Hemodynamic Instability: Is It Really a Barrier to Turning Critically Ill Patients?
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Hemodynamic Instability: Is It Really a Barrier to Turning Critically Ill Patients?

Please give us the guidelines on turning and repositioning hemodynamically unstable patients, patients with an intra-aortic balloon pump, and patients receiving vasopressors.

Kathleen M. Vollman, RN, MSN, CCNS replies:

Specific studies that address the direct questions of how and with what frequency to turn and reposition critically ill patients with hemodynamic instability, whether the patients are receiving vasoactive medications or intra-aortic balloon pump therapy, have not been published. However, a body of evidence is available from which inferences can be made to develop recommendations for safely turning and repositioning hemodynamically unstable patients.

The evidence comes from 3 areas. The first area describes the impact of prolonged bed rest and/or space flight research where bed rest was used to simulate weightlessness and the effect that motion has on the cardiovascular system in healthy adults, elderly persons, and patients with diabetes. The second area is research performed on coronary bypass patients and other critically ill patients that examines the impact of a lateral turn and dangling the patient’s legs on cardiovascular response and recovery. The third body of evidence is the most recent and includes studies of early mobility in critically ill patients that included data on feasibility, safety, and processes of care.

Cardiovascular Response to Bed Rest and Posture Change

Critically ill patients spend a significant amount of time in bed. The changes in the cardiovascular system related to bed rest are significant. The act of lying down shifts 11% of the total blood volume away from the legs, with most going to the chest. Within the first 3 days of bed rest, an 8% to 10% reduction in plasma volume occurs, with the loss stabilizing to 15% to 20% by the fourth week. These changes result in increased cardiovascular workload, elevated resting heart rate, and a decrease in stroke volume with a reduction in cardiac output.

The heart muscle deconditions with bed rest. A recent study demonstrated that cardiac atrophy occurs during prolonged bed rest related to the physiological adaption to reduced myocardial load and work. In healthy persons on 5 days of bed rest, insulin resistance and microvascular dysfunction are seen. Orthostatic tolerance deteriorates rapidly with immobility, with the maximum effect seen at 3 weeks. Baroreceptor dysfunction, changes in autonomic tone, and fluid shifts are thought to be the cause. Bed rest lessens carotid-cardiac baroreflex...
responsiveness, contributing to postural hypotension and tachycardia as a result of reductions in stroke volume and cardiac output.8,9 Head motion alone can reduce cardiac reflex response to central stimulation of the carotid baroreceptors by 30%.8 Low vasoconstrictive reserve can occur because of the hypovolemia and lead to a lower capacity to buffer orthostatic changes.9,10

Researchers recently examined whether the dysfunction in the baroreceptors that occurs with bed rest is due to hypovolemia or is a unique adaptation of the autonomic nervous system to bed rest deconditioning. The results showed that the abnormality was partially normalized by plasma volume restoration.12 The baroreceptor mechanism plays a critical role in adaptation to posture change, and the adaptation is performed in concert with vestibular or inner ear response. The vestibular system has an important sympathetic and parasympathetic influence in the regulation of cardiovascular function during movement and change in posture. Removal of vestibular input in an animal model affects regulation of blood pressure during gravitational changes.17 Full-body rotational stimulation of the inner ear can induce hypotension primarily associated with relaxation of vasoconstriction (parasympathetic influences).16,18

Hemodynamic instability may occur for many reasons. The critically ill patient may start out with poor vascular tone, a dysfunctional autonomic feedback loop, and/or low cardiovascular reserve.17 The patient’s illness and how care is structured may lead to an imbalance of oxygen supply and demand, creating a situation where any care activity (demand) overstretches supply, creating instability.20,22 As we age, the responsiveness of our autonomic nervous system to gravity-related fluid shifts is diminished, placing us at higher risk for cardiac instability. This response may be in part related to an impaired baroreflex function that causes inappropriate autonomic response.23,24 Critically ill patients with a history of diabetes may be at a higher risk for hemodynamic instability. Autonomic dysfunction increases as diabetic complications worsen.25

Another reason for hemodynamic instability in critically ill patients can be inferred from the research on gravity and space flight. Cardiovascular instability during a position change is often seen after patients spend prolonged lengths of time in a stationary position. When people change their gravitational reference from a lying to sitting position, the body goes through a series of physiological adaptations to maintain cardiovascular homeostasis.26 Critically ill patients may experience a similar adaptation when turning laterally, dangling the legs, or standing. With changes in gravitational plane (position change), the stretch receptors read the shift in plasma volume, the inner ear responds, and information is sent to the autonomic nervous system to adapt accordingly.19

With prolonged bed rest, a number of the normal compensatory mechanisms to posture change are disrupted.20,21 Astronauts, as an example, must be able to adapt to changes in gravitational planes in order to maintain an effective circulating volume while in space. Extensive training occurs to ensure tolerance of gravitational changes on carotid-cardiac baroreflex and vestibular response. This training ensures that the astronauts experience cardiovascular adaptation when in space (see Figure).

