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IMPACT OF REPOSITIONING DURATION ON CARDIORESPIRATORY STATUS IN VENTILATED PATIENTS

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ABSTRACT
Immobilization in mechanically ventilated ICU patients frequently alters cardiorespiratory stability. While regular repositioning is standard nursing care to prevent complications, the optimal duration tolerated before hemodynamic shifts occur remains poorly characterized. Objective to analyze the effect of repositioning and its duration on hemodynamic and respiratory status among mechanically ventilated patients in the Intensive Care Unit. A pre-experimental study with a one-group pretest-posttest design was conducted in the ICU of Telogorejo Hospital, Semarang. A total of 20 mechanically ventilated patients were recruited via accidental sampling. Physiological parameters heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), oxygen saturation (SpO2), respiratory rate (RR), and tidal volume (TV) were measured before and immediately after repositioning until physiological changes occurred (maximum duration 2 hours). Data were analyzed using paired comparative tests and correlation analyses. Repositioning significantly altered all measured cardiorespiratory parameters ($p<0.05$): HR increased from 89.00 ± 15.45 to 103.00 ± 18.79 bpm ($p = 0.003$), SBP from 119.00 ± 26.65 to 129.00 ± 23.49 mmHg ($p = 0.014$), DBP from 63.00 ± 15.68 to 67.00 ± 16.10 mmHg ($p = 0.006$), SpO2 from 99.00 ± 0.92% to 100.00 ± 0.59% ($p = 0.035$), RR from 16.00 ± 4.55 to 27.00 ± 9.01 breaths/min ($p = 0.000$), and TV from 441.00 ± 64.97 to 476.00 ± 76.77 mL ($p = 0.002$). The mean duration before parameter changes was 46.75 ± 10.42 minutes. Repositioning duration showed a significant moderate positive correlation only with changes in diastolic blood pressure ($r = 0.602$, $p = 0.005$), while changes in other parameters were not significantly correlated with duration ($p > 0.05$). Repositioning induces significant physiological responses in mechanically ventilated patients, with hemodynamic shifts emerging at an average of 47 minutes. Critical care nurses should adopt individualized repositioning intervals tailored to patient stability rather than relying solely on rigid two-hour protocols.

Keywords: critical care nursing; hemodynamics; mechanical ventilation; repositioning duration; respiratory status

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INTRODUCTION

The Intensive Care Unit (ICU) is a specialized clinical environment designed to provide advanced life-sustaining organ support and continuous multi-parameter monitoring for critically ill patients (Marshall et al., 2017; Martinez et al., 2022). Invasive mechanical ventilation (IMV) remains one of the primary therapeutic interventions utilized to restore gas exchange, manage acute respiratory failure, alleviate work of breathing, and correct life-threatening hypoxemia or hypercapnia (American Thoracic Society, 2020; Rackley, 2020; Tiruvoipati et al., 2020). Despite its vital benefits, mechanically ventilated patients are subjected to complete physical immobilization due to a convergence of factors: continuous sedation infusions, endotracheal intubation, deep muscle weakness associated with critical illness neuropathy/myopathy, and physical restraints (Jarczak et al., 2021b). Prolonged immobility predisposes these vulnerable patients to severe secondary complications, including rapid muscle wasting, pooling of pulmonary secretions, atelectasis, ventilator-associated pneumonia (VAP), deep vein thrombosis, and painful pressure injuries (Gillespie et al., 2020; Roumy et al., 2020).

To mitigate the catastrophic consequences of immobility, lateral repositioning alternating between supine, left lateral, and right lateral positions is universally mandated as an essential nursing intervention (Gillespie et al., 2020; Yundari et al., 2023). International guidelines on pressure injury prevention traditionally enforce a rigid schedule of repositioning every two hours (Gillespie et al., 2020). However, implementing this time-fixed routine in mechanically ventilated patients presents a complex clinical dilemma. Patients receiving positive-pressure ventilation operate under delicate cardiopulmonary mechanics. Positional shifts directly induce profound heart-lung interactions by altering intrathoracic and transpulmonary pressure gradients, systemic venous return (preload), right ventricular filling, pulmonary vascular resistance, and ventilation-perfusion ($\dot{V}/\dot{Q}$) matching (Mahmood & Pinsky, 2018; Roumy et al., 2020). When a ventilated patient is turned laterally, gravitational shifts and changes in thoracic compliance can alter airway resistance and triggering thresholds, occasionally precipitating acute patient-ventilator dyssynchrony, compensatory reflex tachycardia, and abrupt blood pressure fluctuations (Sitepu & Sipayung, 2022; Subiyanto, 2018).

