Semirecumbent Positioning in Ventilator-Dependent Patients: A Multicenter, Observational Study

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Background Positioning of patients is a modifiable risk factor for ventilator-associated pneumonia. Current guidelines for prevention of ventilator-associated pneumonia recommend semirecumbency at 30°, with 45° preferable unless contraindicated.

Objective To assess the use of semirecumbency for ventilator patients in Australian and New Zealand intensive care units.

Methods In a multicenter, observational study, backrest elevation, mean arterial pressure, use of inotropic agents, enteral feeding, and weaning status were recorded 3 times per day by using a predetermined randomization schedule for 7 consecutive days (maximum 21 observation episodes). Severity of illness was recorded daily by using the Sepsis-Related Organ Failure Assessment (SOFA) score.

Results Measurements (n = 2112) were recorded for 371 ventilator patients in 32 intensive care units. Backrest elevation at ≥45° was noted for 112 of 2112 (5.3%; 95% confidence interval [CI], 4.3-6.3) measurements; elevation ≥30° but <45° for 472 of 2112 (22.3%; 95% CI, 20.6-24.1). Contraindications to semirecumbency were noted during 447 measurements. Increased backrest elevation occurred during enteral feeding (2.2°, $P < .001$) and weaning (3.1°, $P < .001$). Decreased backrest elevation was associated with inotropic support (2.8°, $P < .001$), decreased mean arterial pressure (0.7°/10 mm Hg, $P < .001$), and organ failure (0.5°/1-point increment in $SOFA_{max}$ score, $P < .001$). For measurements recorded with no contraindication to semirecumbency, weaning status ($P = .003$) and $SOFA_{max}$ score ($P = .008$) remained associated with the degree of backrest elevation.

Conclusions The findings of this multicenter, observational study suggest that backrest elevation was less than recommended and was influenced by clinical practices and patient condition. (*American Journal of Critical Care.* 2010;19:e100-e108)

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Prevention of ventilator-associated pneumonia (VAP) is a priority of care for patients who require mechanical ventilation. Mortality associated with VAP exceeds mortality due to severe sepsis, central catheter infection, and respiratory tract infection for patients who are not ventilator dependent.[1] VAP also results in prolonged stays in the intensive care unit (ICU) and in the hospital and substantial increases in the use of health care resources.[2-4] Positioning of patients has been identified as a modifiable risk factor for VAP.

Supine positioning of patients is associated with aspiration of abnormally colonized oropharyngeal or gastric contents[5-7] and increased incidence of VAP compared with semirecumbent positioning of patients, defined as backrest elevation at 45° above horizontal.[8] This finding has led to the incorporation of recommendations for semirecumbent positioning into guidelines and care bundles for the prevention of VAP.[9-11] More recently, the feasibility of 45° semirecumbent positioning has been questioned. In a multicenter, randomized trial that used continuous monitoring of backrest elevation during the first 7 days of mechanical ventilation via a monitor-linked device, researchers found that 45° backrest elevation was not maintained in the study intervention group for 85% of the study observation.[12]

Several clinical practice surveys, conducted before the release of VAP prevention guidelines endorsed by various professional societies,[9-11] indicated that semirecumbent positioning for VAP prevention was inconsistently implemented into clinical practice.[4,13-15] Potential reasons for the failure to use semirecumbent positioning for patients include ambiguity of decision-making responsibility for setting semirecumbency targets, contraindications to backrest elevation, use of alternative positions, lack of resources, lack of awareness of semirecumbent positioning as a strategy for preventing VAP, and concerns about safety, including risk of formation of decubitus ulcers.[16] Results of earlier observational studies indicate that patient variables, including hemodynamic stability,[15,17] weaning status,[16] feeding status,[15,17] and severity of illness,[13,18] also may influence patients' positioning.

Subsequently, national campaigns such as the Institute for Healthcare Improvement 100 000 Lives Campaign[19] in the United States and Safer Systems Saving Lives[20] in Australia have promoted widespread adoption of strategies to prevent ventilator-associated complications, including semirecumbent positioning for the prevention of VAP. Our goal was to document the current use of semirecumbent positioning of patients in Australian and New Zealand ICUs and to identify variables associated with increased and decreased backrest elevation.

