IN-HOSPITAL TRANSPORT OF THE CRITICALLY ILL

SUMMARY
The critically ill patient may require transport from the intensive care unit (ICU) to the operating room, radiology suite, or other patient care area for either diagnostic testing or therapeutic interventions. Transport can represent a significant risk to the critically ill mechanically ventilated patient and must be carefully considered in the context of the anticipated benefit to the patient of the transport. During any such transport, every attempt should be made to maintain an equivalent level of patient care and monitoring in order to reduce transport-associated morbidity and mortality.

RECOMMENDATIONS

Level 1
- None

Level 2
- A critical care nurse and a respiratory therapist should accompany all ICU patient transports with a physician present as clinically indicated by the patient’s severity of illness.
- The level of monitoring and support the patient receives in the ICU and during transport should be equivalent.
- Patients with stable oxygenation and ventilation may be transported using a manual resuscitation bag (i.e., “Ambu-bag”) and reattached to a mechanical ventilator at their destination. Care should be taken to maintain the same minute ventilation that was determined to optimize arterial carbon dioxide tension in the ICU.
- The following patients should be transported on an appropriate transport ventilator:
  - Any patient whose clinical condition requires stable oxygenation and ventilation (such as the head injured or acute lung injury patient)
  - Any patient where adequate arterial oxygenation is dependent upon maintenance of a specified level of positive end-expiratory pressure (PEEP)
  - Any patient with an anticipated transport time of greater than 10 minutes
  - Any patient at the attending physician’s discretion
- Patients with head injury should be transported with their head maintained at the same degree of elevation as in the ICU.

Level 3
- All patients requiring PEEP of $\geq 15$ cm H$_2$O or those patients on inverse ratio ventilation should be transported using an appropriate transport ventilator.
- Patients with severe acute lung injury or those who require PEEP $\geq 15$ cm H$_2$O should be maintained on their ICU mechanical ventilator while in the operating room.

INTRODUCTION
The critically ill patient may require transport from the ICU to other patient care areas within the hospital to further their care and management. This may include transfer to the operating room for either initial or ongoing surgical procedures or to the radiology suite or other patient care area for diagnostic testing or therapeutic interventions. The transport phase represents a period of potential cardiopulmonary instability for such patients (1-10). The ability to both continuously monitor and provide appropriate uninterrupted patient care during such transports is essential.
Tests performed outside of the protected and stable environment of the ICU should be kept to a minimum where possible (1,2,5). The decision to transport a critically ill patient to another patient care area should be made after carefully weighing the potential benefits of the test or intervention against the potential hazards of transport and the frequently low yield of such studies (1-3,9). If the test or procedure is unlikely to alter the course or management of the patient positively, the need to move the patient must be questioned and alternative bedside tests or procedures considered (1-3,10).

During transport, 20-75% of critically ill patients have been demonstrated to develop potentially life-threatening complications such as new cardiac arrhythmias, systemic hypo- or hypertension, hypoxemia, hypo- or hypercarbia, or intracranial hypertension (3,5). The development of such complications places the patient at increased risk for myocardial or cerebral ischemia and even death. The occurrence of such complications has been correlated with development of arterial blood gas abnormalities during transport (5,6,10). In many institutions, intubated patients are ventilated using a manual resuscitation bag (“Ambu-bag”) due to their simplicity, portability, and reliability. Multiple studies show, however, that consistent, uninterrupted ventilation is difficult to maintain in the distraction-filled transport environment as patients are moved through doorways, elevators, and onto computed tomography (CT) scanner or other procedural tables (5,6,8). In an attempt to avoid potentially dangerous hypoxia and hypercarbia due to under-ventilation, caregivers tend to over-compensate causing equally detrimental hypocarbia and respiratory alkalosis (5,6,8). The patient with acute respiratory failure who requires advanced mechanical ventilatory support using positive-end expiratory pressure (PEEP), pressure-controlled ventilatory modes, inverse-ratio ventilation, or other sophisticated pressure, flow, or volume delivery techniques may not tolerate even a brief interruption of high-level mechanical ventilatory support. Even the simple maneuver of transferring a patient from one bed to another can result in significant, protracted, and occasionally irreversible, cardiopulmonary dysfunction.

