



OPEN Comparison of low vs high tidal volumes in one-lung ventilation during thoracic surgery: a propensity-weighted cohort study

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The optimal tidal volume (TV) during one-lung ventilation (OLV) for thoracic surgery remains uncertain. This study aimed to evaluate the association between intraoperative tidal volume and the incidence of postoperative respiratory complications in patients undergoing thoracic surgery. We conducted a post-hoc analysis of single-center observational cohort study who underwent elective thoracic surgery with OLV between January 2015 and January 2021. Patients were categorized according to their mean intraoperative TV: < 5 mL/kg versus ≥ 5 mL/kg predicted body weight (PBW). The primary outcome was postoperative respiratory complications (PRCs) within 7 days. Secondary outcomes included other major complications and 30-/90-day mortality. Analyses were adjusted using propensity score overlap weighting. Sensitivity analyses included an alternative 6 mL/kg threshold and stratified analyses by TV range. A post hoc Bayesian analysis was also performed. We included 1,234 patients. PRCs occurred in 37/458 (8.1%) patients in the < 5 mL/kg group and 45/776 (5.8%) in the ≥ 5 mL/kg group. After adjustment, TV < 5 mL/kg was not associated with a reduced risk of PRCs (RR, 1.07; 95% CI, 0.69–1.66). Using a 6 mL/kg threshold yielded similar findings (RR, 0.93; 95% CI, 0.47–1.82). Stratified analyses by tidal volume range (> 4 , 4–5, 5–6, and > 6 mL/kg) showed no significant association between tidal volume and PRCs. However, TV < 5 mL/kg was associated with an increased risk of postoperative atrial fibrillation (RR, 1.50; 95% CI, 1.09–2.05). Bayesian analyses showed no evidence of a beneficial effect of TV < 5 mL/kg on the composite outcome of postoperative complications, even when using favorable prior assumptions. In this cohort, tidal volumes < 5 mL/kg during OLV were not associated with a lower incidence of postoperative respiratory complications

Keywords Tidal volume, One-lung ventilation, Thoracic surgery, Postoperative respiratory complications, Propensity score analysis

Abbreviations

BMI	body mass index
CI	confidence interval
COPD	chronic obstructive pulmonary disease
DP	driving pressure
ESA	european society of anaesthesiology
ESICM	european society of intensive care medicine
IQR	interquartile range
IRB	institutional review board
LTV	low tidal volume
MICE	multiple imputation by chained equations
OLV	one lung ventilation
OR	odds ratio
PBW	predicted body weight
PEEP	positive end-expiratory pressure
POCs	postoperative complications

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PRCs	postoperative respiratory complications
RD	risk difference
RR	relative risk
SD	standard deviation
SFAR	Société Française d'Anesthésie et de Réanimation
SMD	standardized mean difference
STROBE	strengthening the reporting of observational studies in epidemiology
TLV	two-lung ventilation
TV	tidal volume
WRD	weighted average risk difference

Thoracic surgeries carry significant risks, with postoperative respiratory complications (PRCs) affecting 10–20% of patients and a mortality rate of approximately 1%¹. PRCs result from multiple factors, including direct lung injury from surgery, inflammation, impaired thoracic expansion due to postoperative pain, and ventilator-induced lung injury².

In lung resection surgery, one-lung ventilation (OLV) is a standard practice, typically using tidal volumes of 4–6 mL/kg for the ventilated lung³. In comparison, guidelines for two-lung ventilation (TLV) recommend tidal volumes of 6–8 mL/kg to minimize the risk of PRCs⁴. Consequently, the tidal volumes delivered per lung during OLV are proportionally higher than those used in TLV, potentially increasing the risk of volutrauma and subsequent lung injury. However, using lower tidal volumes during OLV, while aiming to protect the lung, poses the challenge of perioperative hypoxemia, which remains a significant concern in this context⁵.

Some studies have reported an increased risk of PRCs with non-protective ventilation strategies⁶. However, non-protective ventilation is generally defined as tidal volumes exceeding 10 mL/kg, often applied without PEEP. This definition does not reflect current clinical practice, raising questions about the actual impact of using lower tidal volumes—below 10 mL/kg—during OLV.

Our study aims to investigate the association between tidal volume and the risk of postoperative respiratory complications, focusing on ventilation practices commonly used in clinical settings.