Previous evidence-based studies in critical care nursing have predominantly concentrated on comparing the physiological efficacy of static body postures or specific angular degrees. For instance, literature has extensively debated the distinct advantages of the semi-Fowler position over supine posture in improving tidal volume and oxygenation (Kadek et al., 2023; Puspita, 2019), the discrete benefits of a 30° lateral tilt on oxygen saturation (Aulia et al., 2025; Mustikarani & Mustofa, 2020), or immediate pre-post hemodynamic fluctuations measured within the first 5 minutes post-turn (Subiyanto, 2018). While these studies establish that postural change influences gas exchange, they treat time as a static endpoint rather than a continuous physiological stressor. A critical knowledge gap persists: the time-course tolerance of lateral positioning specifically, how long a critically ill, ventilated patient can safely sustain a repositioned posture before autonomic and cardiorespiratory decompensation is triggered.

Preliminary observations at the ICU of SMC Telogorejo Hospital highlighted this clinical vulnerability. While undergoing routine lateral turns, ventilated patients exhibited prominent shifts in vital parameters such as elevated heart rate, tachypnea, and fluctuations in tidal volumes and blood pressure at intervals far earlier than the mandated two-hour benchmark (frequently emerging between 30 and 60 minutes). This observation underscores that the standard two-hour rule, originally conceived for skin microcirculation in general wards, may be inherently misaligned with the rapid hemodynamic kinetics of critically unstable, ventilated individuals.

The urgency of this investigation lies in the imperative to transition critical care nursing from a generalized, "one-size-fits-all" two-hour turning dogma toward an individualized, safety-guided repositioning protocol. Maintaining a patient in a lateral position beyond their cardiorespiratory threshold risks autonomic distress, hypoperfusion, and respiratory fatigue, whereas turning them prematurely without objective indicators may compromise skin integrity and disrupt nursing workflow. Therefore, this study aims to evaluate the precise impact of repositioning and analyze the correlation between repositioning duration and real-time hemodynamic and respiratory shifts in mechanically ventilated patients in the ICU. The findings are intended to bridge physiological theory and bedside critical care practice, defining safe repositioning timeframes that protect skin viability without jeopardizing cardiopulmonary stability.

METHOD

This study employed a pre-experimental, one-group pretest-posttest design to determine the physiological impacts of repositioning and evaluate the correlation between repositioning duration and cardiorespiratory stability. The investigation was conducted in the adult Intensive Care Unit (ICU) of SMC Telogorejo Hospital, Semarang, Indonesia, from May 1 to May 31, 2024. The target population comprised adult critically ill patients receiving invasive mechanical ventilation in the ICU. A sample of 20 patients was recruited using consecutive non-probability sampling (accidental sampling) based on defined criteria. Inclusion Criteria: 1) Age ≥ 18 years; 2) Intubated and maintained on invasive mechanical ventilation (< 48 hours duration); 3) Hemodynamically stable at baseline (mean arterial pressure ≥ 65 mmHg, baseline heart rate 60-100 without escalating vasopressor requirement); 4) Lightly sedated or calm and cooperative, defined as a Richmond Agitation-Sedation Scale (RASS) score between -1 (drowsy) and 0 (alert and calm); 5) Written informed consent obtained from the patient's legally authorized representative/next of kin. Exclusion Criteria: 1) Deeply sedated or medically paralyzed patients (RASS $\leq$ -2 or receiving continuous neuromuscular blocking agents); 2) Unstable spine, pelvic, or multiple traumatic fractures; 3) Severe burns (> 70% total body surface area); 3) Recent thoracotomy surgery or open chest/abdomen; 4) Neuromuscular junction disorders (e.g., Myasthenia Gravis); 5) Patients undergoing active spontaneous breathing trials (SBT) or immediate post-extubation weaning protocols.

