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Research Article

Ventilator Associated Pneumonia Prevention Using Body Positioning; Systematic Review

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Abstract

Background: It's uncertain whether body position is optimal to avoid ventilator-associated pneumonia based on available data. The purpose of this systematic review was to know effect of body positions in ventilator associated pneumonia prevention.

Method: We conducted a systematic review according to PRISMA guidelines, we included RCTs of intubated patients receiving mechanical ventilation and hospitalized to intensive care unit. Different body positioning (semi-recumbent, lateral, or prone) or varying positioning degree in patients on mechanical ventilation were the therapies that were evaluated.

Results: Increases in bed head elevation angle lead to considerable improvements in pulmonary compliance and incidence of VAP as well as other mechanical respiratory parameters. The LTP decreased VAP incidence. Treatment with CLRT significantly reduced VAP prevalence. In severe ARDS patients, prone positioning did not reduce VAP incidence.

Conclusion: we conclude that bed elevation decrease the incidence of ventilator associated pneumonia and the duration of mechanical ventilation.

Keywords: Ventilator Associated Pneumonia; Prevention; Body Position

Introduction

Hospital acquired or Ventilator-associated pneumonia (VAP) occurs in mechanically ventilated patients for a minimum of 48 hours [1]. VAP is a common frequent hospital-acquired infections in critical care unit (ICU) [2], despite the fact that it is theoretically preventable. This condition increases mortality, duration of ICU stay, and healthcare expenses [3]. Because it obstructs the natural protective reflexes of the airway, produces more mucus, and irritates mucosa of the respiratory system, the endotracheal tube regarded as one of the primary VAP risk factors [4]. A number of physical therapies, including subglottic secretion drainage [5], and specific body positions [6], have been demonstrated to be beneficial in lowering the risk of VAP.

The term "positioning" describes the application of a certain bodily posture as a therapeutic strategy, typically used in conjunction with other physiotherapy approaches [7]. The patient's body position in the ICU may be designed to enhance ventilation and perfusion, among other things, by expanding lung volumes or using gravity to help clear airway secretions [7]. Semi recruitment position (SRP), or raising the bed head, has been thoroughly researched as a straightforward method for reducing VAP in ventilated patients and it's a suggested intervention in multiple clinical practice guidelines [8]. By keeping the contaminated oropharyngeal secretions and stomach contents out of the lower airway, this position help to prevent VAP [9].

While supine positioning appears to be less effective in VAP prevention than the SRP [8], alternative body positions, like the prone position, may enhance the drainage of respiratory secretions and biofluids, thereby halting the translocation of pathogen into the lower airway [10].

The purpose of this systematic review study was to explicitly compare how well different body positioning prevents VAP.

Method

EMBASE, Web of Science, Cochrane, and PubMed are the online databases from which we conducted an electronic search for publications published between 2006 and 2024. Furthermore, relevant studies were manually searched for in the references of published studies. The search terms and keywords that were used in the search, were as follows: "position", "body position", "supine", "prone", "Trendelenburg", "semirecumbent", "semi-recumbent", "ventilator-associated pneumonia" and, "prevention". We used the same search strategy across databases.

Titles and abstracts were screened independently by two reviewers following removal of duplicates. After that, the reviewers assessed the full-text articles, consulting a third coauthor to resolve any differences that arose between the independent reviewers. RCTs with data on VAP prevalence, mechanical ventilation (MV) and intubation were included in our analysis.

Initially we collected 164 articles from databases and 3 from reference of selected studies, after duplication removal 131 were screened for abstract and title, following exclusion of irrelevant text, 32 full text articles were assessed for eligibility and 6 were found to be eligible and included in the review (Figure 1).