Material and methods

Ethics

We confirm that the study was approved by an institutional review board (IRB Ethical Committee No. 00010254 – Reference: 2020–222, French Society of Anesthesia–Resuscitation), and that approval was also obtained from the Clinical Research Department and Investigations (Amiens, France). In accordance with French national regulations governing retrospective studies, the requirement for written informed consent was waived. Patients were informed about the study through an information sheet and were given the opportunity to opt out at any time. All research procedures were conducted in accordance with relevant ethical standards (Loi Jardé, Decree No. 2016–1537), including the Declaration of Helsinki and applicable national regulatory requirements⁷.

Participant selection

This retrospective, single-center observational study was a secondary analysis of data collected between January 2015 and January 2021. We included all adults (≥ 18 years) scheduled for thoracic surgery requiring OLV. Non-inclusion criteria were patients who had declined the use of their data for research and patients who were pregnant at the time of surgery. Patients without available perioperative ventilation data were also excluded.

Definitions

Low tidal volume (LTV) ventilation was defined as a mean tidal volume of less than 5 mL/kg during one-lung ventilation (OLV). The choice of 5 mL/kg is based on evidence from two-lung ventilation, where tidal volumes of 10 mL/kg or higher are associated with increased complications⁸. For sensitivity analyses, we also evaluated an alternate threshold of 6 mL/kg to define LTV. In a stratified analysis, each tidal volume range (> 4 , 4–5, 5–6, and > 6 mL/kg) was compared with each of the others.

Outcomes

Complications were defined and classified according to the consensus guidelines of the European Society of Intensive Care Medicine (ESICM) and the European Society of Anaesthesiology (ESA)⁹. The primary endpoint was the occurrence of postoperative respiratory complications (PRCs), defined as respiratory failure within 7 days after surgery. Secondary endpoints included other complications within 30 days post-surgery (cardiac, thromboembolic, infectious, mechanical, and neurological complications), 30-day and 90-day mortality rates. Cardiac complications included atrial fibrillation, ischemic heart disease, or cardiogenic shock. Infectious complications included pneumonia, surgical site infection, pleurisy, and septic shock. Mechanical complications were defined as pneumothorax, hemothorax, or hemorrhagic shock. We also included a composite outcome of postoperative complications (POCs), defined similarly to Futier et al., encompassing respiratory failure, pneumonia, 90-day mortality, septic shock, pleural effusion, and pneumothorax⁸.

Data sources and collections

Demographics, medical history, and outcome data were obtained from the hospital electronic records (DxCare and Exacto software). In addition to the existing cohort data, this study involved the collection of supplemental respiratory parameters. Two investigators performed double-checking to ensure data accuracy. Mean tidal volume during OLV was extracted from the anesthesia record. Driving pressure (plateau pressure—PEEP) was also recorded.

Anesthetic management

All patients received general balanced opioid-based anesthesia. The choice of anesthetic and opioid agents was left to the discretion of the anesthesiologist, independently of the surgical team. Induction was performed with propofol or etomidate, combined with sufentanil or remifentanil. Maintenance included desflurane or sevoflurane, with sufentanil or remifentanil. Neuromuscular blocking agents were administered in all patients to facilitate tracheal intubation and surgery.

Confounding variables

We included potential confounders identified in the literature: age, sex, body mass index, preoperative hemoglobin, obstructive lung disease (COPD), obstructive sleep apnea, diabetes, hypertension, history of cardiovascular disease, chronic kidney disease, smoking status and alcohol consumption, abnormal pulmonary function tests, preoperative rehabilitation (including non-invasive ventilation or physiotherapy), duration of surgery, fluid balance, PEEP levels, mean driving pressure during OLV, and neuraxial anesthesia use, among others.

Statistics

Descriptive analyses

Continuous variables are reported as means (standard deviation [SD]) or medians (interquartile range [IQR]) and categorical variables as percentages. Depending on normality and variance, we used the Student *t* test, Welch *t* test, or Wilcoxon rank-sum test to compare continuous variables. For categorical variables, we used the Fisher exact test.

Missing data

Missing data were handled using multiple imputation by chained equations (MICE), with 10 datasets and 10 iterations per dataset¹⁰. Imputations were performed using a random forest algorithm⁹. There were no missing values for outcome variables. The proportion of missing data for each variable is reported in Table 1.

Propensity score estimation and weighting

Propensity scores were computed by logistic regression including all identified confounders. We applied overlap weighting to estimate the average treatment effect within the overlap population, as described by Fan *Li* et al.¹¹. Estimates and 95% confidence intervals (CIs) from the 10 imputed datasets were pooled using Rubin's rules¹². Results are expressed as relative risks (RRs) and average risk differences (RDs), each with 95% CIs.