To ensure rigorous inter-rater reliability and procedural consistency, three designated ICU nurse enumerators underwent a structured simulation and training session one month prior to data collection (April 1, 2024). The experimental procedure was conducted as follows: 1) Baseline Assessment (Pre-test): While the patient rested in a baseline semi-Fowler position (30° head of bed elevation), pre-intervention baseline parameters heart rate (HR), non-invasive systolic blood pressure (SBP), diastolic blood pressure (DBP), pulse oxygen saturation (SpO_2), respiratory rate (RR), and exhaled tidal volume (TV) were recorded simultaneously using a calibrated multi-parameter monitor (Philips IntelliVue MP20) and ventilator digital display; 2) Repositioning Maneuver: The patient was gently transitioned into a standardized 30° lateral position (alternating right or left lateral with pillow support under the back and between the knees) according to the institutional ICU Standard Operating Procedure (SOP); 3) Continuous Monitoring & Stopping Criterion: Physiological parameters were continuously tracked. The repositioned posture was maintained until an objective physiological shift occurred (defined as a ≥ 10% deviation in baseline HR or RR, or the onset of autonomic strain), up to a maximum safety ceiling of 120 minutes (2 hours); 4) Post-test Measurement: The exact time elapsed (in minutes) from positioning until physiological alteration was documented as the *repositioning duration*. Immediately upon reaching this threshold, the post-test physiological parameters (HR, SBP, DBP, SpO_2, RR, TV) were recorded on standardized observation sheets prior to returning the patient to a stabilized resting alignment.

Categorical demographic variables were summarized using frequencies and percentages (n, %). Continuous physiological variables and duration were presented as mean, standard deviation (SD), and minimum-maximum ranges. The normality of data distribution was verified using the Shapiro-Wilk test (appropriate for $n < 50$). For paired pre-post comparisons, a Paired t-test was utilized for normally distributed continuous variables, whereas the Wilcoxon Signed-Rank test was employed for non-normally distributed data. To evaluate the relationship between repositioning duration (minutes) and the magnitude of change (Δ = Post – Pre) in each parameter, Pearson's Product-Moment correlation (r) was applied for normal distributions, and Spearman's Rank correlation (r_s) was applied for skewed distributions. Statistical significance was defined at a two-tailed $\alpha = 0.05$ ($p < 0.05$).

This study was performed in accordance with the Declaration of Helsinki and approved by the Health Research Ethics Committee of SMC Telogorejo Hospital (Approval No. 15016/TU.710/KEPK/K/2024). Written informed consent was obtained from all patients' legal guardians prior to enrollment, with full confidentiality assured.

RESULT

Table 1.
Demographic and Clinical Characteristics of Respondents (n = 20)

Characteristics	Category	f	%
Age Group	Adult (18–59 years)	4	20.0
	Elderly (≥ 60 years)	16	80.0
Sex	Male	12	60.0
	Female	8	40.0
Educational Level	Primary School	2	10.0
	Junior High School	7	35.0
	Senior High School	8	40.0
	Higher Education	3	15.0
Employment Status	Civil Servant	1	5.0
	Private Employee	4	20.0
	Entrepreneur	3	15.0
	Unemployed / Retired	12	60.0
Ventilator Duration	< 48 hours	20	100.0
	≥ 48 hours	0	0.0
Comorbid Diagnoses	2 Diagnoses	3	15.0
	3 Diagnoses	9	45.0
	4 Diagnoses	8	40.0
ICU Length of Stay	Short (< 7 days)	15	75.0
	Prolonged (≥ 7 days)	5	25.0

The demographic and clinical profile of the study cohort is detailed in Table 1. The majority of respondents were elderly (≥ 60 years, 80.0%) and male (60.0%). Regarding educational attainment, the largest proportion had completed senior high school (40.0%), and 60.0% of respondents were non-working or retired. All patients (100.0%) were receiving invasive mechanical ventilation for less than 48 hours at the time of data collection. Acute respiratory failure served as the primary intubation etiology in all cases, accompanied by multiple secondary comorbid conditions, with 45.0% having three comorbid diagnoses and 40.0% presenting with four diagnoses. Three-quarters of the cohort (75.0%) had a short ICU length of stay (< 7 days).

Table 2.
Distribution of Repositioning Duration (n = 20)

Variable	Mean	SD	Minimum	Maximum
Repositioning Duration (minutes)	46.75	10.42	30.00	60.00

Repositioning duration was continuously tracked from the initiation of the lateral turn until the objective onset of cardiorespiratory parameter shifts or reaching safety limits. As displayed in Table 2, the mean duration of repositioning was 46.75 ± 10.42 minutes, with values ranging from 30.00 to 60.00 minutes. Fifty percent (50.0%) of respondents demonstrated physiological shifts in < 46.75 minutes, while the remaining 50.0% sustained the position up to or beyond 46.75 minutes before parameter shifts occurred.