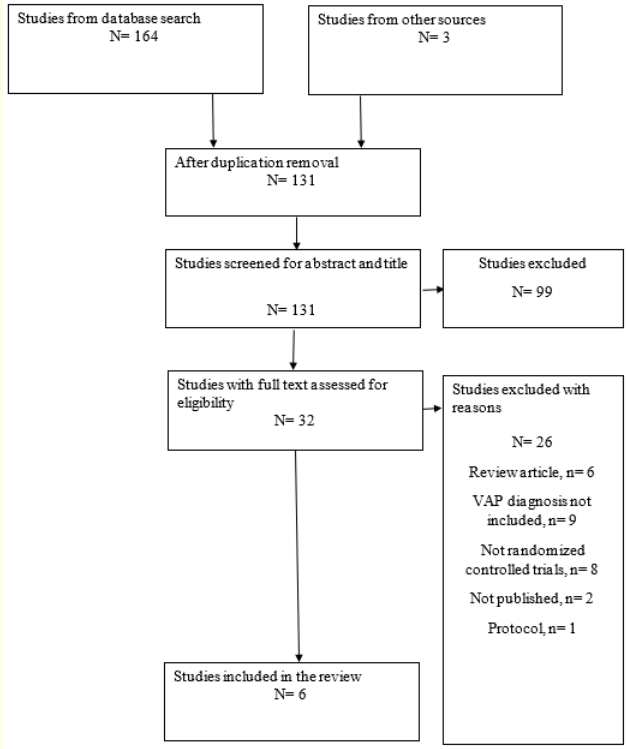

Figure 1: PRISMA consort chart of selection process.

We included studies comparing the supine, prone, lateral, and SRP or alternate positioning drgree of patients on MV. The VAP incidence served as the primary study outcome measure. Excluded from consideration were trials with crossover, cluster randomization, and quasi-experimental designs that were published as abstracts only. Furthermore, research that were unpublished, not published in English, or that had duplicate data were not included.

A standard form for data extraction was used to gather the following information from the RCTs included: citation; sample size; country; outcome; body position; characteristic of population; study design; bundle of care given.

Results

In our study we included 6 randomized controlled trials with total of 1610 patients. Two studies were conducted in Iran [11,12], one in Netherlands [13], one in Austria [14], and one in Italy, Spain, Germany, USA and Croatia [15] (Table 1). Different positions were used in the included studies; Supine Position and Prone position [16], 45° angle SRP and 60° angle SRP [12], supine position, 30° angle SRP, and 45° angle SRP [11], lateral Trendelenburg position (LTP) and SRP [15], 45 degree with SRP [13], continuous lateral rotation therapy (CLRT) [14].

Citation	Sample size	Region	Study design	Study population	Type of interventions	Care given	Criteria to diagnose VAP
Hassankhan., *et al*. 2017 [12]	First arm, n = 11 Second arm, n = 10	Iran	Randomized controlled trial	MV intubated patients for more than or equal 7 days	Control group: 45° angle SRP Intervention group: 60° angle SRP	Endotracheal continuous suction; monitoring of the endotracheal cuff; protocol for suctioning both oral and endotracheal passages; bihourly position changes; avoidance of stress ulcers Heparin and chlorhexidine mouthwash	Endotracheal suction sample for sputum culture.
Najafi., *et al*. 2017 [11]	Group 1, n = 40 Group 2, n = 40 Group 3, n = 40	Iran	3 group randomized controlled trial	Adults in the ICU, underwent MV after hospitalization.	Group 1: Supine position Group 2: 30° angle SRP Group 3: 45° angle SRP	Position changes every two hours, pressure area evaluations, wet sheet changes, chlorhexidine rinses, and tracheal suction	Positive culture from BAL
Ayzac., *et al*. 2016 [16]	First arm, n = 229 Second arm, n = 237 Consecutive, n = 237	France	Randomized controlled trial, prospective, multicenter	Invasive MV adult patients with ARDS	First study arm: Supine Position Second arm: Prone position, for 16 h	Sedation, weaning from MV, and neuromuscular blockade.	Tracheal aspirate ≥ 10^7 colony forming unit /ml BAL ≥ 10^4 colony forming unit /ml Wimberly brush ≥ 10^3 colony forming unit /ml
Li., *et al*. 2017 [15]	LTP, n = 194 SRP, n = 201	Italy, Spain, Germany, USA Croatia.	Multicenter, randomized, controlled study	Severely ill patients receiving invasive ventilation	Group 1: LTP Group 2: SRP, n	Respiratory gas active humidification that. Patients were switched from side to the other every six hours.	Mini-BAL or BAL Positive culture

