Original Research Article

Haemodynamic Responses to Physiotherapy in Mechanically Ventilated Critically Ill Patients: A Prospective Observational Study.

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Abstract:

Physiotherapy is a crucial component in the management of critically ill patients on mechanical ventilation. However, concerns regarding its impact on haemodynamic stability remain a limiting factor in its routine application. Objectives: To evaluate the haemodynamic changes occurring during and after physiotherapy sessions in mechanically ventilated critically ill patients. Methods: A prospective observational study was conducted on 100 critically ill patients on mechanical ventilation in the intensive care unit. Standard physiotherapy interventions including positioning, chest percussion, vibration, and endotracheal suctioning were administered. Heart rate, mean arterial pressure, oxygen saturation, and respiratory rate were recorded pre-, during, and post-physiotherapy. Results: Significant but transient changes in haemodynamic parameters were observed during physiotherapy, with a return to baseline values within 15 minutes post-intervention. There was a mild increase in HR and RR, and a slight decrease in SpO_2 and MAP during interventions. No adverse events or sustained haemodynamic instability were reported. Conclusion: Physiotherapy can be safely administered to critically ill, ventilated patients with minor and self-limiting haemodynamic changes. Regular monitoring is essential to ensure patient safety during these interventions.

Keywords: Mechanical ventilation, Physiotherapy, Haemodynamics, Critical care, Intensive care, Chest physiotherapy

Introduction:

Mechanical ventilation is commonly used in the management of critically ill patients to support or replace spontaneous breathing. However, prolonged mechanical ventilation can lead to complications such as atelectasis, secretion retention, ventilator-associated pneumonia, and overall deconditioning.[1,2] Physiotherapy in the ICU setting aims to mitigate these complications through mobilization, secretion clearance, and enhancement of respiratory mechanics. Despite these known advantages, concerns over the haemodynamic effects of physiotherapy often limit its use, particularly in patients perceived as unstable. Some interventions, especially chest physiotherapy and suctioning, are believed to transiently affect blood pressure, heart rate, and oxygen saturation. These effects have not been comprehensively studied in a real-world clinical setting, particularly with standardized physiotherapy protocols.[3,4] Therefore, this study was undertaken to evaluate the haemodynamic responses to routine physiotherapy in critically ill, mechanically ventilated patients, with the objective of determining the safety and tolerance of these procedures in such a population.

Materials and Methodology:

After obtaining ethical clearance, this prospective observational study was conducted in the medical intensive care unit (ICU) of a tertiary care hospital for a period of 10 months. A total

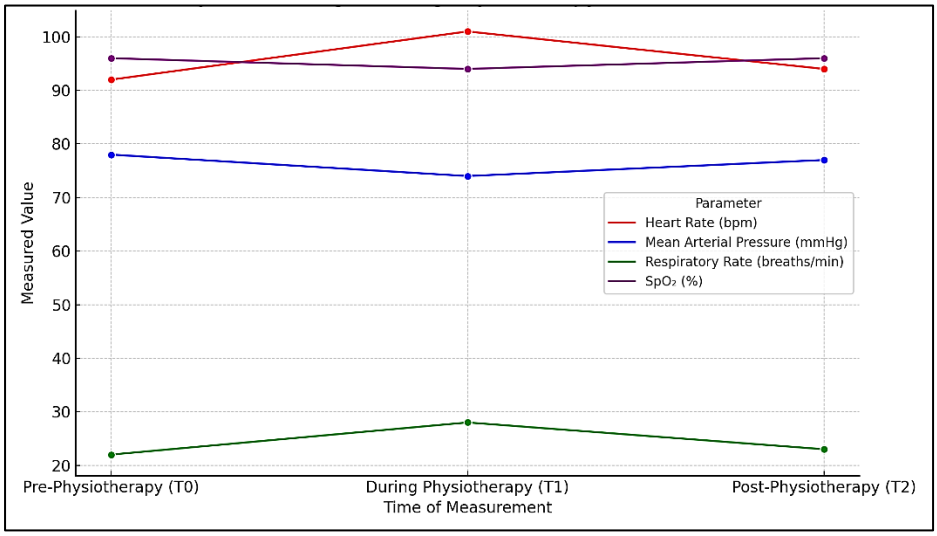
of 100 adult patients on mechanical ventilation for more than 24 hours were enrolled. Inclusion criteria comprised adult patients (age ≥18 years) who were haemodynamically stable, either without or on a steady dose of vasopressor support, and who were receiving routine physiotherapy as part of ICU care and on invasive blood pressure monitoring. Patients were excluded if they had unstable haemodynamic requiring escalating vasopressor doses, recent myocardial infarction or stroke, high intracranial pressure, or a do-not-resuscitate status.