Balance assessment

We assessed covariate balance after weighting by calculating standardized absolute differences (SMD) for each variable. An SMD < 0.1 was considered indicative of satisfactory balance. We present these SMDs visually in “love plots”. The distribution of propensity score weights and effective sample size per imputation are provided in the supplementary materials.

Sample size

The registry was initially designed to detect a 30% relative reduction in postoperative respiratory complications, assuming a 25% incidence in the control group, with a two-sided $\alpha = 0.05$ and 85% power, requiring approximately 1,140 patients. Given the observed control incidence of 5.8%, this sample provides 80% power only to detect risk ratios ≤ 0.40 or ≥ 1.88 ; more moderate effects cannot be excluded. To explore whether the limited number of events affected statistical power, we performed an additional post hoc analysis using a composite endpoint adapted from Futier et al., including respiratory failure, pneumonia, septic shock, pleural effusion, pneumothorax, and 90-day mortality. This outcome was analyzed using a separate Bayesian logistic regression model, adjusted for the same set of confounders^[13].

Sensitivity analyses

Sensitivity analyses included applying a 6 mL/kg threshold to define low tidal volume (LTV) ventilation. In addition, we conducted separate analyses where each tidal volume category (<4, 4–5, 5–6, and >6 mL/kg predicted body weight) was compared to the rest of the cohort. That is, for each range, we assessed whether patients within that specific range had different outcomes compared to all other patients outside that range. All sensitivity analyses used the same statistical approach as the primary analysis.

Post-HOC Bayesian analysis

We conducted a Bayesian multivariable logistic regression with stan to assess the association between low tidal volume (<5 mL/kg) and postoperative complications (POCs), using the composite outcome definition from Futier et al.^{8,14}. The model was adjusted for previously described confounders. Two priors were specified for the exposure variable: an informative favorable prior derived from Futier et al. (OR, 3.33; log-transformed mean, 1.20; SD, 0.4) reflecting the expected protective effect of low tidal volumes, and a noninformative prior (mean, 0; SD, 10) assuming no prior knowledge of effect direction. All other covariates were assigned weakly informative priors (mean, 0; SD, 10). Convergence was evaluated using effective sample sizes (>400), potential scale reduction factors ($R \approx 1.00$), and visual inspection of trace plots. Posterior distributions of regression coefficients (β) and corresponding 95% credible intervals are reported. Analyses were performed using R version 4.0.3.