Van., *et al*. 2006 [13]	Interventional group, n = 112 Standard care group; 109	Netherlands	Multicentered prospective trial	Adult patients were expected to be intubated for at 48 hours or more after being admitted to the intensive care unit.	Interventional group: 45 degree with SRP Standard care group; with 10 degree, supine position	H2 antagonists or sucralfate for the prevention of stress ulcers. Using a naso-gastric tube for enteral nutrition	Quantitative cultures of samples obtained using bronchoscopic procedures.
Staudinger., *et al*. 2010 [14]	Intervention group, n = 75 Control group, n = 75	Austria	Prospective randomized controlled trial	Patients who were ventilated for 48 hours for medical reasons and did not have acute lung damage, ARDS, or pneumonia were eligible to be included.	Intervention group (CLRT) Control group: standard care	Orotracheal intubation, Suctioning, Enteral nutrition, Heat and moisture exchange filters, Sedoanalgesia, proton pump inhibitors for stress ulcer prevention, Subglottic secretion drainage	Positive culture from BAL

Table 1: Characteristics of included studies.

Positive culture from BAL was used as diagnostic tool for 3 of the studies, quantitative cultures of samples obtained using bronchoscopic procedures in one study, Tracheal aspirate and Wimberly brush in one study, and endotracheal suction sample for sputum culture in one study. In the supine and prone position groups, the incidence rate of VAP was 1.18 and 1.54 per 100 invasive MV days, respectively, according to Ayzac., *et al*. (2016) [16]. In the Hassankhan., *et al*. 2017 [12] study, bed elevation at 60° resulted in significantly lower pulmonary infiltration on a chest X-ray, lower axillary temperature, higher pulmonary compliance, and bigger tidal volume when compared to the control group. There were statistically significant differences in VAP rate between the control groups and the bed elevation to 30 and 45 degrees, according to the Najafi., *et al*. 2017 study [11]. In the 2017 study by Li., *et al*. [15] the incidence of VAP was 0.5% and 4.0%, respectively, in individuals with SRP and LTP. In the Van., *et al*. 2006 study [13], VAP was found in 10.7% of patients in the SRP and 6.5% of patients in the supine group. According to Staudinger., *et al*.'s (2010) study [14], the rotation group reported 11% and the control group 23% of VAP cases (Table 2).

Citation	Main findings
Ayzac., *et al*. 2016 [16]	The incidence rate of VAP was 1.18 and 1.54 per 100 invasive MV days of in the supine and prone position groups, respectively. In the prone group, the estimated cumulative likelihood of VAP at 90 days was 46.5%, while in the supine group, it was 33.5%. The difference between the two cumulative probability curves was not statistically significant. VAP was linked to a higher death rate during the ICU stay in the univariate Cox model (p = 0.03).
Hassankhan., *et al*. 2017 [12]	Bed elevation when compared to the control group, at 60° led to considerably lower pulmonary infiltration on a chest X-ray (p = 0.009), lower axillary temperature (p = 0.001), larger tidal volume (p<0.001), and higher pulmonary compliance (p = 0.038). In the intervention group, the total prevalence of VAP was 20%, whereas in the control group, it was 73% (p = 0.016). In this sense, the risk of VAP was more than three times lower when the head-of-bed elevation was raised from 45° to 60°.

