Weaning from Mechanical Ventilation in the Operating Room – A Systematic Review

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INTRODUCTION

- Postoperative pulmonary complications (PPCs): common, most frequent is atelectasis
- Even mild PPCs associated with adverse outcomes (including ICU admission)
- **Limited research addressing weaning**, though it is performed for most surgical patients
- Current strategies may ***increase*** PPCs

OBJECTIVES

- **To evaluate weaning strategies in the operating room and their association with postoperative pulmonary outcomes**
- To guide clinical practice on weaning from mechanical ventilation, and highlight unknowns for future research

METHOD

- Multiple databases, 1946 – March 2023
- Inclusion: adult (over 18 years) patients undergoing surgery under general anesthesia
- Intervention: weaning from mechanical ventilation following surgery
- Outcomes: atelectasis, oxygenation (PaO_2, PaO_2/FiO_2, postoperative oxygen supplementation), lung volume changes, PPCs

RESULTS

Intervention	Intervention group	Control group	Outcome Measured	GRADE	Risk of Bias	Overall Effect
Outcome: Atelectasis						
PSV & PEP	**33% [RR 0.58; 95% CI, 0.35-0.91]**	**57%**	**Incidence of atelectasis [Jeong et al. 2021]**	High ⊕⊕⊕⊕	Low	Likely beneficial
PSV & PEP & FiO_2	**1.6±3.6** 6.2±4.1%	**0.3±3.7** 10.8±7.1%	**Pulmonary aeration at PACU (qLUSS score) [Girard et al. 2023]** Percentage of non-aerated lung tissue [Pereira et al. 2018]	Moderate ⊕⊕⊕	Some Concerns	Likely beneficial
FiO_2	**6.8±3.4 vs. 2.6±1.1%** 5.5 [0-16.9] cm^2 3 [1-6] & 20% [RR 0.512; 95% CI, 0.311-0.843]	**8.3±6.2%** 6.8 [0-27.5] cm^2 7 [3-9] & 39%	**Postoperative atelectasis [Benoit et al. 2002]** Atelectasis area [Edmark et al. 2014] LUS score & Significant atelectasis [Park et al. 2021]	Low ⊕⊕	High	Likely beneficial
PEEP	**5.2 [2.4-14.3] cm^2**	**4.9 [3.0-12.7] cm^2**	**Postoperative atelectasis [Ostberg et al. 2019]**	High ⊕⊕⊕⊕	Low	No effect
Outcome: Oxygenation						
PSV & PEP	**92±26 mmHg**	**83±13 mmHg**	**PaO_2 at PACU [Jeong et al. 2021]**	High ⊕⊕⊕⊕	Low	Likely beneficial
PSV & PEP & FiO_2	**12% & 26 [22, 28] hrs.**	**58% & 13 [2, 26] hrs.**	**% oxygen supplementation & Duration of supplemental O_2 administration [Girard et al. 2023]**	High ⊕⊕⊕⊕	Low	Likely beneficial
FiO_2	**75 vs. 95 mmHg*** **67±7 mmHg** 435 [300-525] mmHg 12.7% vs. 8.1%	**85 mmHg*** **62±6 mmHg** 427 [345-502] mmHg 14.2%	**PaO_2 at PACU [[Benoit et al. 2002]** **PaO_2 60 mins postoperative [Kleinsasser et al. 2014]** PaO_2/FiO_2 90 mins after extubation [Staehr et al. 2012] Estimated venous admixture [Edmark et al. 2016]	Moderate ⊕⊕⊕	Some Concerns	Likely beneficial
PEEP	**1.52±6.71 mmHg** 423 [308 to 561] mmHg	**1.98± 6.52 mmHg** 418 [349 to 582] mmHg	**A-a partial pressure difference [Lumb et al. 2010]** **PaO_2/FiO_2 15-45 mins after extubation [Ostberg et al. 2019]**	Moderate ⊕⊕⊕	Some Concerns	No effect
Outcome: Lung Volumes						
PSV & PEP & FiO_2	+0.5 L*	-0.6 L*	End-expiratory lung volume [Kostic et al. 2018]	Low ⊕⊕	High	Likely beneficial
FiO_2	**41±14% vs. 37±13% & 44±17% vs. 40±20%** 1633 mL [1343-1948]	**46±14% & 49±20%** 1615 mL [1375-2318]	**End-expiratory & Total lung impedance reduction [Park et al. 2020]** FRC [Staehr et al. 2012]	Moderate ⊕⊕⊕	Low	No effect
Outcome: PPCs						
FiO_2 & PEEP	43% [RR 0.90; 95% CI, 0.74-1.10] vs. 41% [RR 0.84; 95% CI,0.69-1.03] vs. 39% [RR 0.80; 95% CI, 0.65-0.99]	48%	% patients with PPCs [Ferrando et al. 2018]	Moderate ⊕⊕⊕	Low	Likely beneficial

*Values estimated from a Figure

Bold = studies that only studied the weaning phase

Note: PSV = pressure support ventilation, PEEP = positive end-expiratory pressure, LUS = lung ultrasound, FiO2 = fraction of inspired oxygen, CT = computed tomography, A-a = alveolar-arterial oxygen pressure difference, FRC = functional residual capacity, PPCs = postoperative pulmonary complications; qLUSS = quantitative lung ultrasound score

CONCLUSION

- Interventions combining low FiO_2, PSV & PEEP improved postoperative pulmonary outcomes:
  - Atelectasis, oxygenation & lung volumes
  - Individualized PEEP reduced incidence of PPCs
- We recommend weaning after surgery be performed with low FiO_2, PSV and individualized PEEP
- Future studies needed to develop a standardized mechanical ventilation weaning protocol

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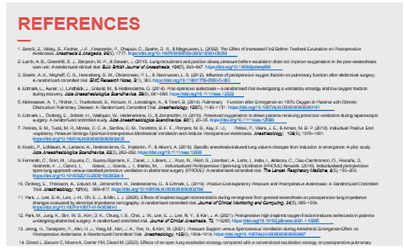

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