Group	Characteristic	>5 ml/kg (n = 776)	<5 ml/kg (n = 458)	Difference ²	95% CI ^{2,3}	SMD after adjustment
Pre-operative	Gender	429 (55%)	405 (88%)	0.79	0.67 to 0.91	< 0.001
	Age	65 (58 – 71)	64 (58 – 70)	0.06	–0.06 to 0.17	< 0.001
	Body mass index	25.9 (23.0 – 29.8)	25.3 (22.2 – 28.1)	0.24	0.12 to 0.35	< 0.001
	COPD	224 (29%)	132 (29%)	0.00	–0.11 to 0.12	< 0.001
	Obstructive sleep apnea	68 (8.8%)	37 (8.1%)	0.02	–0.09 to 0.14	< 0.001
	Diabetes	123 (16%)	82 (18%)	0.06	–0.06 to 0.17	< 0.001
	Unknown	0	1			
	Hypertension	426 (55%)	261 (57%)	0.04	–0.07 to 0.16	< 0.001
	Cardiac disease	148 (19%)	105 (23%)	0.09	–0.02 to 0.21	< 0.001
	Chronic renal failure	27 (3.5%)	19 (4.1%)	0.03	–0.08 to 0.15	< 0.001
	Smoking	611 (79%)	397 (87%)	0.22	0.10 to 0.33	< 0.001
	Unknown	0	1			
	Alcohol	119 (15%)	81 (18%)	0.06	–0.05 to 0.18	< 0.001
	Radiotherapy or chemotherapy	91 (12%)	63 (14%)	0.06	–0.05 to 0.18	< 0.001
	Hemoglobin (g/dl)	13.30 (12.30 – 14.20)	13.60 (12.50 – 14.40)	–0.13	–0.24 to –0.01	< 0.001
	Unknown	35	15			
	DLCO or FEV1 < 60%	333 (47%)	208 (50%)	0.07	–0.05 to 0.20	< 0.001
	Unknown	62	45			
	Asa score > 3	344 (44%)	218 (48%)	0.07	–0.05 to 0.18	< 0.001
	Non invasive ventilation	176 (27%)	108 (31%)	0.07	–0.06 to 0.20	< 0.001
	Unknown	130	104			
	Physiotherapy	53 (9.4%)	47 (14%)	0.16	0.02 to 0.29	< 0.001
	Unknown	211	133			
	Tidal volume [ml/kg]	5.60 (5.27 – 6.08)	4.59 (4.31 – 4.80)	2.3	2.2 to 2.5	< 0.001
Surgery	Type of surgery			0.13	0.02 to 0.25	< 0.001
	Segmentectomy	80 (10%)	43 (9.4%)			
	Lobectomy	612 (79%)	348 (76%)			
	Bi-lobectomy	27 (3.5%)	16 (3.5%)			
	Pneumonectomy	57 (7.3%)	51 (11%)			
	Surgery duration	150 (120 – 183)	150 (120 – 200)	–0.13	–0.25 to –0.02	< 0.001
	Video-assisted surgery	506 (65%)	294 (64%)	0.02	–0.09 to 0.14	< 0.001
	Operator			0.02	–0.11 to 0.14	< 0.001
	1	244 (37%)	136 (36%)			
	2	102 (15%)	58 (16%)			
	3	122 (18%)	70 (19%)			
	4	120 (18%)	68 (18%)			
	5	76 (11%)	41 (11%)			
	Unknown	112	85			
Anesthetic	Epidural	124 (16%)	91 (20%)	0.10	–0.01 to 0.22	< 0.001
	Unknown	1	1			
	Blood transfusion	14 (1.8%)	17 (3.7%)	0.12	0.00 to 0.23	< 0.001
	Fluid volume	1500 (1000 – 2000)	1500 (1000 – 2000)	–0.07	–0.19 to 0.05	< 0.001
	Apgar score < 4	3 (0.4%)	5 (1.1%)	0.08	–0.03 to 0.20	< 0.001
	One lung ventilation tidal volume	5.60 (5.27 – 6.08)	4.59 (4.31 – 4.80)	2.3	2.2 to 2.5	< 0.001
	Driving pressure	17.0 (15.0 – 19.0)	16.0 (14.0 – 18.0)	0.17	0.06 to 0.29	< 0.001
	PEEP	4.00 (3.00 – 5.00)	4.00 (3.00 – 5.00)	0.16	0.04 to 0.27	< 0.001

Table 1. Clinical characteristics of patients ventilated with less than and more than 5 ml/kg during one-lung ventilation. Data are expressed as median (interquartile range, IQR) for continuous variables and as frequencies (percentages) for categorical variables. Difference: Standardized mean difference. SMD: Absolute mean difference after adjustment. IC95%: 95% confidence interval. ¹n (%); Median (IQR). ²Standardized Mean Difference. ³CI = Confidence Interval. ⁴Pearson's Chi-squared test.

Presentation

Preliminary results were presented at the Congrès de la Société Française d'Anesthésie et de Réanimation (SFAR), Paris, 2024.

Results

Patients baseline characteristics

Between January 2015 and January 2021, 1,247 patients were enrolled. Thirteen were excluded due to missing perioperative ventilation data, resulting in 1,234 patients included in the analysis. Among them, 458 patients received a mean tidal volume < 5 mL/kg during one-lung ventilation, and 756 received ≥ 5 mL/kg (see supplementary Fig. 1). Postoperative respiratory complications occurred in 37 of 458 patients (8.1%) in the < 5 mL/kg group and in 45 of 756 patients (5.8%) in the ≥ 5 mL/kg group. Only five patients in the ≥ 5 mL/kg group received a tidal volume > 8 mL/kg. Baseline characteristics are detailed in Table 1.

Post-operative respiratory complications

The distribution of propensity scores is shown in Supplementary Fig. 2, and covariate balance before and after overlap weighting is presented in Supplementary Fig. 3. After weighting, all covariates had a standardized mean difference (SMD) below 0.1, indicating adequate balance between groups. The adjusted relative risk of postoperative respiratory complications (PRCs) was 1.07 (95% CI, 0.69–1.66) (Fig. 1), with a weighted average risk difference ranging from -0.02 to 0.03 (supplementary Table 1).