> In one study, a 45° backrest elevation was not maintained 85% of the time.

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Methods

Sample

Participating ICUs were recruited for this prospective, observational study by using a mailed flyer sent to the nurse manager of all adult level II and III ICUs in Australia and level I, II, and III ICUs in New Zealand. Australian level I ICUs were excluded because they admit ventilator-dependent patients infrequently compared with other ICUs. Patients who were 16 years and older and receiving mechanical ventilation during the 7-day observation period in 2008 were included. Patients receiving noninvasive ventilation were excluded. Upon extubation, patients became ineligible for further measurement of backrest elevation.

Approval, with informed consent waived, for this observational, noninterventional study was obtained from the institutional review boards of all participating hospitals, the Multiregion Ethics Committee of New Zealand, and RMIT University.

Study Procedures

Before data were collected, all site investigators were sent a study pack that included measurement devices, the measurement schedule, and a detailed description of data collection requirements, including definitions of all data items and study procedures. Registered nurses employed in formal ICU research coordinator roles or senior clinical nurses (clinical nurse specialists or above, with more than 5 years of ICU experience and a graduate specialty qualification) nominated themselves as site coordinators. Research coordinators were also members of the Australia and New Zealand Clinical Trials Group with experience collecting data for multicenter trials, including a recently published study[21] of intensive versus conventional glucose control in critically ill patients. A national coordinator was available in each country throughout the study to answer queries about data collection.

Thirty-two intensive care units in Australia and New Zealand were used.

The degree of backrest elevation was measured 3 times per day for 7 consecutive days. The predetermined, randomized measurement schedule was provided to each participating site. Measurement times were randomly selected from three 8-hour time blocks (8 AM to 3:59 PM, 4 PM to 11:59 PM, and midnight to 7:59 AM) for each 24-hour period to ensure that measurements were distributed across all nursing shifts. Different measurement times were used each day in recognition of the possibility that different positions may be used at various times of the day and to prevent nurses from anticipating the time of observation and altering positioning accordingly. Site investigators who were not directly responsible for positioning of patients recorded all measurements. Nurses remained unaware of the measurement schedule and were not informed of the angle of backrest elevation once measured. All backrest measurements were recorded by using an angle indicator temporarily attached with magnets to the part of the bed frame that elevates. When attached in a parallel fashion to the bed frame, the angle indicator dial used gravity to indicate the degree of backrest elevation on a protractor. Accuracy of angle detection was confirmed before the study began by using a mounted protractor and a movable metal arm.

One-third of the intensive care units had a policy for backrest elevation of 30° or more.

During each measurement episode, the following were noted: the patient's position (supine, slightly right lateral, slightly left lateral, completely right lateral, completely left lateral, prone, and sitting out of bed), mean arterial blood pressure, requirement for inotropic agents, use of continuous enteral feeding, and ventilator weaning status. Slightly lateral positioning was defined as being turned 45° or less on the indicated side. Completely lateral positioning was defined as being turned more than 45° on the indicated side. Forty-five degrees was selected as the cut point on the basis of the median angle reported in previous studies of lateral positioning.[22] The presence of the following potential contraindications for semirecumbent positioning at 45° from the horizontal were observed: suspected or existing spinal injury; intracranial hypertension; hemodynamic instability; unstable pelvic fracture; prone positioning; hemodynamic support devices such as an intra-aortic balloon pump, left ventricular assist device, and extracorporeal membrane oxygenation; femoral catheterization for continuous renal replacement therapy; abdominal wound; after femoral sheath removal; and a procedure underway.