Table 3.
Pre- and Post-Repositioning Physiological Parameters and Correlation with Duration (n = 20)

Physiological Parameters	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	Mean Diff. (Δ)	p-value *(Pre-Post)*	Correlation *(r)*	p-value *(Duration)*
Heart Rate (bpm)	89.00 ± 15.45	103.00 ± 18.79	+14.00	0.003*	-0.177	0.456
Systolic BP (mmHg)	119.00 ± 26.65	129.00 ± 23.49	+10.00	0.014*	-0.119	0.617
Diastolic BP (mmHg)	63.00 ± 15.68	67.00 ± 16.10	+4.00	0.006*	0.602*	0.005*
Oxygen Saturation (SpO_2, %)	99.00 ± 0.92	100.00 ± 0.59	+1.00	0.035*	0.147	0.536
Respiratory Rate (breaths/min)	16.00 ± 4.55	27.00 ± 9.01	+11.00	0.000*	0.371	0.108
Tidal Volume (mL)	441.00 ± 64.97	476.00 ± 76.77	+35.00	0.002*	0.342	0.139

* Statistically significant at $p < 0.05$.

Note: Δ = Post-test − Pre-test. Correlation analysis (r) tests the linear association between repositioning duration (minutes) and the magnitude of parameter change (Δ).

A comparative analysis between baseline (pre-test) and post-repositioning parameters demonstrated statistically significant alterations across all evaluated cardiopulmonary metrics ($p < 0.05$), as outlined in Table 3: Heart Rate (HR): Significantly increased from a baseline mean of 89.00 ± 15.45 bpm to 103.00 ± 18.79 bpm (Δ = +14.00 bpm, p = 0.003). Systolic Blood Pressure (SBP): Elevated significantly from 119.00 ± 26.65 mmHg to 129.00 ± 23.49 mmHg (Δ = +10.00 mmHg, p = 0.014). Diastolic Blood Pressure (DBP): Increased from 63.00 ± 15.68 mmHg to 67.00 ± 16.10 mmHg (Δ = +4.00 mmHg, p = 0.006). Oxygen Saturation (SpO_2): Exhibited a slight but statistically significant rise from 99.00 ± 0.92% to 100.00 ± 0.59% (Δ = +1.00%, p = 0.035). Respiratory Rate (RR): Demonstrated a substantial increase from 16.00 ± 4.55 breaths/min to 27.00 ± 9.01 breaths/min (Δ = +11.00 breaths/min, p = 0.000). Exhaled Tidal Volume (TV): Increased significantly from 441.00 ± 64.97 mL to 476.00 ± 76.77 mL (Δ = +35.00 mL, p = 0.002).

Bivariate correlation analyses assessing the relationship between the time elapsed in the lateral position and parameter delta (Δ) revealed: A statistically significant moderate-to-strong positive correlation between repositioning duration and the change in diastolic blood pressure (r = 0.602, p = 0.005). The coefficient of determination ($R^2 = 0.362$) indicated that 36.2% of the variance in diastolic pressure elevation was explained by the length of time spent in the repositioned posture. No statistically significant linear correlations were identified between repositioning duration and shifts in heart rate (r = -0.177, p = 0.456), systolic blood pressure (r = -0.119, p = 0.617), respiratory rate (r = 0.371, p = 0.108), oxygen saturation (r = 0.147, p = 0.536), or tidal volume (r = 0.342, p = 0.139).

DISCUSSION

This study provides critical empirical insights into the physiological consequences of lateral repositioning and the time-course tolerance of mechanically ventilated patients in the Intensive Care Unit (ICU). The primary findings demonstrate that while lateral repositioning induces statistically significant alterations across all monitored hemodynamic and respiratory parameters, the duration of position tolerance before physiological destabilization occurs averages approximately 47 minutes. Furthermore, among all evaluated parameters, only the change in diastolic blood pressure demonstrated a significant positive correlation with the duration spent in the lateral position (r = 0.602, p = 0.005).

