

Systematic Review

Respiratory Therapist Driven Ventilator Bundle Adherence And Patient Outcomes: Lung Protective Ventilation, Sedation Coordination, Oral Care, And Proning Implementation

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Abstract

Background: Respiratory therapist (RT) driven ventilator bundles promote lung-protective ventilation, sedation, oral care, VAP prevention, and proning coordination. We evaluated whether adherence to these elements is linked to better outcomes in mechanically ventilated adults. **Methods:** We systematically reviewed original studies identified from electronic databases. Eligible studies include ventilated adults and evaluated an RT-driven or RT-integrated bundle element, reporting adherence or clinical outcomes. Two reviewers screened and extracted data, and findings were synthesized narratively by bundle domain. **Results:** Eight studies met inclusion criteria in emergency department and ICU settings. Lung-protective ventilation initiatives improved adherence; some cohorts reported lower mortality and more VFD. ICU liberation approaches were associated with fewer delirium, early VAP events and shorter ventilation duration. VAP bundle audits showed higher compliance with lower VAP rates. **Conclusion:** RT-driven bundle adherence aligns with improved patient centered outcomes, although effects differ by component and study design. Standardized adherence definitions and risk adjusted evaluations are needed.

Keywords: Respiratory therapist; ventilator bundle; lung-protective ventilation; sedation interruption; ICU liberation; ventilator-associated pneumonia; prone positioning

Published: December 8th 2025

<https://doi.org/10.65759/57f9kt71>

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Introduction

Respiratory therapist (RT), driven ventilator bundles aim to improve outcomes by standardizing high value practices and monitor adherence in the ventilator course in ICUs. In our review the bundle includes lung-protective ventilation (LPV), sedation and awakening coordination, oral care and ventilator-associated pneumonia (VAP) prevention, and proning coordination.

Systematic reviews show clinical associations of LPV with improved outcomes. In ARDS, a metaanalysis found that low tidal-volume ventilation (4–8 mL/kg) was associated with lower 28 day mortality (pooled risk ratio 0.79, 95% CI 0.66– 0.94) compared with higher tidal volumes (1). Protocolized approaches to protective ventilation have also been evaluated in broader ICU populations (2).

Prone positioning is another coordinationdependent intervention where timing, duration, and implementation fidelity were important. In trials using protective ventilation with reduced tidal volumes, a systematic review and meta analysis found that prone positioning reduced mortality (risk ratio 0.74, 95% CI 0.59–0.95) compared with supine ventilation (3). A metaanalysis in the low tidal-volume showed a significant mortality decrease in studies with low baseline tidal volume (RR 0.66, 95% CI 0.50–0.86) (4).

Sedation coordination has been evaluated in a Cochrane review of daily sedation interruption in mechanically ventilated adults (5). A ventilator care bundle meta-analysis reported reduced VAP incidence and shorter duration of mechanical ventilation with bundle implementation (6). A Cochrane review found that weaning protocols reduced duration of ventilation and ICU stay (7).

Evidence on specific oral antiseptics is mixed; a systematic review concluded that routine oral chlorhexidine did not reduce VAP or ventilatorassociated events and should not be used as a ICU strategy (8). Consistent delivery of LPV, coordinated sedation, reliable VAP-prevention processes, and timely proning translate into fewer complications and faster liberation from ventilation. We evaluated adherence to these elements is linked to better outcomes in mechanically ventilated adults.

Methods

This systematic review was conducted to evaluate respiratory therapist (RT) driven ventilator bundle adherence in association with improved patient outcomes in mechanically ventilated adults. The review focused on bundle domains relevant to bedside ventilator management and coordination, including lungprotective ventilation, sedation with breathing trials, oral care, ventilator-associated pneumonia (VAP) prevention bundles, and proning coordination for severe hypoxemia. The protocol was developed a priori and the review process followed PRISMA guidance for study identification, screening, eligibility, and inclusion.