To examine variables potentially associated with semirecumbency, we collected data for each measurement episode on hemodynamic status (mean arterial pressure and use of inotropic agents), feeding status, and weaning status. Severity of illness was recorded daily by using the Sepsis-related Organ Failure Assessment (SOFA) score[23] and for the first 24 hours of ICU admission by using the Acute Physiology and Chronic Health Evaluation (APACHE) II score. Demographic data and the reason for ventilation were also noted for each patient, as we hypothesized that the patient's age and primary diagnosis might influence the patient's positioning. The clinical pulmonary infection score (CPIS)[24] was recorded for each day of ventilation. The $SOFA_{max}$ score[25] was determined by summing the worst daily scores for each of the 6 components of the SOFA score over the data collection period. A $CPIS_{max}$ score was calculated by summing the worst daily scores of the 5 elements of the CPIS score. Presence of VAP was determined daily by the attending clinician on the basis of clinical findings or microbiological confirmation. Current guidelines for backrest elevation and presence of objective tools to measure backrest elevation were identified for each participating ICU.

Statistical Analysis

Continuous variables were expressed as means and standard deviations or medians and interquartile ranges depending on their distribution. Categorical variables were expressed as frequencies and proportions and their 95% confidence intervals (CIs) were calculated. Differences in measurements recorded in units with either a unit policy or a measurement device were examined by using Student *t* tests. Repeated-measures regression analyses,[26] with correlation among measurements taken for the same patient and measurements recorded within the same ICU controlled for, were used to examine differences in backrest elevation in the presence or absence of contraindications to semirecumbent positioning, as well as the univariate and multivariate relationships between the degree of backrest elevation and patient variables considered potentially influential on patient positioning. Before inclusion in the multivariate model, the variables of interest were assessed for the presence of multicollinearity by using a tolerance statistic. Repeated-measures regression analyses were conducted considering all recorded backrest elevation measurements and those measurements recorded in the absence of contraindications to semirecumbent positioning. All analyses were carried out by using SAS Version 9.1 (SAS Institute, Cary, North Carolina).

Results

Data were recorded on 371 patients from 32 ICUs in Australia (21/132, 15.9% of eligible ICUs) and New Zealand (11/25, 44% of eligible ICUs). Seventeen out of a possible 70 (24.3%) level III ICUs participated, as did 13 of 80 (16.3%) level II ICUs and 2 of 7 (28.6%) New Zealand level I ICUs. Twelve ICUs (37.5%) indicated that the unit had a policy recommending backrest elevation of 30° or more at the time of data collection. Only 7 of 32 ICUs (22%) had objective measurement of backrest elevation available either built into the beds or as a separate device.

Demographic characteristics of ventilator patients are shown in Table 1. Postoperative respiratory failure was the most frequent indication for mechanical ventilation in both countries. For 10 patients (2.7%), acute respiratory distress syndrome (ARDS) was either the primary indication for ventilation or developed during the patient's ICU stay. VAP was diagnosed in 12 of 371 patients (3.2%); 7 of 12 VAP diagnoses (58.3%) were confirmed microbiologically and the remaining 5 diagnoses (41.7%) were based only on clinical findings.

During the 7-day observation period, 2150 observation episodes were documented and backrest elevation was recorded for 2112 of the 2150 observations. Backrest elevation at 45° or greater was noted for 112 of 2112 measurements (5.3%; 95% CI, 4.3%-6.3%), and elevation of 30° or greater but less than 45° was found for 472 of 2112 measurements (22.3%; 95% CI, 20.6%-24.1%). Backrest elevation of 15° or less was recorded for 353 of 2112 measurements (16.7%; 95% CI, 15.1%-18.3%). The mean (SD) backrest elevation was 23.8° (12.2°) when all measurements were considered; backrest elevation was 4.9° (95% CI, 3.5°-6.3°) higher for patients with no contraindication to elevation to 30° or higher (included patients with intracranial hypertension, $P<.001$) and 4.6° (95% CI, 3.3°-5.9°) higher for measurements recorded with no contraindication to semirecumbency to 45° or greater ($P<.001$). Contraindications noted during 447 measurements are shown in Table 2. Mean backrest elevation recorded in units that had a measurement device available for use at the bedside was 2.2° (95% CI, 1.1°-3.6°) higher than the mean elevation in those units without measurement devices ($P<.001$). No difference in mean backrest elevation was found when units with and without a policy recommending semirecumbent positioning were compared ($P=.09$).