Secondary outcomes

After adjustment for confounding variables, there was no significant difference between the < 5 mL/kg and ≥ 5 mL/kg tidal volume groups for most outcomes. However, tidal volume < 5 mL/kg was significantly associated with an increased risk of postoperative atrial fibrillation (RR, 1.50; 95% CI, 1.09–2.05). Detailed results are presented in Fig. 1 and supplementary Table 1.

Sensitivity analysis

Patient characteristics according to the < 6 mL/kg and ≥ 6 mL/kg groups are presented in Supplementary Table 2. The distribution of propensity scores is shown in Supplementary Fig. 4, and covariate balance before and after overlap weighting is shown in Supplementary Fig. 5, with a standardized mean difference < 0.1 for all confounding variables. After adjustment, no association was found between tidal volumes ≥ 6 mL/kg and postoperative respiratory complications or any other outcome (Supplementary Fig. 6 and Supplementary Table 3). As part of the sensitivity analyses, each tidal volume category (< 4 , 4–5, 5–6, and > 6 mL/kg predicted body weight) was compared with the rest of the cohort. No significant differences were observed (see Fig. 2).

Post-HOC Bayesian analysis

The posterior mean β coefficient for tidal volume < 5 mL/kg was 0.02 (95% credible interval, -0.25 to 0.28) when using the informative favorable prior derived from Futier et al., and 0.18 (95% credible interval, -0.11 to 0.48) with a noninformative prior (see Fig. 3). Both analyses suggest that tidal volume < 5 mL/kg is unlikely to be associated with a lower risk of postoperative complications (POCs), as defined by the composite outcome.

Discussion

This study comparing intraoperative low tidal volume ventilation (< 5 mL/kg) with higher tidal volume strategies in patients undergoing scheduled thoracic surgery with one-lung ventilation did not show a reduction in the risk of postoperative respiratory complications. This result remained consistent when applying an alternative threshold of 6 mL/kg, as well as across segmented tidal volume ranges (< 4 mL/kg, 4–5 mL/kg, 5–6 mL/kg, and > 6 mL/kg compared against each other). Regarding secondary outcomes, tidal volumes ≥ 5 mL/kg were associated with a significantly lower incidence of postoperative atrial fibrillation, although this association was not observed when using the 6 mL/kg threshold. No significant differences were found for other complications, including infectious, thrombotic, or neurological events, nor for mortality or length of hospital stay. The Bayesian analysis, incorporating both informative favorable and non-informative priors, yielded posterior estimates suggesting that tidal volumes < 5 mL/kg are unlikely to be associated with a reduction in postoperative complications. Even when using a favorable prior derived from Futier et al. that assumed a protective effect of low tidal volumes, the posterior probability of benefit remained low, strengthening the evidence against very low tidal volume ventilation.

Current practices advocate for protective ventilation targeting tidal volumes of 6 to 8 mL/kg of predicted body weight to reduce postoperative respiratory complications⁴. In lung resection surgeries, reducing tidal volume could theoretically decrease respiratory complications by reducing mechanical stress on the ventilated lung⁸. However, few clinicians set tidal volumes below 4 mL/kg due to the risk of worsening hypoxemia¹⁷, which may require additional rescue therapies including increased PEEP, recruitment maneuvers, or other interventions¹⁸.

Our findings align with recent observational studies using propensity score methods that have failed to demonstrate a protective effect from lower tidal volumes^{15,16}. Amar et al. found no association between tidal volume and respiratory complications using 8 mL/kg and 6 mL/kg thresholds¹⁶, and Colquhoun et al. observed no benefit from tidal volumes < 5 mL/kg²⁰. By contrast, the El Tahan et al. meta-analysis reported significant reductions in respiratory complications⁶, but this analysis was heavily influenced by studies with methodological limitations.

Most studies in this meta-analysis compared protective ventilation strategies with high tidal volumes of 10–12 mL/kg during one-lung ventilation. Critically, these studies were conducted before Futier et al. demonstrated

