International Platform of Registered Systematic Review and Meta-analysis Protocols

INPLASY

Effects of Postoperative Pulmonary Rehabilitation on Pulmonary Function and Clinical Outcomes Following Liver Surgery: A Systematic Review

INPLASY2026110051
doi: 10.37766/inplasy2026.11.0051
Received: 13 November 2026
Published: 13 November 2026

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ADMINISTRATIVE INFORMATION

Support - No support.

Review stage at the time of initial registration - Preliminary searches.

Conflicts of interest - None declared.

INPLASY registration number: INPLASY2026110051

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 13 November 2026 and was last updated on 13 November 2026.

INTRODUCTION

Review question / Objective This systematic review aims to evaluate the effects of postoperative pulmonary rehabilitation on pulmonary function and clinical outcomes in patients undergoing liver surgery, including hepatic resection and liver transplantation. Specifically, it seeks to determine whether postoperative pulmonary rehabilitation improves pulmonary function, reduces postoperative pulmonary complications, and enhances postoperative recovery compared with usual care or other interventions.

Condition being studied Postoperative pulmonary complications, which may delay recovery and prolong hospitalization. Although postoperative pulmonary rehabilitation has been widely used to improve respiratory function and reduce pulmonary complications following major surgery, its effectiveness specifically in patients undergoing liver surgery remains unclear. Furthermore, evidence regarding the effects of different pulmonary rehabilitation interventions in this population has not been systematically synthesized. Therefore, this systematic review aims to evaluate the effects of postoperative pulmonary rehabilitation on pulmonary function, postoperative pulmonary complications, and other clinical outcomes in patients undergoing liver surgery. The findings may provide evidence to support the development of effective postoperative pulmonary rehabilitation strategies for this population.

METHODS

Search strategy The main sources to be searched are CENTRAL - Cochrane Central Register of Controlled Trials, Embase and PubMed.

Participant or population Adult patients (aged ≥18 years) undergoing liver surgery, including hepatic resection and liver transplantation.

Intervention Postoperative pulmonary rehabilitation interventions initiated after surgery, including breathing exercises, respiratory muscle

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training, inspiratory muscle training, incentive spirometry, airway clearance techniques, and exercise-based rehabilitation programs incorporating pulmonary rehabilitation components.

Comparator Usual care, standard postoperative care, or conventional rehabilitation without the additional pulmonary rehabilitation intervention.

Study designs to be included Both randomized and nonrandomized studies will be included, including randomized controlled trials, nonrandomized controlled studies, prospective and retrospective comparative studies, and case series reporting relevant postoperative outcomes.

Eligibility criteria Studies will be eligible if they meet the following criteria: (1) adult patients (aged ≥18 years) undergoing liver surgery, including hepatic resection or liver transplantation; (2) pulmonary rehabilitation interventions initiated after surgery, including breathing exercises, respiratory muscle training, inspiratory muscle training, incentive spirometry, airway clearance techniques, or exercise-based rehabilitation programs incorporating respiratory training components; (3) studies reporting at least one relevant outcome, including pulmonary function, postoperative pulmonary complications, functional recovery, length of hospital stay, or quality of life; and (4) randomized controlled trials, nonrandomized controlled studies, prospective or retrospective observational studies, and case series. Studies involving preoperative rehabilitation or prehabilitation, interventions unrelated to pulmonary rehabilitation, pediatric populations, animal experiments, reviews, conference abstracts without sufficient data, and studies without relevant postoperative outcomes will be excluded. No geographical restrictions will be applied.

Information sources A systematic literature search will be conducted using PubMed/MEDLINE, Embase, the Cochrane Library, and Web of Science to identify relevant studies published up to November 2026. Reference lists of included studies and relevant review articles will also be manually screened to identify additional eligible studies. No geographical restrictions will be applied.

Main outcome(s) The primary outcomes will be pulmonary function and postoperative pulmonary complications (PPCs). Pulmonary function will be assessed using measures such as forced vital capacity (FVC), forced expiratory volume in one second (FEV1), peak expiratory flow (PEF), and respiratory muscle strength. PPCs will include atelectasis, pneumonia, pleural effusion, respiratory failure, and prolonged mechanical ventilation, as reported in the included studies.

Quality assessment / Risk of bias analysis The methodological quality and risk of bias of the included studies will be independently assessed by two reviewers using appropriate tools according to study design. Randomized controlled trials will be evaluated using the Cochrane Risk of Bias 2 (RoB 2) tool, nonrandomized comparative studies using the ROBINS-I tool, and case series using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Case Series. Any disagreements between reviewers will be resolved through discussion or consultation with a third reviewer.

Strategy of data synthesis A narrative synthesis will be conducted to summarize the characteristics and findings of the included studies, focusing on pulmonary function, postoperative pulmonary complications, and other clinical outcomes. Results will be presented according to surgical procedure, intervention type, and outcome measures. If sufficient clinically and methodologically homogeneous data are available, a meta-analysis will be performed using a random-effects model. Otherwise, findings will be synthesized descriptively. Randomized and nonrandomized studies will be analyzed separately, and case series will be included only in the narrative synthesis.

Subgroup analysis Subgroup analyses will be performed according to the type of liver surgery (hepatic resection vs. liver transplantation) and the type of pulmonary rehabilitation intervention, if sufficient data are available. If quantitative subgroup analyses are not feasible, differences between subgroups will be explored descriptively.**3. Subgroup analysis ***.

Sensitivity analysis If a meta-analysis is feasible, sensitivity analyses will be performed by excluding studies at high risk of bias and assessing the robustness of the pooled results. If quantitative synthesis is not possible, sensitivity analyses will not be conducted.

Country(ies) involved Republic of Korea.

Keywords Liver surgery; Postoperative Complications; Pulmonary rehabilitation.

Contributions of each author

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