A similar concept may apply with critically ill patients who have hemodynamic instability (regardless of whether they are taking vasopressors) that occurs with a manual turn. If we train patients to turn, thus preventing "prolonged gravitational...

\[\text{Figure} \quad \text{Impact of bed rest on the cardiovascular system.} \quad \text{Adapted from Convertino;12 with permission.}\]
equilibrium” or remaining in a stationary position for extended periods, less instability with position changes may result. Commonly, patients are unstable when turned after long intervals in a stationary position in the operating room, intensive care unit (ICU), emergency department, and computed tomography scanner, regardless of whether the patient is having vasoactive agents infused. Such patients may benefit from a course of training using continuous rotational therapy.

As stated earlier, the vestibular system influences many components of the autonomic nervous system’s adaptation to posture change. A manual turn is usually accomplished rapidly, making vestibular adjustment much more difficult. Rotational therapy can gradually retrain patients to tolerate turning or we can slow down the patients’ movement during the mobility technique to allow adaptation and increase the frequency.

**Response and Recovery From a Lateral Turn or Dangling Legs of Critically Ill Patients**

The second body of evidence is drawn from observing the response of mixed venous oxygen saturation (SvO₂) to position change in patients recovering from open heart surgery and the effect of mechanical ventilation on cardiovascular response during position change. SvO₂ is an indirect reflection of the relationship between oxygen supply and demand.

Researchers in several studies have examined the impact of a lateral turn on SvO₂ in coronary bypass graft patients and other critically ill patients with and without vasoactive medications. A mean decrease in SvO₂ of 8% to 11% immediately after position change that returned to baseline within 5 minutes was reported. In some studies, the reduction was as high as 22% in patients with low cardiac reserve.

Gawlinski and Dracup studied the effect of positioning on SvO₂ in critically ill patients with ejection fractions less than 30%. They found statistically significant differences in SvO₂ among all 3 positions (left, right, supine). The greatest difference occurred within the first 4 minutes after the position change and also in the left lateral position. A stepwise regression analysis showed that oxygen consumption (demand) accounted for a greater amount of the variance in SvO₂ during position change than oxygen delivery (supply).

Skeletal muscle movement causes an increase in peripheral use of oxygen that is reflected in the SvO₂. Similar results have been demonstrated when initiating the dangling posture in critically ill patients. In the most recent study, Price examined the impact of sitting on the side of the bed on heart rate, blood pressure, SvO₂, and oxygen saturation in 55 men who had undergone coronary artery bypass surgery. The results showed that most patients experienced an increase in heart rate, decreased blood pressure, and a reduction in SvO₂ that returned to baseline levels (for supine position) within 10 minutes.

Patients receiving mechanical ventilation have additional factors that may influence the supply side of the supply/demand equation. Relative hypovolemia can occur with positive pressure ventilation, as a result of a reduction in venous return relative to an increase in intrathoracic pressure. The addition of positive end-expiratory pressure can worsen that effect. In one study, the impact on size and shape of the inferior vena cava was examined in response to position change in people without cardiac disease. The results showed a decrease in vessel diameter and area in both lateral positions versus the vessel dimensions in supine patients. The smallest diameter of the inferior vena cava occurred when persons were in the left lateral position. This finding is most likely due to the greater number of structures within the thoracic cavity that may create a larger compression effect while the person is in the lateral position.

Critically ill patients are hemodynamically affected by a position change. These effects can be mitigated by the careful planning of nursing care activities to reduce excess oxygen demand on the patient outside of the demand that will occur during a position change. By allowing for physiological rest before an increase in oxygen demand, the ability to tolerate the activity increases. The evidence supports that most of the hemodynamic instability is transient. To balance the risk and benefits of turning critically ill patients, the care should include the following steps: determining the timing of the position change in relation to other care activities, monitoring for tolerance after 5 to 10 minutes in a new position, and (if the left lateral position is used) being aware of the potential for greater cardiovascular compromise necessitating a temporary decision to keep the patient supine or in the right lateral position.
Feasibility, Safety, and Processes of Care

Additional challenges for in-bed mobilization of critically ill patients include concerns about the safety of the endotracheal tube, catheters, and other invasive devices; amount of personal and equipment resources needed; the patient’s size, pain, and discomfort; and the time, valuing, and priority of turning and repositioning.38-42

Studies that provide direction on how to safely turn and position patients with an intra-aortic balloon pump in place are lacking. The hemodynamic concerns are similar to the concerns in patients with low cardiac reserve. The structural goal in positioning patients with an intra-aortic balloon pump is to prevent kinking of the device during turning. The use of log rolling and foam wedges to hold the body in alignment has been suggested.43,44

Winkelman and Peerboom41 conducted 49 separate interviews with 33 nurses identifying barriers and facilitators to mobility of patients in and out of bed. From the 49 activity descriptions, 41 related to in-bed activity. Fifty-nine percent of the nurses stated safety concerns about the activity, whereas 46% stated that low respiratory and energy reserves were also a part of the decision not to perform in-bed mobilization. Thirty-four percent of the nurses stated safety issues, which included loss of tubes or catheters and potential injury of the patient or staff. The authors reported that the number of staff, presence of physical therapy or nursing assistants, and the admitting diagnosis were not associated with the success of mobilization. What facilitated success with in-bed or out-of-bed mobilization was the presence of a protocol, Glasgow coma score greater than 10, beds that provided a chair position, or a physician’s order.