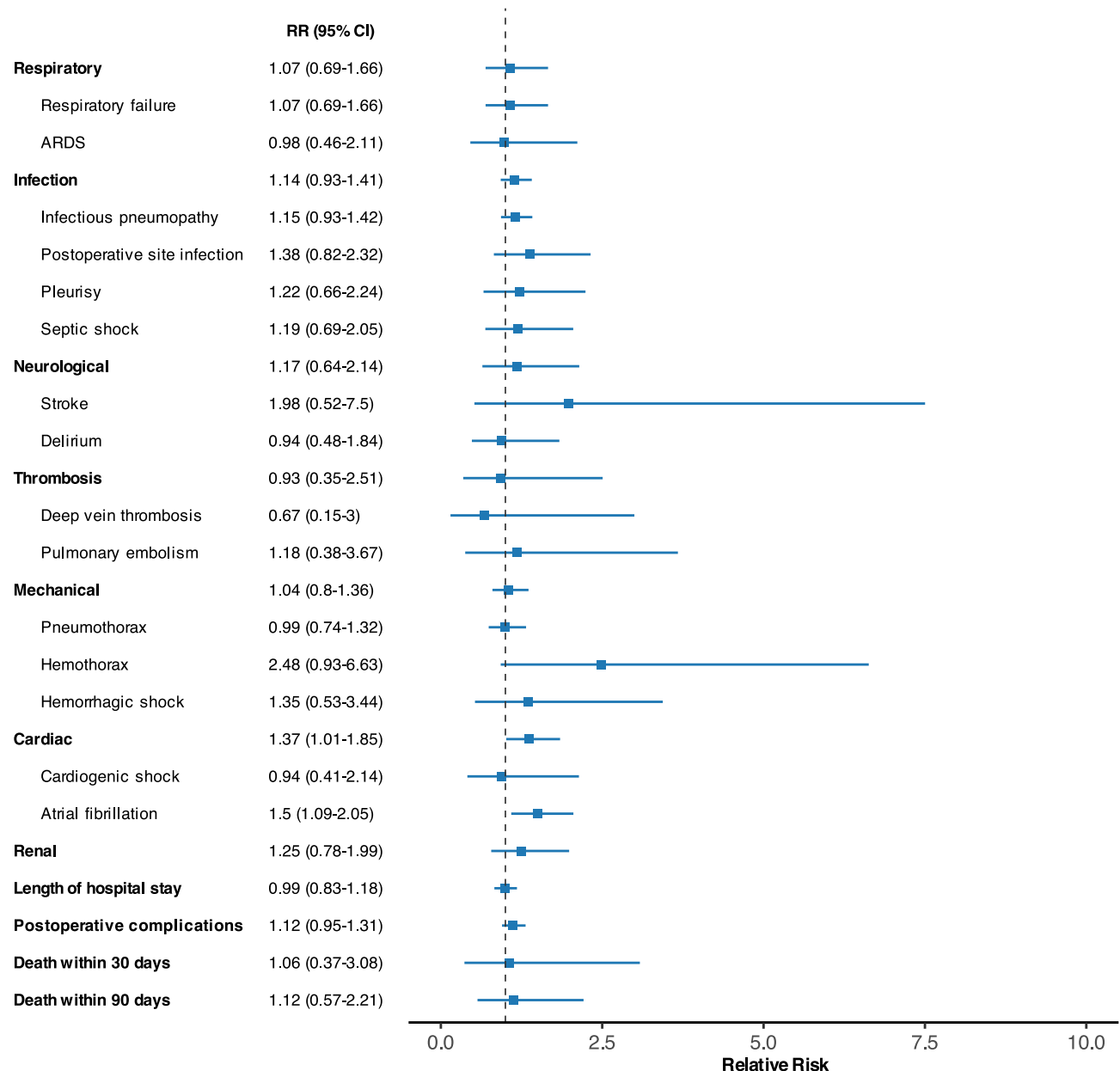


Fig. 1. Estimation of adjusted relative risks (RR) for each outcome of interest for patients ventilated with less than and more than 5 ml/kg during one-lung ventilation. Adjustment was performed using propensity score overlap weighting. RR Estimation of relative risk after adjustment, IC95% 95% confidence interval.

in 2013 that such volumes cause harm during two-lung ventilation⁴. If 10 mL/kg causes complications during two-lung ventilation, using these volumes during one-lung ventilation essentially doubles the dose delivered to the functioning lung. These older studies were therefore comparing reasonable ventilation strategies with approaches now established as harmful, explaining the pronounced treatment effects favoring protective ventilation. Furthermore, 13% of the meta-analysis variance was explained by Park et al., which primarily evaluated a driving-pressure-based approach rather than tidal volume strategies¹⁸.

In our contemporary cohort, only five patients received >8 mL/kg and none exceeded 10 mL/kg, with universal PEEP application reflecting current clinical practice rather than the historical extremes used in pre-2013 studies. This context is crucial for interpreting our null findings, as we compared clinically relevant ventilation strategies rather than reasonable practice versus harmful extremes.