Table 1
Characteristics of patients included in the study (N = 371)

Characteristic	Australia (n = 280)	New Zealand (n = 91)
Age, median (interquartile range), y	63 (46-74)	58 (45-67)
Male sex, No. (%) of patients	184 (66)	73 (80)
APACHE II score, median (interquartile range)	18 (13-23)	17 (13-23)
SOFAmax score, median (interquartile range)	6 (4-10)	7 (5-10)
CPISmax, median (interquartile range)	5 (0-10)	4 (0-8)
Indication for ventilation, No. (%) of patients		
Postoperative[a]	105 (37.5)	45 (49.4)
Trauma	28 (10.0)	4 (4.4)
Cardiac arrest	26 (9.2)	2 (2.2)
Pneumonia	19 (6.8)	6 (6.6)
Sepsis	19 (6.8)	6 (6.6)
Overdose	16 (5.7)	3 (3.3)
Traumatic head injury	14 (5.0)	8 (8.8)
Primary neurological disorder	14 (5.0)	3 (3.3)
Heart failure	10 (3.6)	3 (3.3)
Aspiration	9 (3.2)	2 (2.2)
Chronic obstructive pulmonary disease	3 (1.1)	0 (0.0)
Acute respiratory distress disease	3 (1.1)	1 (1.1)
Neuromuscular disease	0 (0.0)	3 (3.3)
Other[b]	9 (3.2)	5 (5.5)
Not reported	5 (1.8)	0 (0.0)

Abbreviations: APACHE, Acute Physiology and Chronic Health Evaluation; $CPIS_{max}$, maximum; Clinical Pulmonary Infection Score; $SOFA_{max}$, maximum score on Sequential Organ Failure Assessment.

[a] Postoperative refers to those patients who require continuation of mechanical ventilation after surgery because of underlying medical problems, advanced age, airway maintenance, or the high risk of the operative procedure.

[b] Other: pancreatitis, allergic reaction, neuroleptic malignant syndrome, pulmonary embolus, liver failure, burn injury, thrombotic thrombocytopenic purpura, decreased level of consciousness of unknown cause.

Table 2
Contraindications to semirecumbent positioning

Contraindication	No. (%) of observations (N = 2150)	
	Australia (n = 1632)	New Zealand (n = 518)
None	1301 (79.7)	402 (77.6)
Intracranial hypertension[a]	75 (4.6)	23 (4.4)
Suspected or existing spinal injury	65 (4.0)	8 (1.5)
Undergoing procedure	65 (4.0)	21 (4.1)
Hemodynamic instability	60 (3.7)	32 (6.2)
Femoral catheter in situ	27 (1.7)	1 (0.2)
Extracorporeal membrane oxygenation/left ventricular assist device	17 (1.0)	4 (0.8)
Intra-aortic balloon pumping	11 (0.7)	23 (4.4)
Unstable pelvic fracture	5 (0.3)	2 (0.4)
Abdominal wound	3 (0.2)	1 (0.2)
After removal of femoral sheath	3 (0.2)	1 (0.2)

[a] Considered a contraindication for semirecumbent positioning at 45° elevation of the head of the bed.

Table 3
Patients' position during measurement of backrest elevation

Position	No. (%) of observations (N = 2150)	
	Australia (n = 1632)	New Zealand (n = 518)
Supine	905 (55.5)	265 (51.2)
Slightly left lateral	305 (18.7)	110 (21.2)
Slightly right lateral	271 (16.6)	101 (19.5)
Completely left lateral	35 (2.1)	17 (3.3)
Completely right lateral	40 (2.5)	11 (2.1)
Prone	2 (0.1)	0 (0.0)
Sitting out of bed	38 (2.3)	3 (0.6)
Not reported	36 (2.2)	11 (2.1)

Of the 2150 measurement episodes, 719 (33.4%) were recorded during administration of inotropic agents, 1369 (63.7%) while the patient received enteral feeding, and 857 (39.9%) during weaning. Patients' positions when backrest elevation was measured are shown in Table 3. Measurements recorded with the patient supine were 1.2° (95% CI, 0.3°-2.1°) degrees higher than measurements obtained with the patient laterally positioned ($P = .008$).