When in-hospital transport is deemed necessary and the benefit to the patient clearly outweighs the potential risks involved, every attempt should be made to adequately resuscitate and stabilize the patient prior to transport (1-3,7). Careful coordination with the patient's destination should be performed to prevent delays and prolonged transport times. Appropriate monitoring, resuscitation equipment, and medications should be procured based upon the anticipated need and duration of the planned transport. Both a critical care nurse and a respiratory therapist should accompany the patient on every transport; the addition of an appropriate physician should be considered based upon the patient's severity of illness. For patients in whom stable alveolar ventilation is crucial, a portable end-tidal carbon dioxide monitor or Wright’s spirometer attached to the manual resuscitator should be employed (5,6). In the severely ill who are most sensitive to changes in arterial oxygen and carbon dioxide tension, maintenance of stable alveolar oxygenation and ventilation using an appropriate portable transport ventilator appears to be prudent (5,6,8).

LITERATURE REVIEW

Braman et al. prospectively studied the occurrence of hemodynamic and respiratory complications in 32 adult medical or surgical ICU patients requiring transport to another area of the hospital (5). Patients were ventilated using either a manual resuscitation bag (“Ambu-bag”) or a portable transport ventilator. 75% of patients who were manually ventilated demonstrated clinically significant physiologic changes during transport while only 44% of patients on a transport ventilator developed similar changes. Although not statistically significant, such changes demonstrate that both hemodynamic and respiratory physiology is more labile with manual ventilation in the critically ill. The majority of patients demonstrated evidence of either under- or over ventilation during transport despite administration by a “trained respiratory therapist” (Class II)

Gervais et al. evaluated manual vs. mechanical ventilation during in-hospital transport in a prospective, randomized manner (6). Manual ventilation during patient transport without controlling minute ventilation, through use of either a spiromter on the manual resuscitator or a transport ventilator, was shown to result in a statistically higher incidence of unintended, potentially detrimental, hypocarbia (Class I).
Andrews et al. prospectively studied 50 head-injured patients requiring in-hospital transport (7). 51% of patients demonstrated evidence of significant arterial hypertension, arterial hypotension, intracranial hypertension, or hypoxia during transport. 87% of patients with physiologic abnormalities post-transport demonstrated similar instability in the four hours pre-transport. This finding suggests that pre-transport instability may be used to identify patients who are at increased risk for developing transport-related complications (Class II).

Dockery et al. evaluated manual vs. mechanical ventilation during pediatric transport in a prospective, randomized manner (8). Manual ventilation resulted in a statistically greater amount of variation in ventilatory parameters compared to mechanical ventilation using a transport ventilator. During brief transports that ranged from 8 to 12 minutes, end-tidal carbon dioxide tensions during manual ventilation were noted to be significantly lower than at baseline when compared to patients on mechanical ventilation (Class I).

Hurst et al. prospectively studied the impact of transport on 100 consecutive mechanically ventilated patients (9). Only 39% of transports resulted in diagnostic tests that led to a change in patient management within 48 hours. Abdominal CT scanning (51%) and angiography (57%) were associated with the highest percentage of tests leading to a management change. During 28% of transports, the loss of ICU staff required that nurses be “pulled” from other critical care areas to cover the staffing deficit (Class II). Rizzo et al. identified similar findings in a prospective evaluation where only 29% of CT scans were found to provide clinically useful information (Class II) (11).

Waydas et al. prospectively studied 49 in-hospital transports in 28 consecutive, critically ill patients who were maintained on a portable ventilator during transport (10). 84% of transports resulted in a deterioration of respiratory function (described as “considerable” in 43%) as evidenced by a decrease in PaO₂/FiO₂ ratio. This decrease required an increase in FiO₂ in 61% and an increase in PEEP in 25%. In 20% of patients, the reduced PaO₂/FiO₂ ratio was still present > 24 hours post-transport. A pre-transport PEEP requirement was the only variable that was significantly correlated with a post-transport change in PaO₂/FiO₂ ratio suggesting that patients with acute lung injury requiring PEEP therapy represent a population of patients at increased risk for transport-related complications (Class II).

Indeck et al. prospectively evaluated 103 consecutive patient transports identifying 113 “serious” hemodynamic or respiratory physiology changes that required an increase in support during the transport (12). Only 24% of the transports resulted in a change in the patient’s management over the subsequent 48 hours (Class II).

Szem et al. performed a prospective, cohort-matched study of 759 surgical patients requiring in-hospital transport (13). They classified patients as being at either low-risk or high-risk (PEEP > 5 cm H₂O or continuous dobutamine or norepinephrine infusion) for transport. High-risk patients had a significantly higher associated mortality (29%) than did low risk patients (11%) which was felt to be an indication of the high-risk patient’s severity of illness rather than an effect of patient transport. In-hospital transport was felt to be “safe” and associated with a low occurrence of transport-related complications (Class II).
REFERENCES