The lack of benefit from very low tidal volumes may be explained by several factors. First, recruitment maneuvers were not standardized in our protocol. The iPROVE-OLV study demonstrated benefits from combining tidal volumes <6 mL/kg with specific recruitment maneuvers¹⁹, and the IMPROVE study similarly combined recruitment with protective ventilation¹⁹. Without adequate recruitment, low tidal volumes may promote atelectasis and cyclic injury, potentially negating protective benefits²⁰.

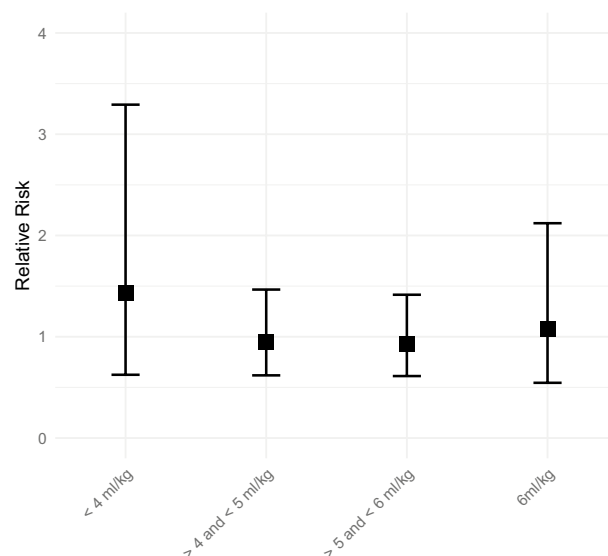


Fig. 2. Segmented analysis of tidal volume for estimation of adjusted Relative Risks (RR) for Postoperative Respiratory Complications. Each segmentation of tidal volume (V_t) is compared to other possible V_t values. Adjustment was performed using propensity score overlap weighting. Estimation of average treatment effect for the overlap population. RR Estimation of relative risk after adjustment, IC95% 95% confidence interval.