Physiotherapy sessions were provided once per shift by experienced ICU physiotherapists. Interventions included patient repositioning, chest percussion and vibration, passive and active-assisted range-of-motion exercises, and endotracheal suctioning when indicated. The total duration of each session ranged between 20 and 30 minutes. Haemodynamic parameters including heart rate (HR), mean arterial pressure (MAP), respiratory rate (RR), and peripheral oxygen saturation (SpO_2) were recorded at three specific intervals: 5 minutes before physiotherapy (T0), during the peak of physiotherapy (T1), and 15 minutes after the session (T2). Data were analyzed using repeated measures ANOVA to compare values at the three time points, and a p-value of less than 0.05 was considered statistically significant.

Results:

The study included 100 patients, with a mean age of 58.6 years (±14.2), comprising 60 males and 40 females. The primary diagnoses among the participants were sepsis (30%), acute respiratory distress syndrome (25%), post-operative care (20%), neurological conditions such as stroke or traumatic brain injury (15%), and other miscellaneous causes (10%). All patients received a standardized physiotherapy session during the study period.

Haemodynamic monitoring revealed that during physiotherapy (T1), there was a statistically significant but clinically tolerable increase in heart rate and respiratory rate. Mean HR increased from 92 ± 10 bpm at T0 to 101 ± 12 bpm at T1, returning to 94 ± 9 bpm at T2. Respiratory rate similarly rose from 22 ± 4 breaths/min to 28 ± 5 during intervention and normalized to 23 ± 4 post-session. Mean arterial pressure decreased slightly from 78 ± 6 mmHg at baseline to 74 ± 7 mmHg during physiotherapy, returning to 77 ± 5 mmHg afterward. SpO_2 showed a minor drop from 96 ± 2% to 94 ± 3% during treatment, which resolved to 96 ± 2% post-procedure. No major adverse events such as sustained desaturation, hypotension, arrhythmias, or unplanned extubation were reported.



Graph 1: Haemodynamic parameter trends before, during, and after physiotherapy

Haemodynamic Parameter	Pre-Physiotherapy (T0)	During Physiotherapy (T1)	Post-Physiotherapy (T2)	p-value (Repeated Measures ANOVA)
Heart Rate (bpm)	92	101	94	< 0.01
Mean Arterial Pressure (mmHg)	78	74	77	< 0.01
Respiratory Rate (breaths/min)	22	28	23	< 0.01
SpO_2 (%)	96	94	96	< 0.05

Table 1: Hemodynamic parameters recording in pre, during and post physiotherapy.

The analysis of haemodynamic parameters revealed statistically significant changes in response to physiotherapy in mechanically ventilated patients. The heart rate showed a notable increase during physiotherapy compared to baseline, with values rising from a pre-therapy mean of 92 bpm to 101 bpm during the session, before settling to 94 bpm post-therapy. The p-value for heart rate changes was found to be less than 0.01, indicating a statistically significant variation. This suggests that physiotherapy induces a mild cardiovascular response, likely due to physical exertion or stimulation, even in critically ill patients.

Similarly, mean arterial pressure (MAP) exhibited a significant decrease during physiotherapy, dropping from 78 mmHg pre-therapy to 74 mmHg, before partially recovering to 77 mmHg post-session. With a p-value of less than 0.01, this change is statistically significant and clinically relevant. It highlights the need for monitoring perfusion parameters during physical interventions, as transient hypotensive responses may occur, especially in hemodynamically unstable individuals.

Respiratory rate also increased significantly during physiotherapy, rising from a mean of 22 breaths per minute at baseline to 28 during therapy, and subsequently returning to 23 breaths per minute post-intervention. The p-value was again below 0.01, confirming a significant physiological response. This increase is consistent with the increased respiratory demand and workload associated with therapeutic mobilization and airway clearance techniques.