Safety regarding the activity event and the patient’s ability to hemodynamically tolerate the movement may be the most significant. A prospective cohort study46 of 103 patients receiving mechanical ventilation helped to evaluate the safety of mobilizing critically ill patients. During the study, 1449 activity events were performed and the percentage of adverse events was recorded. The activity events included sitting on the bed, sitting in the chair, and ambulating. The adverse events were defined as fall to the knees, catheter/tube removal, systolic blood pressure exceeding 200 mm Hg, systolic blood pressure less than 90 mm Hg, oxygen desaturation less than 80%, and extubation. The results showed adverse events in less than 1% of patients, and 69% of the patients ambulated at least 100 feet (30 m) at discharge from the respiratory care ICU.46 This study was conducted on critically ill patients who had received 4 days or more of mechanical ventilation. Can those same safety results be seen mobilizing patients with in-bed and out-of-bed activity in less than 24 hours of intubation?

Pohlman and colleagues48 examined the feasibility of early physical and occupational therapy on 49 patients receiving mechanical ventilation within a mean of 1.5 days from intubation. At least one of the common barriers to in-bed or out-of-bed mobility (eg, the presence of acute lung injury, vasoactive infusions, delirium, continuous renal replacement therapy, or a body mass index exceeding 30) was present in 89% of all activity encounters. Mobilization was interrupted prematurely only 4% of the time, and causes included agitation and ventilator asynchrony. The patients were able to perform upper and lower extremity exercises 85% of the time, side-to-side movement in 76% of all sessions, and sitting on the edge of the bed 69% of the time. Fifty-three percent of the patients had a positive ICU delirium score, and the patients’ fraction of inspired oxygen was greater than 60% in 35% of all sessions. Seventeen percent of patients were having 1 vasoactive agent infused, and 14% were receiving infusions of 2 or more vasoactive agents during in-bed or out-of-bed mobility sessions.

Adverse events occurred in 16% of all sessions and included desaturation of more than 5% in 6% of patients, increase in heart rate exceeding 20% in 4.2% of patients, ventilator asynchrony in 4% of patients, agitation in 25%, and device removal (not life threatening) in 0.8%. During the therapy session, most patients had 1 central venous catheter (75%), the presence of acute lung injury (58%), and delirium (53%). This study affirms that it is safe and feasible to perform in-bed and out-of-bed mobilization very early in a patient’s ICU stay despite physiological and structural challenges.

Safety can be ensured and the risk of hemodynamic instability can be reduced while turning and
repositioning a critically ill patient through inferences made from the evidence.45-46 The following are recommendations for turning and repositioning a critically ill patient with or without a vasoactive infusion or the presence of an intra-aortic balloon pump.

1. Critically ill patients who are older, with comorbid conditions such as diabetes and preexisting cardiac disease and/or the presence of vasoactive agents, will be at greater risk for not tolerating in-bed mobilization. It is critical that the nurse assess the risk factors and plan when activity will occur to allow sufficient physiological rest to meet the oxygen demand that positioning will place on the body. A clinician may also choose to preoxygenate before position change to increase the oxygen supply side. When positioning these high-risk patients, the right lateral position should be used initially to prevent the hemodynamic challenges reported with use of the left lateral position. Last, consider reducing the speed of the turn to minimize the influence of inner ear changes on cardiovascular response.

2. Prevent prolonged gravitational equilibrium by initiating a turning schedule within hours of admission to the ICU. Prolonged periods in a stationary position result in greater hemodynamic instability when the patient is turned.

3. Toleration of a position change should not be assessed for 5 to 10 minutes after a position change.

All the evidence indicates that critically ill patients require this amount of time to equilibrate to the new position.

4. If the patient does not tolerate manual turning using the just-stated recommendations, as evidenced by a sustained decrease in blood pressure and oxygen saturation and/or an increase in heart rate, the patient should be returned to the supine position and the nurse should consider the use of continuous lateral rotational therapy in an effort to train the patient’s body to tolerate side-to-side movement. Continuous lateral rotation therapy should be managed by a protocol.

Significant problems are created for ICU patients when they are not mobilized effectively. The solution rests in increasing the awareness of the importance of early mobilization both in bed and out of bed. We must shift the ICU culture from one in which patients are on bed rest and not moving as the norm, to one in which mobilization enables the prevention of complications and faster healing and recovery.49 In-bed mobility is a fundamental nursing activity that requires knowledge and skill to apply effectively and succeed in mobilizing hemodynamically unstable critically ill patients. CCN

References


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