Najafi., *et al*. 2017 [11]	In terms of VAP, there were reported to be statistically significant changes between the control groups and the bed elevation to 30 and 45 degrees (P = 0.01). Nevertheless, there were no statistically significant variations in the groups' pressure ulcer mean scores. When it came to nursing care in the group at 45 degrees elevation, the staff nurses made the biggest shift in position.
Li., *et al*. 2017 [15]	In LTP and SRP patients, the incidence of microbiologically proven VAP was 4.0% and 0.5%, respectively. For LTP and SRP patients, the 28-day death rates were 30.9% and 26.4%, respectively. Similarly, no variations were discovered in the remaining secondary results. In LTP patients, six severe adverse events were reported.
Van., *et al*. 2006 [13]	After an average of 6 and 7 days, respectively, VAP was detected in 6.5% of patients in the supine group and in 10.7% of patients in the SRP. The number of patients receiving enteral feeding, getting stress ulcer prevention, getting pressure sores, death rates, and how long patients had to be on ventilator or in the ICU did not differ between the groups.
Staudinger., *et al*. 2010 [14]	During the ICU stay, the rotation group experienced 11% and the control group 23% of VAP cases, respectively. The rotation group's ventilation duration and length of stay were both noticeably shorter. The development of VAP was not statistically significant in the logistic regression model (p = .08). In 39% of the patients, intolerance to CLRT was noted during the weaning phase. Comparable numbers of people died in each category.

Table 2: Main findings of included studies.

Discussion

In our systematic review study we found that, bed head elevation to 45-degree compared to 30 degrees, assisted in preventing VAP compared to bedtime routine. The SRP (30 to 60°) was found to be an effective way to reduce the incidence of VAP [6], which is consistent with our findings. However, the VAP reduction did not reach statistical significance. Although it has been traditionally recommended to reduce gastric reflux, pulmonary aspiration, and VAP, the SRP has also been in debate [10]. This position facilitates the transfer of oropharyngeal infections into the lower respiratory tract by allowing the infected secretions on the cuff to enter the lungs due to gravity [10,17]. Nevertheless, our findings are in keeping with the SRP that is advised by a number of guidelines [18,19] as a VAP preventive approach.

The best level of head-of-bed elevation is still unknown, despite the fact that there is sufficient data to support the SRP as a means of preventing VAP. Thus, it appears that the SRP at 60°, depending on our included studies is the most effective level in preventing VAP. However, these findings should be interpreted with caution as only two of the studies [11,13] monitored the planned bed head elevation angles, and one was failed to adhere to the recommended SRP angle position [13]. Furthermore, while our findings support the preventive benefits of greater angles in the SRP, other investigators have hypothesized that high head-of-bed elevation may raise the risk of pressure sores in the sacral region [20] and, hemodynamic instability [21] among other complications.

Ayzac., *et al*. (2016) study utilized prone position to increase oxygenation in patients suffering from ARDS and not to prevent VAP. Although the prone posture reduced the VAP incidence, it did not increase survival, according to a prior meta-analysis [22]. In order to maintain a better ration of ventilation/perfusion and increase arterial oxygenation in ARDS patients, the prone posture has been employed extensively [23].

When comparing the LTP to the SRP, the duration of stay in ICU and hospital were shortened in LTP. The premise of this investigation was that the tracheal and pulmonary axes can be orientated below horizontal in the LTP, which facilitates mucus evacuation and prevents pulmonary aspiration [10]. Although no significant adverse events happened in patients placed in lateral-horizontal decubitus, a prior nonrandomized trial indicated a trend towards a lower VAP incidence in the lateral-horizontal position group when compared to the SRP group [24].

According to Staudinger., *et al*. (2010) [14], CLRT considerably decreased the prevalence of VAP. In recent years, there has been

a surge in the use of CLRT as an adjuvant in the management and prevention of pneumonia. Many of the institutions often recommend CLRT for patients in ICU [25]. There is not enough evidence to support CLRT's inclusion as a completely validated treatment, despite some data suggesting that it may have an influence on treating and preventing nosocomial infections acquired by ventilated patients [25].

Conclusion

According to our study we conclude that VAP incidence improve significantly when bed head elevation angle is increased. As a result, it is advised that nurses raise bed head for patients who are hospitalized to the ICU and are on MV to 45 degrees or 60 degrees. VAP incidence was reduced by the LTP. Continuous lateral rotation therapy considerably decreased the prevalence of VAP. Prone positioning did not lower VAP incidence in severe ARDS patients.

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