When all measurements were considered, that is, including measurements recorded when a contraindication to semirecumbent positioning was present, patient variables associated with increased backrest elevation were enteral feeding (2.16°; 95% CI, 0.96°-3.34°, $P < .001$) and weaning (3.08°; 95% CI, 2.03°-4.14°, $P < .001$). Decreased backrest elevation was associated with inotropic support (2.79°; 95% CI, 1.49°-4.09°, $P < .001$), decreased mean arterial pressure (0.73°; 95% CI, 0.36°-1.09° for each 10 mm Hg decrease, $P = .001$), and organ failure (0.50°; 95% CI, 0.27°-0.72° for each 1-point increment in the $SOFA_{max}$ score, $P < .001$). Patient's age, reason for mechanical ventilation, diagnosis of VAP, CPISmax score, and APACHE II score recorded for the first 24 hours of ICU admission were not associated with the degree of backrest elevation. Enteral feeding, weaning status, $SOFA_{max}$ score, and mean arterial pressure continued to be independently associated with backrest elevation when adjusted by multivariate regression for age, indication for ventilation, inotropic support, $CPIS_{max}$, and APACHE II score (Table 4). Considering only those measurements recorded in the absence of a contraindication to semirecumbent positioning to 45° or greater, only weaning status and the $SOFA_{max}$ score remained associated with the degree of backrest elevation ($P = .003$ and $P = .008$, respectively; Table 5).

Discussion

In this multicenter study, the average degree of backrest elevation was comparable to the elevations reported in observational studies previously conducted in other countries[4,14,15] and in an Australian study published 15 years prior.[13] Our results, however, reflect a backrest elevation below the level recommended for prevention of VAP.[9-11] Current guidelines recommend 30° to 45° of backrest elevation, although high-level evidence exists only for 45° or greater semirecumbency.[8] Increased backrest elevation was associated with enteral feeding and weaning status. A previous study of determinants for semirecumbent positioning as perceived by clinicians also showed that patients' weaning status influenced the use of semirecumbency.[16] Semirecumbent positioning may improve oxygenation and maximize ventilatory efforts by decreasing abdominal compression on the lung bases and enabling recruitment of dependent lung areas.[27,28] This effect occurs during both mandatory and spontaneous ventilation; therefore, it is unclear why nurses preferred a higher degree of backrest elevation for weaning patients.

Clinical practice guidelines currently advocate 45° backrest elevation for patients receiving enteral feeding.[29] Interestingly, in the present study, although an association between enteral feeding and increased backrest elevation was found when all measures were considered, this relationship was no longer present when only those measurements recorded in the absence of contraindications to semirecumbency were evaluated. This finding suggests that nurses disregarded feeding status for patients able to maintain semirecumbent positioning but when contraindications were present, attempted a higher degree of backrest elevation for patients receiving enteral feeding. In 2 previous observational studies,[15,17] researchers also noted a lack of association with enteral feeding and backrest elevation, although contraindications to backrest elevation were not accounted for in those studies.

In our study, mean arterial pressure was associated with reduced backrest elevation when all recorded measurements were considered. Although statistically significant, the degree of change in backrest elevation was only 0.7° for each decrement of 10 mm Hg in mean arterial pressure, which is unlikely to alter a patient's hemodynamic response. Grap and colleagues[15] also demonstrated a relationship between backrest elevation and systolic and diastolic blood pressure. Hemodynamic instability has been suggested as a contraindication to semirecumbency,[16] although few empirical data have been collected to describe the relationship between backrest elevation and mean arterial pressure.[28,30,31]

Severity of illness as measured by the $SOFA_{max}$ score also was associated with a decrement in backrest elevation. This association remained present even when measurements recorded with a contraindication to semirecumbency were excluded. Possible rationales for lower backrest elevation in patients with more severe illness include cardiovascular and respiratory instability as well as increased need for multiple procedures warranting horizontal positioning. Severity of illness as measured by the APACHE II score recorded in the first 24 hours of ICU admission had previously been shown to be associated with lower backrest elevation.[13] Our study did not show an association between backrest elevation and APACHE II score. Arguably the $SOFA_{max}$ score, which takes into account daily ratings of organ failure,[32] is a more sensitive predictor of head-of-bed elevation than is a single measurement of illness severity recorded early in the patient's ICU admission.