In contrast, the oxygen saturation (SpO_2) showed a modest decline during physiotherapy—from 96% pre-intervention to 94%—which returned to baseline post-therapy. The associated p-value of less than 0.05 indicates that even this slight change was statistically significant. Although the decrease was within clinically acceptable limits, it underlines the importance of continuous oxygenation monitoring during physiotherapy, particularly in patients with limited respiratory reserves.

Overall, the statistically significant changes observed in heart rate, mean arterial pressure, respiratory rate, and oxygen saturation suggest that physiotherapy induces a temporary but measurable haemodynamic response in critically ill ventilated patients. These responses, while

transient and generally well-tolerated, emphasize the need for vigilant monitoring during physiotherapeutic interventions in the intensive care setting.

Discussion:

Physiotherapy in the intensive care unit (ICU) plays a critical role in preventing the complications of immobility, promoting airway clearance, and enhancing overall respiratory function. However, when administered to mechanically ventilated patients, especially those who are hemodynamically unstable or critically ill, physiotherapeutic interventions can lead to transient physiological stress. [5-8] The present study aimed to evaluate the haemodynamic responses—specifically changes in heart rate, mean arterial pressure, respiratory rate, and oxygen saturation—during and after physiotherapy in ventilated ICU patients.

The results demonstrated statistically significant changes in all measured haemodynamic parameters. Heart rate increased significantly during physiotherapy sessions, with a mean rise from 92 bpm at baseline to 101 bpm. This increase is consistent with previous studies suggesting that passive and active mobilization, chest physiotherapy, and other stimulation during treatment can induce sympathetic nervous system activation. The elevated heart rate is a physiological response to increased metabolic demand and catecholamine release. [9-13] However, the return of heart rate to near-baseline values post-therapy supports the transient and generally tolerable nature of this change in most patients.

Mean arterial pressure (MAP) showed a slight but statistically significant decrease during physiotherapy, from a baseline average of 78 mmHg to 74 mmHg. While this drop remained within clinically acceptable ranges, it suggests that certain physiotherapy techniques, particularly those involving positioning or mobilization, can transiently affect venous return and systemic vascular resistance. These effects may be more pronounced in patients who are hypovolemic or on vasopressor support, indicating the need for individual assessment before initiating therapy. [14,15] Despite the decrease, MAP values largely returned toward baseline post-procedure, suggesting that the haemodynamic impact is short-lived.

The respiratory rate (RR) increased significantly during physiotherapy, from 22 to 28 breaths per minute, indicating an increase in ventilatory demand. This response is expected, as physiotherapy often includes deep breathing exercises, manual techniques to aid secretion clearance, and mobilization—all of which can elevate respiratory workload. The post-session return to baseline RR indicates that this response is manageable and does not lead to sustained respiratory distress in appropriately selected patients.

Oxygen saturation (SpO_2) showed a minor but statistically significant decrease during therapy, dropping from 96% to 94%. This decline, although small, may reflect temporary ventilation-perfusion mismatch or increased oxygen consumption during activity. Importantly, SpO_2 levels returned to baseline shortly after the intervention, suggesting no long-term compromise in oxygenation. Nevertheless, in patients with marginal oxygen reserves, such as those with severe ARDS or underlying pulmonary disease, even slight desaturation may be clinically significant and warrants close monitoring.

The findings of this study are consistent with previous literature that emphasizes the safety of physiotherapy in ICU settings when administered judiciously. Several studies have shown that while physiotherapy may transiently alter haemodynamic parameters, it rarely results in adverse outcomes when patients are appropriately screened and monitored. [16,17] These results underscore the importance of individualized assessment prior to physiotherapy, especially in

patients receiving high levels of ventilator support, vasoactive medications, or those with unstable cardiovascular status.

A strength of this study lies in its sample size of 100 patients, which provides a reasonable basis for generalization within ICU settings. However, the lack of stratification based on disease severity, ventilator mode, and physiotherapy technique may limit the ability to identify specific subgroups at higher risk of adverse haemodynamic changes. Moreover, the study utilized mean values rather than patient-level longitudinal data, which might mask inter-individual variability in responses.

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