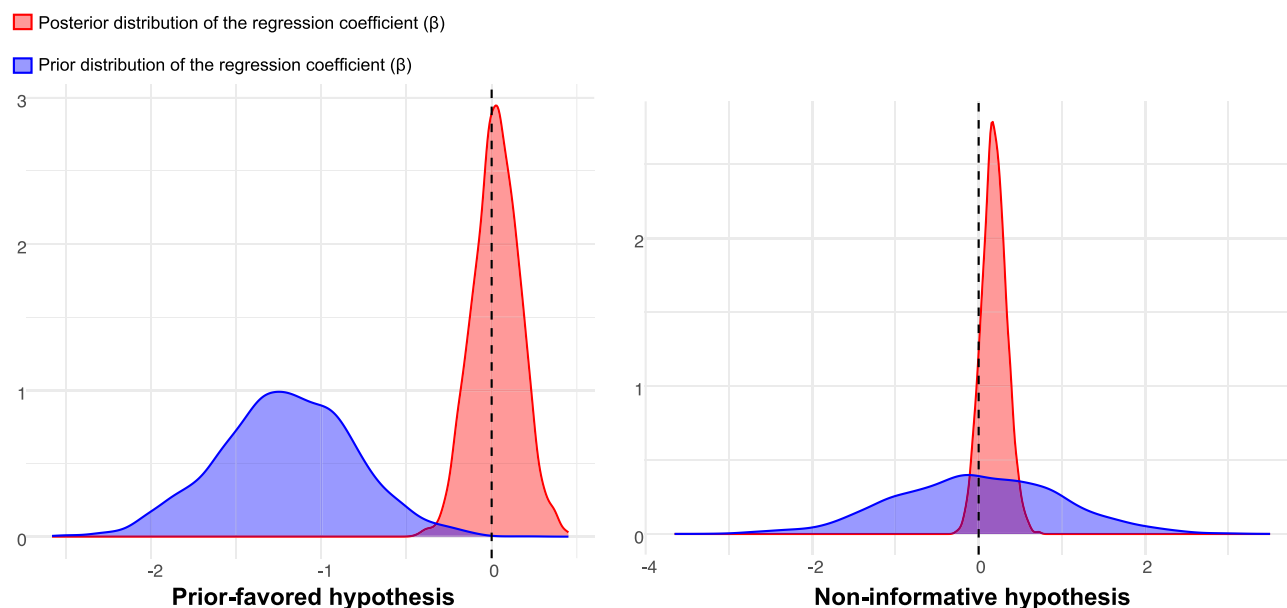


Fig. 3. Bayesian post-HOC analysis. Prior (blue) and posterior (red) distributions of the regression coefficient (β) for the association between low tidal volume ventilation (< 5 mL/kg predicted body weight) and postoperative complications, based on Bayesian multivariable logistic regression. The outcome was defined according to the composite criteria used by Futier et al.⁸. The left panel displays results using an informative prior derived from Futier et al. (log OR = 1.20, SD = 0.4). The right panel displays results using a noninformative prior (mean = 0, SD = 10). All models were adjusted for relevant confounders. Posterior distributions were estimated using Markov Chain Monte Carlo sampling, with convergence assessed by $R \approx 1.00$, effective sample sizes > 400 , and trace plot inspection.

The lack of protective effect from very low tidal volumes in our study may reflect the limitations of focusing on a single ventilation parameter. Recent evidence suggests that mechanical power—which incorporates tidal volume, respiratory rate, driving pressure, and PEEP—provides a more comprehensive assessment of ventilator-induced lung injury risk than tidal volume alone. A large registry analysis demonstrated that mechanical power was dose-dependently associated with postoperative respiratory failure during one-lung ventilation, with driving pressure being the dominant component rather than tidal volume or respiratory rate^[21]. This suggests

that tidal volume may have limited impact on lung injury, particularly at moderate volumes, and that the overall intensity of mechanical ventilation should be considered. The focus on isolated tidal volume reduction, without optimizing other ventilation parameters, may therefore be insufficient for meaningful lung protection.

Our study revealed an unexpected association between tidal volumes < 5 mL/kg and increased atrial fibrillation risk. This observation, if confirmed, could be secondary to systemic inflammation induced by atelectasis. However, this finding warrants cautious interpretation as a secondary endpoint analysis, but could potentially relate to systemic inflammation induced by atelectasis in the context of inadequate recruitment strategies²².

Study limitations include the retrospective, single-center design limiting generalizability and confounding control, and the lack of standardized recruitment protocols. The observational nature precludes establishing causality, and residual confounding remains possible despite propensity score adjustment. The sample size of the original cohort was calculated based on an overestimated incidence of the primary respiratory outcome. As the observed incidence was low, the actual sample size did not provide enough power to detect modest differences. To address this limitation, we conducted a post hoc Bayesian analysis using a broader composite outcome, based on the definition used by Futier et al., which included respiratory failure, pneumonia, septic shock, pleural effusion, pneumothorax, and 90-day mortality. Secondary endpoints, particularly those with low incidence, should be interpreted with caution and considered exploratory. To address potential power limitations of our primary outcome analysis, which was calculated based on effects observed in our original cohort, we conducted a post hoc Bayesian analysis using a broader composite outcome similar to Futier et al., including respiratory failure, pneumonia, mortality, septic shock, pleural effusion, and pneumothorax. While this composite outcome may limit the interpretation of individual components and could potentially dilute specific treatment effects, even with this expanded outcome and favorable prior assumptions, the posterior probability of benefit remained low, reinforcing our primary findings.

In conclusion, this study found no evidence supporting the use of very low tidal volumes (< 5 mL/kg) during one-lung ventilation for reducing postoperative respiratory complications. These findings, combined with emerging evidence on mechanical power as a more comprehensive ventilation intensity metric, suggest that future research should focus on optimizing overall mechanical ventilation delivery rather than isolated tidal volume reduction. Clinical practice should continue following existing guidelines, with tidal volumes between 5–6 mL/kg combined with individualized recruitment strategies and PEEP optimization representing a reasonable approach until further evidence becomes available.

Conclusion

This study did not demonstrate an association between tidal volumes < 5 mL/kg during one-lung ventilation and a lower incidence of postoperative respiratory or overall complications. However, the low incidence of respiratory complications limits the ability to exclude a modest effect on this outcome. These findings underscore the need for future studies to better define protective ventilation strategies during one-lung ventilation, possibly considering a broader set of physiological parameters beyond tidal volume alone.

Data availability

The datasets are not publicly available due to institutional restrictions. For further information, contact: rayan.braik@aphp.fr.

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Author contributions

RB conceived the study, performed the statistical analysis, and drafted the manuscript. OAA contributed to study design and manuscript revision. PB, JW, YG, and TF collected the data and contributed to preliminary data cleaning. All authors approved the final version of the manuscript.

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Declarations

Competing interests

The authors declare no competing interests.

Additional information

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