Reasons for poor compliance with semirecumbency in our study are uncertain. Those ICUs with measurement devices available at the bedside had higher mean backrest elevation than did units without devices, but backrest elevation remained below

Table 4
Variables associated with backrest elevation (all measurements)

Variable	Change in backrest elevation, degrees, mean (95% CI)[a]	
	Univariate regression	Multivariate regression
Age (10-year increment)	+0.49 (+0.03 - +0.94)	0.38 (-0.09 - +0.86)
Enteral feeding	+2.16 (+0.96 - +3.34)	+2.02 (+0.75 - +3.30)
Weaning	+3.08 (+2.03 - +4.14)	+2.38 (+1.29 - +3.48)
Inotropic support	-2.79 (-1.49 - -4.09)	-1.18 (-0.26 - +2.61)
Mean arterial pressure (10 mm Hg increment)	+0.73 (+0.36 - +1.09)	+0.63 (+0.25 - +1.02)
Reason for mechanical ventilation		
Not intrapulmonary[b]	1	1
Intrapulmonary[c]	+2.47 (-0.11 - +5.06)	+1.55 (-0.88 - +3.98)
Postoperative	+0.32 (-1.57 - +2.21)	+0.85 (-1.17 - +2.86)
$SOFA_{max}$ increment	-0.50 (-0.27 - -0.72)	-0.42 (-0.16 - -0.68)
APACHE II score increment	0.05 (-0.06 - +0.16)	+0.06 (-0.06 - +0.17)
$CPIS_{max}$ increment	0.06 (-0.39 - +0.48)	+0.30 (-0.14 - +0.75)

Abbreviations: APACHE, Acute Physiology and Chronic Health Evaluation; CI, confidence interval; $CPIS_{max}$, maximum Clinical Pulmonary Infection Score; $SOFA_{max}$, maximum score on Sepsis-related Organ Failure Assessment.

[a] Mean estimates and 95% CIs were derived from generalized estimating equations controlling for correlation among measurements taken for the same patient and those recorded within the same intensive care unit.
[b] Reasons for mechanical ventilation that are not intrapulmonary include trauma, cardiac arrest, sepsis, overdose, traumatic head injury, primary neurological disorders, heart failure, and neuromuscular disease.
[c] Intrapulmonary reasons for mechanical ventilation include pneumonia, aspiration, chronic obstructive pulmonary disease, and acute respiratory distress syndrome.

the level recommended in VAP prevention guidelines. The presence of a unit policy recommending semirecumbency did not affect backrest elevation. Various studies[33-35] have shown that implementation of unit protocols and objective measurement devices can result in improved compliance with semirecumbency. We did not directly assess nurses' awareness of unit protocols or use of measurement devices available to them in our study.

Contraindications to semirecumbency have previously been cited as a nonmodifiable reason for poor compliance.[16] We found that backrest elevation was 4.6° higher when contraindications were absent; however, the mean elevation remained below the level recommended in current guidelines. Nursing convenience also may preclude semirecumbency, because this position may be difficult to maintain for patients receiving multiple interventions.[36] We included "procedure underway" as a contraindication in an attempt to account for patients undergoing interventions such as chest radiography,

Higher elevations occurred with enteral feeding and weaning status.

Table 5
Variables associated with backrest elevation (contraindication to semirecumbent positioning absent)