Eligibility criteria: We included original quantitative studies that enrolled adult mechanically ventilated patients in emergency department (ED) or ICU settings; evaluated an RTdriven or RT-integrated ventilator bundle element (standardized low tidal volume ventilation, RT-led ventilator protocols, RT-coordinated spontaneous breathing trials, coordinated sedation interruption processes linked to breathing trials, VAP bundle adherence audits, or proning coordination strategies); and reported at least one adherence outcome and a patient outcome (mortality, ventilator-free days (VFD), ICU

length of stay, VAP incidence, delirium, mobility, extubation outcomes). We excluded pediatric studies, case reports and series without analytic comparison, editorials, narrative reviews, and studies not reporting bundle adherence or clinical outcomes.

Information sources and search strategy: Studies were retrieved from electronic databases (PubMed, Scopus and WOS) and screened in full text. The search targeted key concepts: mechanical ventilation, lung protective ventilation, tidal volume, ventilator bundle, respiratory therapist, protocol, spontaneous breathing trial, sedation interruption, VAP bundle, oral care, and prone positioning. Reference lists of included studies were also reviewed to identify additional eligible studies.

Study selection and data extraction: Two reviewers screened titles and abstracts and then full texts against eligibility criteria. Discrepancies were resolved by discussion. A standardized extraction form captured study design, setting, sample size, patient population, bundle elements, RT roles, adherence definitions and rates, and outcomes.

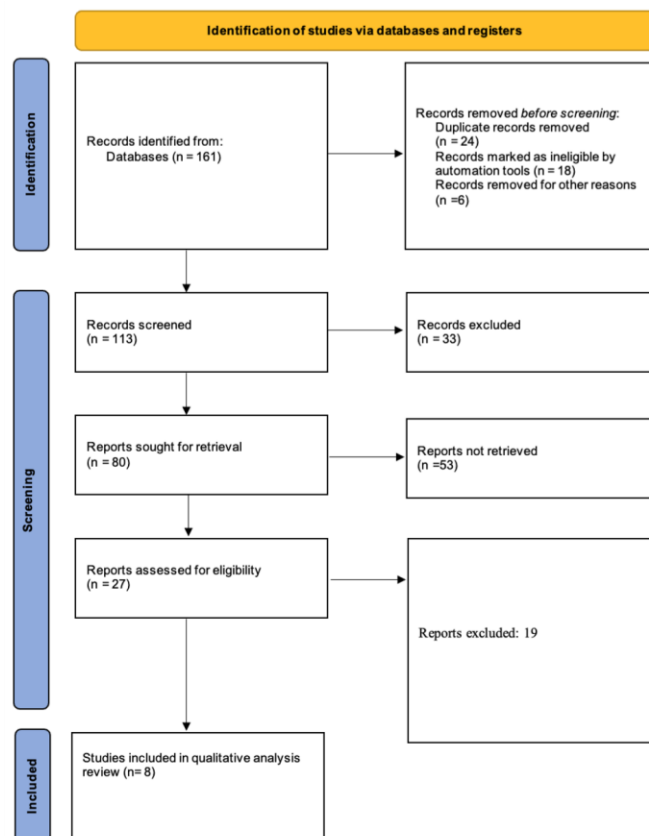


Fig 1: PRISMA flow chart

Risk of bias assessment: Randomized trials were assessed using Cochrane RoB criteria, while nonrandomized or pre post designs were assessed using domains relevant to selection bias, baseline comparability, fidelity of adherence, missing data, and outcome ascertainment. Findings were synthesized qualitatively and organized by bundle domain, showing adherence changes and direction of patient outcomes.

Results

We include eight studies on RT-driven ventilator bundle and were mapped to the prespecified domains. Two studies evaluated ED initiated protocolized ventilation. In a before after ED bundle implementation, low tidal volume ventilation increased from 11.1% to 61.5%. In the ARDS subgroup, hospital mortality decreased from 54.8% to 39.5%, VFD and ICU free days increased from 0.3

to 1.1 and 0.5 to 2.2, respectively (Fuller et al. 2017). In ED protocol trial, protocol adherence improved from 13.6% to 27.6%, and lung protective ventilation increased from 87.7% to 94.3, while VFD and mortality were not different between groups (Foley et al. 2020).

improve evidence-based prone positioning in severe ARDS (Klaiman et al. 2021).

