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Fully automated closed-loop ventilation is safe and effective in post-cardiac surgery patients

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Dear Editor,

A recent Cochrane review shows that automated ventilation, like assisted support ventilation (ASV), may reduce duration of weaning, ventilation, and ICU stay [1]. An extension of ASV is the fully automated closed-loop ventilating mode Intelligent-ASV (iASV). Minute ventilation is not only automatically calculated on the basis of ASV's least work of breathing concept according to Otis [2], but in combination with the patients end-tidal CO₂ (EtCO₂). And unlike ASV, it automatically adjusts FiO₂ and positive end-expiratory pressure (PEEP) on the basis of the ARDS Network PEEP-FiO₂ tables to maintain a target pulse oxymetry [3].

We conducted a prospective non-inferiority pilot study to determine the safety and efficacy of iASV compared to ASV and our conventional ventilation (pressure-controlled ventilation followed by pressure support ventilation) in patients weaning on a post-anesthesia care unit (PACU). Included were low-risk post-cardiac surgery adults, suitable to wean on the PACU. Excluded were patients with a positive history of COPD Gold 3 or 4, lung surgery, and patients in shock. The ventilation mode could be changed when current ventilation

was inefficient. The medical ethical committee approved the study and patients were excluded if they objected to use of their information.

In total 128 patients were included and divided into three groups, conventional ventilation ($n = 49$), iASV ($n = 53$), and ASV ($n = 26$), based on the moment of admission at the PACU. Analysis of variance (ANOVA) between groups showed no statistically significant difference of age, BMI (kg/m²), smokers, Euro-score, extracorporeal circulation time, and type of cardiac surgery.

Ventilation-related safety issues requiring interventions were not observed in all groups.

The number of interactions was statistically significantly lower in the iASV group compared to the other groups (Fig. 1). Mechanical ventilation time, the number of reintubations, and the amount of desaturations, defined as a SpO₂ lower than 85 %, showed no statistically significant differences ($p > 0.05$).

Fully automated closed-loop ventilation is able to mimic the dynamic process of human breathing by constantly adjusting ventilation and oxygenation depending on the individual demand. In our prospective

trial we showed that full closed-loop ventilation with iASV is a safe and effective mode to ventilate, oxygenate, and wean low-risk post-cardiac surgery patients.

The reduced number of interactions with the ventilator decreases workload, the risk of human errors, and may reduce inadequate ventilation time. This reduction could even be underestimated, because most physicians and nurses lacked confidence to extubate the patient directly from the new ventilation mode (iASV).

Our results were consistent with previous studies comparing iASV with conventional ventilation modes [4, 5]. These studies even report a statistically significant higher percentage of acceptable and optimal ventilation time (99.5 % instead of 93 %, $p < 0.001$) [4], with statistically significant lower ventilating pressures, volumes, and FiO₂ in both low- and high-risk critically ill patients [4, 5].

Our non-inferiority trial confirms that iASV is as safe and efficient as conventional ventilation and ASV to ventilate and oxygenate weaning patients after cardiac surgery. However, more studies are needed in

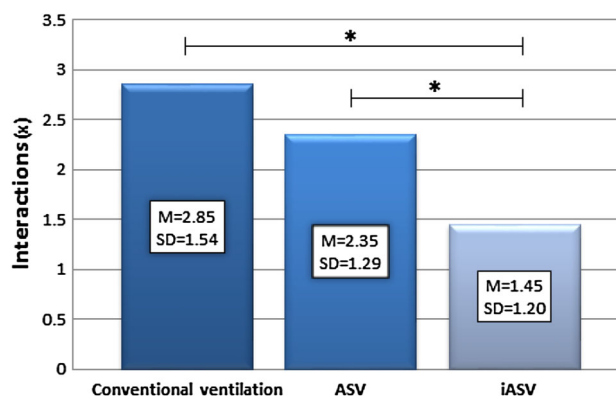


Fig. 1 Representation of the number of interactions with the ventilator in the conventional ventilation group, ASV group, and iASV group. * $p < 0.001$. *M* mean, *SD* standard deviation

critically ill and postoperative patients to fully understand the clinical impact of fully closed-loop ventilation like iASV.

Conflicts of interest The authors declare that they have no conflict of interest.

References

1. Rose L, Schultz MJ, Cardwell CR, Juvet P, McAuley DF, Blackwood B (2013) Automated versus non-automated weaning for reducing the duration of mechanical ventilation for critically ill adults and children. *Cochrane Database Syst Rev* 6:CD009235. doi: [10.1002/14651858.CD009235.pub2](https://doi.org/10.1002/14651858.CD009235.pub2)
2. Otis AB, Fenn WO, Rahn H (1950) Mechanics of breathing in man. *J Appl Physiol* 2:592–607
3. Brower RG, Lanken PN, MacIntyre N, Matthay MA, Morris A, Ancukiewicz M, Schoenfeld D, Thompson BT (2004) Higher versus lower positive end-expiratory pressures in patients with the acute respiratory distress syndrome. *N Engl J Med* 351:327–336. doi: [10.1056/NEJMoa032193](https://doi.org/10.1056/NEJMoa032193)
4. Lellouche F, Bouchard PA, Simard S, L'Her E, Wysocki M (2013) Evaluation of fully automated ventilation: a randomized controlled study in post-cardiac surgery patients. *Intensive Care Med* 39:463–471. doi: [10.1007/s00134-012-2799-2](https://doi.org/10.1007/s00134-012-2799-2)
5. Arnal JM, Garnero A, Novotni D, Demory D, Ducros L, Berric A, Donati SY, Corno G, Jaber S, Durand-Gasselin J (2013) Feasibility study on full closed-loop control ventilation (IntelliVent-ASV) in ICU patients with acute respiratory failure: a prospective observational comparative study. *Crit Care* 17:R196. doi: [10.1186/cc12890](https://doi.org/10.1186/cc12890)

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