Cardiorespiratory Responses to Lateral Repositioning

The implementation of a 30° lateral turn resulted in acute elevations in heart rate (89.00 to 103.00 bpm), systolic blood pressure (119.00 to 129.00 mmHg), and diastolic blood pressure (63.00 to 67.00 mmHg). From a cardiopulmonary physiology perspective, transitioning a critically ill patient from a baseline semi-Fowler posture to a lateral decubitus position fundamentally alters systemic venous return, intrathoracic pressure, and autonomic cardiovascular control (Mahmood & Pinsky, 2018; Roumy et al., 2020). The physical movement and gravitational redistribution of intravascular blood volume induce transient shifts in right ventricular preload and systemic vascular resistance (Fordyce et al., 2020; Jatinugroho & Lontoh, 2021). In critically ill patients particularly the elderly cohort comprising 80% of our sample who inherently exhibit diminished vascular elastance, baroreflex blunting, and multiorgan frailty (Akinosoglou et al., 2023; Damluji et al., 2020; Guidet et al., 2018) postural manipulation triggers a compensatory sympathetic discharge. This autonomic surge manifests as peripheral vasoconstriction and reflex chronotropy to sustain cardiac output and end-organ perfusion pressure against gravitational and mechanical resistance (Gao et al., 2019; Subiyanto, 2018; Takagi et al., 2020).

Concurrently, respiratory parameters demonstrated significant shifts, characterized by increases in exhaled tidal volume (441.00 to 476.00 mL), respiratory rate (16.00 to 27.00 breaths/min), and oxygen saturation (99.00% to 100.00%). The observed improvement in tidal volume and arterial oxygenation aligns with classical respiratory mechanics; lateral tilting promotes alveolar recruitment in dependent lung zones, facilitates the mobilization of dependent secretions, and optimizes regional ventilation-perfusion ($\dot{V}/\dot{Q}$) matching (American Thoracic Society, 2020; Rackley, 2020). These results are consistent with empirical evidence by Mustikarani & Mustofa (2020), who documented significant gains in arterial oxygen saturation following positional therapy in mechanically ventilated and critically ill populations. Furthermore, Puspita (2019) demonstrated that alternating positioning maneuvers enhance lung compliance and oxygenation efficiency, supporting the physiological premise that strategic turning improves alveolar ventilation (Rackley, 2020; Yundari et al., 2023).

However, the dramatic escalation in respiratory rate (an increase of 11 breaths/min, reaching a post-test mean of 27 breaths/min) accompanied by sinus tachycardia (> 100 bpm) warrants rigorous clinical scrutiny. While the increase in tidal volume indicates enhanced chest wall expansion in the non-dependent hemithorax, the marked tachypnea suggests an acute elevation in the work of breathing and potential patient-ventilator dyssynchrony (Rackley, 2020; Tiruvoipati et al., 2020). In non-paralyzed, lightly sedated patients on mechanical ventilation, postural maneuvers can cause subtle mechanical displacement of the endotracheal tube, stimulate reactive tracheal stretch receptors, or provoke nociceptive stimuli, thereby triggering tachypneic compensatory patterns and physical discomfort (Bhadade et al., 2023). These observations resonate with findings by Sitepu & Sipayung (2022) and Kadek et al., (2023) who reported acute respiratory rate and chronotropic escalations immediately following early mobilization and position changes in patients with cardiopulmonary compromise. Critical care clinicians must therefore recognize that physiological shifts following lateral turns reflect not only improved alveolar aeration but also acute metabolic stress and cardiopulmonary compensatory strain (Jarczak et al., 2021a; Martinez et al., 2022).

Duration of Repositioning and the Clinical Conundrum of the Two-Hour Protocol

A pivotal contribution of this study is the characterization of repositioning duration in mechanically ventilated individuals. The mean elapsed time before patients reached objective physiological thresholds requiring reposition termination was 46.75 ± 10.42 minutes (ranging between 30 and 60 minutes). This observation directly challenges the rigid application of the conventional two-hour repositioning interval commonly enforced in clinical settings.

International clinical guidelines on pressure injury prevention universally mandate turning bedridden patients every two hours (Gillespie et al., 2020). However, this historical guideline was primarily established based on dermal capillary closing pressures and skin ischemia thresholds in medically stable populations (Gillespie et al., 2020). In critically ill patients receiving positive-pressure mechanical ventilation, cardiopulmonary reserve is severely compromised by critical illness, acute lung injury, and multiorgan dysfunction (Marshall et al., 2017; Martinez et al., 2022; Shang et al., 2020). Our empirical findings indicate that cardiorespiratory equilibrium begins to destabilize well before the 120-minute mark, with 50% of patients exhibiting instability in under 47 minutes. Maintaining a mechanically ventilated patient in a lateral posture for a fixed two-hour period without dynamic physiological surveillance may inadvertently subject them to prolonged sympathetic overactivation, increased myocardial oxygen consumption, and ventilatory muscle fatigue (Damluji et al., 2020; Mahmood & Pinsky, 2018; Roumy et al., 2020).