ICU based strategies stressed RT supported standardization and coordination. A multi-cycle quality improvement initiative targeting lung protective ventilation showed a sustained shift in LTVV compliance, with the run chart center line rising from 43.5% to 61.5%, and key process measures showed greater RT role for selecting tidal volume (Donadee et al. 2022). For sedation and awakening coordination, ABCDE bundle implementation was associated with better liberation and neurocognitive outcomes: mechanically ventilated patients spent more days breathing without ventilator assistance and experienced less delirium with an adjusted odds ratio of 0.55 (Balas et al. 2014). In an RCT focused on daily sedation interruption, early VAP incidence was lower in the protocol group across days 3 to 5 (Shahabi et al. 2016). RT-directed weaning shortened weaning, ventilation, and ICU stay (Kirakli et al. 2014). Oral care was most commonly represented through ventilator bundle compliance audits. Over four years, bundle compliance increased from 90% to 97% with a reduction in VAP rate from 3.6 to 1.0 per 1,000 ventilator days and lower ventilator utilization (Al Thaqafy et al. 2014). For proning coordination, studies in the provided set was implementation focused; a qualitative study identified operational strategies, education, written protocols, electronic prompts, and prone teams, to

Table 1: characteristics of the included studies

Study	Setting and population	Design	Bundle elements	RT driven component	Outcomes reported
Fuller et al. 2017 (9)	ED adults receiving invasive mechanical ventilation; ARDS subgroup analyzed	Before and after ED ventilator bundle implementation	Lung-protective ventilation + standardized ventilator management bundle processes	Protocolized ventilator setup and titration support in ED workflow	Process (LTVV use); clinical outcomes in ARDS subgroup
Foley et al. 2020 (10)	ED adult patients started on mechanical ventilation	Prospective trial of an ED ventilator protocol versus usual care	Lung-protective ventilation + protocol adherence monitoring	RT engagement in protocol delivery and ventilator mode/setting standardization	Protocol adherence and lung-protective ventilation rates; VFD, ICU length of stay, mortality
Donadee et al. 2022 (11)	Adult ICUs; mechanically ventilated patients (quality improvement project)	Quality improvement with run-chart feedback and PDSA cycles	Lung-protective ventilation (LTVV) adherence	Role clarity for RT selecting tidal volume and feedback loops to improve practice	LTVV compliance shift over time; process measures of RT practice change
Balas et al. 2014 (12)	Medical/surgical ICUs; 146 pre- vs 150 post-bundle patients	Pre-post implementation study	Sedation/awakening coordination + spontaneous breathing trial coordination + delirium monitoring + early mobility	Coordination of spontaneous breathing trials within an ICU liberation bundle	Days breathing without ventilator assistance; delirium prevalence; mobilization; safety outcomes
Shahabi et al. 2016 (13)	Critical care units; 80 mechanically ventilated patients on IV sedation	Randomized clinical trial	Sedation interruption (daily sedation vacation) component relevant to awakening coordination	Not RT-led (nurse-driven protocol), included here for bundle outcome linkage	Early ventilator-associated pneumonia (VAP) incidence over days 3–5
Kirakli et al. 2014 (14)	ICU; 73 RT-directed protocol group vs 97	Before-after (protocol-based RT-	Spontaneous breathing trial coordination +	RT-directed protocol execution for SBT/weaning	Weaning duration; total ventilation duration; ICU length of stay;