Variable	Change in backrest elevation, degrees, mean (95% CI)[a] Univariate regression	Multivariate regression
Age (10-year increment)	+0.35 (-0.10 - +0.80)	+0.32 (-0.16 - +0.80)
Enteral feeding	+0.90 (-0.41 - +2.22)	+0.92 (-0.51 - +2.35)
Weaning	+2.39 (+1.25 - +3.52)	+1.79 (+0.61 - +2.96)
Inotropic support	-1.97 (-0.53 - -3.40)	-0.88 (-2.46 - +0.69)
Mean arterial pressure (10 mm Hg increment)	+0.49 (+0.09 - +0.88)	+0.41 (-0.00 - +0.83)
Reason for mechanical ventilation		
Not intrapulmonary[b]	1	1
Intrapulmonary[c]	+1.17 (-1.27 - +3.61)	+0.68 (-1.66 - +3.02)
Postoperative	+0.09 (-1.79 - +1.97)	+0.30 (-1.77 - +2.38)
$SOFA_{max}$ increment	-0.38 (-0.61 - -0.16)	-0.35 (-0.61 - -0.09)
APACHE II score increment	+0.03 (-0.07 - +0.14)	+0.04 (-0.07 - + 0.16)
$CPIS_{max}$ increment	+0.09 (-0.34 - +0.52)	0.39 (-0.07 - +0.85)

Abbreviations: APACHE, Acute Physiology and Chronic Health Evaluation; CI, confidence interval; $CPIS_{max}$, maximum Clinical Pulmonary Infection Score; $SOFA_{max}$, maximum score on Sepsis-Related Organ Failure Assessment.

[a] Mean estimates and 95% CIs were derived from generalized estimating equations controlling for correlation among measurements taken for the same patient and those recorded within the same intensive care unit.
[b] Reasons for mechanical ventilation that are not intrapulmonary include trauma, cardiac arrest, sepsis, overdose, traumatic head injury, primary neurological disorders, heart failure, and neuromuscular disease.
[c] Intrapulmonary reasons for mechanical ventilation include pneumonia, aspiration, chronic obstructive pulmonary disease, and acute respiratory distress syndrome.

linen change, or catheter insertion at the time of measurement. The minimum time between measurements generated by the randomization schedule was 2 hours, theoretically allowing enough time for nurses to reposition patients to semirecumbency after a procedure. Also femoral catheterization for continuous renal replacement therapy was included as a contraindication in an effort to account for alarms associated with high circuit pressures due to semirecumbency and obstruction of the access catheter.

Use of alternative positions is another potentially acceptable reason for decreased backrest elevation, as 45° elevation may not be feasible during lateral positioning.[37] Yet in our study, the mean degree of backrest elevation recorded with the patient supine was only 1.2° higher than the mean level recorded during lateral positioning. Results of other surveys suggest that nurses' perception of patients' discomfort,[38] inability to accurately gauge backrest elevation,[39] decubitus ulcer formation,[16] and lack of awareness of positioning recommendations[14] may influence positioning practices. Prevention of VAP was previously identified as the second most important aim for positioning ventilator-dependent patients in the aforementioned Australian survey,[40] suggesting that clinicians practicing in Australian ICUs are aware of guidelines for preventing VAP.

Limitations

Our study has a number of limitations. First, monitoring of backrest elevation was limited to 3 times daily as opposed to the continuous monitoring used in a more recent randomized trial of semirecumbency.[12] Therefore, we cannot assume our findings reflect all position changes experienced by patients in a 24-hour period. Second, our study involved only 20% of eligible ICUs in Australia and New Zealand, and thus its results may not be generalizable to practice within all units in these and other countries. Third, contraindications to semirecumbency were identified by the site coordinators by observing patients and available charts. Other contraindications may have existed that were not obvious to the study coordinator. Also, because of the large number and geographical distances of participating sites, we were unable to assess interrater reliability of data collection by site investigators across sites. Fourth, despite our efforts to blind nurses from measurement of backrest elevation, nurses may have viewed the angle recorded, influencing their use of backrest elevation.

Conclusions

Our study shows that adherence to current positioning recommendations for the prevention of VAP was infrequent. Those patients receiving enteral feeding and undergoing weaning were more likely to experience a higher degree of backrest elevation. Although current guidelines support semirecumbency during enteral feeding, rationales for increased backrest elevation during weaning as opposed to full ventilatory support remain unclear. Patients with greater severity of illness experienced lower backrest elevation independent of hemodynamic status. This finding warrants further exploration because sicker patients may be at higher risk for the development of VAP because of a prolonged requirement for mechanical ventilation. Further work is required to elucidate nurses' decision making regarding positioning practices in real time, and empirical studies must be done to determine the safety of semirecumbency in higher acuity patients.

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