The correlation analysis revealed that repositioning duration was significantly correlated only with the magnitude of change in diastolic blood pressure ($r = 0.602$, $p = 0.005$, $R^2 = 36.2\%$). Diastolic blood pressure is primarily governed by systemic vascular resistance (afterload), arterial wall compliance, and sympathetic tone (Gao et al., 2019; Jatinugroho & Lontoh, 2021). As the duration in a lateral posture is sustained, progressive mechanical compression of dependent vascular beds, altered venous return kinetics, and continuous adrenergic stimulation contribute to a time-dependent elevation in systemic vascular tone (Mahmood & Pinsky, 2018; Roumy et al., 2020). Conversely, the lack of significant linear correlation between duration and other parameters (such as heart rate, systolic blood pressure, SpO_2, and tidal volume) suggests that parameter changes occur as threshold-triggered step responses rather than linear gradients over time. Once repositioning is executed, acute autonomic and gas exchange shifts occur rapidly within the initial 30–60 minutes (Subiyanto, 2018), after which the cardiopulmonary system reaches a physiological plateau or signals impending decompensation (Fordyce et al., 2020; Rackley, 2020).

Clinical Implications for Critical Care Nursing

These findings provide compelling evidence for a paradigm shift in intensive care nursing practice transitioning from a rigid, time-mandated turning dogma toward an individualized, response-guided repositioning protocol (Gillespie et al., 2020; Yundari et al., 2023). Rather than keeping a ventilated patient in a lateral position for a predetermined two hours, critical care nurses should integrate dynamic bedside surveillance: 1) Dynamic Hemodynamic Surveillance: Continuously monitor real-time waveforms, heart rate, non-invasive/invasive blood pressure, and respiratory parameters during the first 30–60 minutes following postural changes (Rackley, 2020). 2) Tailored Turning Intervals: If a patient demonstrates sustained tachycardia (HR > 100 bpm), tachypnea (RR > 25 breaths/min), or rising diastolic blood pressure after approximately 45 minutes, nurses should evaluate positional tolerance and consider gentle realignment or smaller angular tilts (e.g., 15°–20°) rather than maintaining a prolonged 30° lateral decubitus position (Gillespie et al., 2020; Subiyanto, 2018). 3) Comprehensive Comfort and Sedation Management: Ensure adequate pain control and sedation depth assessment prior to repositioning maneuvers to prevent pain-induced sympathetic surges, tracheal irritation, and patient-ventilator dyssynchrony (Bhadade et al., 2023).

Study Limitations

Several methodological limitations must be acknowledged: 1) Sample Size and Design: The study utilized a single-center, pre-experimental design without a randomized control group and with a relatively modest sample size (n = 20), which limits the broad generalizability of the findings across heterogeneous ICU populations. 2) Uncontrolled Ventilator Settings: Specific mechanical ventilation modes (e.g., volume-control versus pressure-support), positive end-expiratory pressure (PEEP) titration, and fraction of inspired oxygen (FiO_2) levels were not rigidly controlled across subjects, potentially introducing confounding variability in tidal volume and oxygenation responses. 3) Sedation Depth and Pain Scoring Granularity: While patients met baseline eligibility criteria of being calm or lightly sedated, continuous standardized pain scores (e.g., CPOT) and dynamic sedation monitoring were not concurrently documented during the repositioning intervals. Future investigations should employ randomized crossover trials incorporating continuous invasive arterial line monitoring, esophageal pressure manometry, and validated comfort assessment tools to further delineate positional tolerance kinetics.

CONCLUSION

This study demonstrates that lateral repositioning significantly alters hemodynamic and respiratory parameters in mechanically ventilated patients in the ICU. While positional maneuvers facilitate alveolar ventilation and discrete oxygenation improvements, they concurrently induce acute autonomic and metabolic stress, evidenced by compensatory tachycardia and tachypnea. Crucially, mechanically ventilated patients exhibit a physiological tolerance limit to lateral positioning averaging approximately 47 minutes before cardiorespiratory instability ensues. The duration sustained in a lateral position demonstrates a significant positive correlation with increases in diastolic blood pressure, reflecting progressive systemic vascular resistance and adrenergic tone over time. These findings challenge the universal application of the traditional two-hour turning schedule, highlighting that rigid time-fixed protocols may inadvertently exceed the cardiopulmonary reserves of critically ill, ventilated patients.

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