Table 2. Main findings mapped to bundle components

Bundle component	Adherence and process effect	Key patient outcomes
Lung-protective ventilation	Low-tidal-volume ventilation increased from 11.1% to 61.5%.	In ARDS subgroup, hospital mortality decreased from 54.8% to 39.5%; VFD 0.3 to 1.1; ICU-free days 0.5 to 2.2.
ED protocol adherence for ventilator management	Protocol adherence improved (13.6% to 27.6%) and lung-protective ventilation increased (87.7% to 94.3%).	No significant differences reported in VFD, ICU/hospital length of stay, or mortality.
RT-focused LTVV quality improvement	LTVV compliance center line shifted from 43.5% to 61.5% over the initiative; RT selecting tidal volume increased (40.6% and 60.1% to 91.0% and 96.2% across cycles).	Primarily process improvement; clinical endpoints not the main focus.
Sedation/awakening and breathing coordination	ABCDE bundle associated with improved mobilization (48% to 66%) and more ventilator-independent breathing days (median 21 to 24).	Delirium prevalence decreased (62.3% to 48.7%); adjusted odds of delirium reduced (OR 0.55).
Daily sedation interruption	Structured protocol (daily interruption) vs routine, assessed over first 5 days.	Lower early VAP incidence: day 3 (0% vs 15%), day 4 (12.5% vs 50%), day 5 (27.7% vs 55.3%).
RT-directed weaning coordination	Protocol-based RT-directed group achieved shorter weaning and total MV duration.	Weaning duration 2 vs 26 hours; total MV duration 3.1 vs 5 days; ICU LOS 6 vs 12 days; extubation success (among weaned) 94% vs 78%.
Oral care bundle (IHI ventilator bundle)	Bundle compliance increased from 90% (2010) to 97% (2013).	VAP rate decreased from 3.6 to 1.0 per 1,000 ventilator-days; ventilator utilization ratio decreased from 0.73 to 0.59.
Prone positioning	Implementation package: educational outreach, written clinical protocols, EHR-based alerts, and hospital wide prone-positioning teams.	Implementation study did not report patient outcomes; focused on determinants and strategies to increase evidence-based prone use.

Discussion

Higher adherence to RT-driven ventilator bundle elements is linked to better clinical outcomes, especially fewer complications and shorter time on mechanical ventilation in practice. This is consistent with the evidence base for each bundle element: when delivered reliably, LPV and prone positioning reduce ventilator associated lung injury, and VAP-

prevention processes reduce infectious complications.

LPV is a central pathway that connects process adherence to downstream outcomes. The ARDS meta-analysis showing lower 28-day mortality and shorter ICU and hospital stay with low tidal volume ventilation (1) supports prioritizing delivery of LPV targets as a measurable bundle component. RT-led

protocols can standardize tidal-volume targets and pressure monitoring in shifts and ventilation modes. Preventive strategies using lower tidal volumes have been evaluated in heterogeneous ICU populations and support the concept of earlier LPV application (2).

Prone positioning represents a second high impact mechanism. Sud et al. showed that prone positioning, reduced mortality compared with supine ventilation (3). Mortality benefit was strongest in studies with low baseline tidal volume, indicating that prone positioning and LPV function as an integrated strategy rather than independent (4). Implementation barriers mean that RT-driven checklists and role assignment are necessary to deliver prone positioning safely.

VAP prevention and oral care are included in ventilator bundles, a ventilator care bundle metaanalysis found reduced VAP incidence and shorter duration of mechanical ventilation with bundle implementation (6). A focused systematic review concluded that routine oral chlorhexidine did not reduce VAP or ventilator associated events and should not be adopted as a universal ICU strategy (8). These findings argue for defining

RT driven oral care adherence around interventions with benefit and local feasibility rather than assuming chlorhexidine exposure is beneficial.

Sedation coordination affect ventilator duration through delirium risk, secretion clearance, and patient-ventilator synchrony. A Cochrane review of daily sedation interruption synthesized trial

evidence relevant to ventilator duration and ICU outcomes (5). Protocolized weaning shorten ventilation time and ICU stay (7), and bundle interventions have been associated with reduced VAP and shorter ICU stay (15). Future research should report element level adherence and bundle, adjust for severity and indication, and include balancing measures to confirm safety and resource use with clear adherence definitions.

Conclusion

In this systematic review we found that RT-driven ventilator bundle adherence is associated with improved clinical outcomes. Studies reported higher uptake of lung-protective ventilation, more coordinated sedation practices, reduced delirium or early VAP events, shorter ventilation duration and lower ICU utilization. VAP bundle auditing was linked to higher compliance and lower VAP rates, while prone positioning studies reinforced implementation supports to increase appropriate use.

Data Availability Statement

The datasets generated or analyzed during the current study are available from the corresponding author on reasonable request.

Conflict of Interest

The authors declare no conflicts of interest.

Funding Statement

This study did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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