Intrahospital Transport of the Mechanically Ventilated Patient

by Richard J. Zahodnic, MBA, RRT, RPFT

The transfer of mechanically ventilated patients to other departments within the hospital, whether for diagnostic or therapeutic interventions, is a procedure frequently encountered by the average respiratory therapist. It is typically a clinical situation that is under-appreciated in its complexity and potential risk for complications.

Transfer within the hospital of ventilated patients can be as simple as a five-minute transfer from the postanesthesia care unit (PACU) to the intensive care unit (ICU), or as involved as a two- to three-hour “road trip” to the radiology department. Regardless of duration, however, the transfer team needs to be aware of potential problems that can develop while the patient is outside the critical care areas. A structured approach to each transfer, similar to a flight checklist by a flight team, should be completed before transit.

Important issues prior to transport

First, the question of whether the trip is truly necessary should be considered. Although many diagnostic studies require transfer to the area where the equipment is located, in some cases a more portable alternative can be brought to the patient’s bedside. Indek reviewed 103 consecutive transports from the Shock Trauma Unit to diagnostic areas and found that 68 percent of patients experienced serious physiologic changes, while only 25 (24 percent) of the transports resulted in significant changes to the patient’s management.

A second issue to address is what kind of monitoring will be required for the duration of the transfer. The incidence of complications during intrahospital transfer is well documented, with alterations to blood gas and pH values, as well as a loss of airway and alterations in hemodynamic stability (including cardiac arrest), occurring at a significant rate.

Monitoring of the patient during transport should be at least as extensive as that within the ICU and perhaps, in the case of minute ventilation and oxygenation, more extensive. This may mean that additional respiratory monitoring such as capnography and volume measurement by spirometry be made available for the duration of transport in addition to the electrocardiogram, invasive pressure monitoring, and oximetry currently in use.

A third area for evaluation is transport team personnel. A
well-defined cadre of personnel, familiar with the intricacies of intrahospital transport, reduces the incidence of complications. The level of critical support necessary for the duration of transport and the severity of the patient’s condition at the time of transport should dictate the number and qualification of personnel required.

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The use of a manual resuscitation device (MRD) to ventilate a ventilator-dependent patient during intrahospital transport has been shown to be a safe alternative, provided the personnel responsible for ventilation approximates the minute ventilation and oxygen requirements as dictated by pre-transport ventilation. The use of a spirometer to monitor volumes during transport may reduce the risk of inadvertent hypo- or hyperventilation. The variability of volumes delivered with manual ventilation, especially relating to that attained when one versus two hands is used for squeezing the MRD, should be appreciated. Use of an MRD with supplemental oxygen requires the patient to be ventilated at an enriched oxygen level (typically an FIO₂ of 1.0), which should not cause clinical problems in the short term for most adult patients but may require additional oxygen resources should the transport be of an extended duration.

In the case of neonates, the enriched oxygen atmosphere present with use of an MRD require that oxygenation be monitored more closely to prevent inadvertent hyperoxygenation.

Options for transport

Many authors have recommended the use of a mechanical ventilator for the intrahospital transport, as there can be significant variability in the arterial carbon dioxide tension (PCO₂), end-tidal carbon dioxide levels (ETCO₂), and arterial pH when transport ventilation with an MRD is compared to the use of a mechanical ventilator. The ability to better control minute ventilation and monitor for fluctuations of this value allow for more stable arterial carbon dioxide levels and arterial pH values.

Although the technology exists to monitor blood gases in transport with a portable blood gas analyzer, a more practical approach is to monitor ETCO₂ via capnography. The use of capnography in conjunction
A comparison of manual and mechanical ventilation during pediatric transport. Critical Care Medicine, 27(4), 802-806.


with an MRD or mechanical ventilator may facilitate a more optimal level of ventilation when direct assessment of spirometry is not available. Capnography can be used not only to guide appropriate ventilation but also to provide reassurance at all times that the airway remains secured. In the event of a cardiopulmonary event, capnography can give noninvasive information about the effectiveness of resuscitative efforts and may signal the return of spontaneous circulation.17

The use of a mechanical ventilator for intrahospital transport can be accomplished by using either a ventilator designed specifically for transport, or, if the transport is of a short duration, using the patient’s critical care ventilator for the transport. Transport ventilators have been reviewed extensively by Branson.18 Although there have been many additional products made available since the publication of his article, the evaluation methodology should be applied to any transport ventilator currently being evaluated.

The transport ventilator should have all the modes of ventilation available that may be used by a patient in the critical care unit (CCU). This includes...
intermittent mandatory ventilation as well as pressure-support ventilation in both a pressure-controlled ventilation breath delivery scheme and a volume-controlled ventilation scheme. In addition, FIO₂ (fraction of inspired oxygen) should be adjustable, especially if transport of neonates at risk of developing retinopathy of prematurity is planned. Also, the ventilator should be capable of having positive end-expiratory pressure applied (ideally as an integral part to the ventilator as opposed to an external valve) and should have a full complement of alarms to alert to changes in tidal volume, minute volume, and pressure required to ventilate the patient.

Additional important features include the size and weight of the unit, the battery life, the amount of gas consumption, the ease with which the device and associated valves and tubing can be disassembled and cleaned, and the ease with which changes can be made and the device evaluated for proper function.

As an additional test, the transport ventilator should be evaluated on a test bench with a variety of resistances and compliances applied to the test lung, and the flow and volume evaluated for clinical application. Heinrichs has shown that tidal volume can be quite varied from a transport ventilator under less than ideal conditions and may jeopardize the patient’s ability to be effectively ventilated.19 Evaluations of some models released since Branson’s study are available and have shown less variability than encountered by Heinrichs.20,21 A recent study by Campbell, et al, identifies that there can be significant work imposed on a spontaneous breath by some transport ventilators.22 This information should be taken into account when selecting and operating a transport ventilator.

Alternately, the patient’s critical care ventilator can be used for transport. Elaborate transport units have been developed23,24 to facilitate use of existing ventilators for intrahospital transport. These transport units have backup gas sources and power sources to allow for extended transport duration. Many new critical care ventilators have been recently released that have internal batteries capable of powering the ventilator for a period ranging from 30 minutes to two and one-half hours and also have internal mechanisms that result in low gas usage.

Portable critical care

Whichever method of transporting critically ill mechanically ventilated patients is chosen, the monitoring of minute ventilation and airway pressure, as well as all hemodynamic and oxygenation variables, should be as extensive as that being employed while the patient was being cared for in the critical care area. Additionally, regardless of the method of ventilation being selected, the transport team must assess the need to humidify inspired gases. If humidification is desired due to the patient’s condition or the duration of the transport, a heat and moisture exchanger can be used for the duration of the transport.25

In summary, intrahospital transport is a complex maneuver involving multiple personnel who must be well trained to monitor for, recognize, and treat critical changes occurring during transport of the ventilator-dependent patient.26

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