventions include standard respiratory care or usual treatment in ICUs, such as conventional oxygen therapy, mechanical ventilation, or no specific respiratory training. This comparison allows for assessing the added benefit of the evaluated interventions (NIV, HFNC, and RMT) over routine care in improving pulmonary function and recovery in critically ill patients.

Study designs to be included RCTs.

Eligibility criteria Inclusion Criteria:

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Randomized controlled trials (RCTs) evaluating respiratory interventions (NIV, HFNC, RMT) in critically ill adult patients.
Studies published in English, without geographical restrictions, and focusing on pulmonary function in ICU settings.
Trials reporting measurable outcomes related to pulmonary function (e.g., PImax, PEmax) or respiratory recovery.
Exclusion Criteria:

Case reports, case series, expert opinions, qualitative studies, and studies with incomplete or duplicated data.
Non-randomized studies, retrospective analyses, or studies without control groups.

Information sources OVID Medline.

Main outcome(s) The primary outcomes of interest are improvements in pulmonary function parameters, particularly:
Maximal inspiratory pressure (PImax)
Maximal expiratory pressure (PEmax)
These are key indicators of respiratory muscle strength and lung function in critically ill patients. Secondary outcomes may include other indicators of respiratory function, such as exercise capacity, length of ICU stay, and recovery time.

Quality assessment / Risk of bias analysis The quality of included studies will be assessed using the Cochrane Risk of Bias tool. This tool evaluates potential biases in randomized controlled trials based on factors such as:
Random sequence generation
Allocation concealment
Blinding of participants and personnel
Blinding of outcome assessment
Incomplete outcome data
Selective reporting
The assessment will be used to identify high, low, or unclear risk of bias across the studies, providing insight into the reliability of the results.

Strategy of data synthesis A narrative synthesis will be provided for the included studies, summarizing key characteristics and findings. Quantitative data will be pooled in a meta-analysis, where effect sizes will be calculated using a random-effects model to account for variability across studies. Heterogeneity will be assessed using the I^2 statistic, with potential sources of heterogeneity explored through subgroup and sensitivity analyses. Forest plots will be generated to visualize the effect sizes of the interventions compared to control groups.

Subgroup analysis NAs.

Sensitivity analysis NAs.

Language restriction English.

Country(ies) involved China.

Keywords Lung; Respiratory Interventions; Pulmonary Function; Exercise Capacity; Meta-analysis.

Contributions of each author
Author 1 - Xiaofeng Zhu.
Author 2 - X Zhang.
Author 3 - M Zhou.

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