specific categories:

**Primary transport** (prehospital care) is the transfer of patients from a site of illness or injury to the hospital. Secondary transport is the transfer of the patient from hospital to another for continuing care. Technologies have dramatically improved the information available from diagnostic testing such as computed tomography (CT), magnetic resonance imaging (MRI), angiography, heart catheterization, and nuclear imaging, as well as various interventions that can be done using these tools. As a result, critically ill patients are, with increasing frequency, moving not only between hospital facilities but also between departments within the same hospital (intra-hospital).
the publication of guidelines by professional organizations on how the transfer of the critically ill should be conducted (1–6).

**TRANSPORT SCENARIOS**

Vigilance and anticipation are basic attributes of critical care medicine, and are vital in the safe conduct of each transport. Differences exist, however, in the physiologic status of patients likely to be encountered, as well as the expected stresses imposed by the move. Therefore, organization and logistics should be adapted to each specific transfer. In developing a rational approach, we may consider four different common scenarios for intrahospital transport, as defined by Venkataraman and Orr (7).

**Transfer from Critical Care Areas (to Ward)**

Individuals transferring out of a critical care area no longer need the extensive monitoring they had in the ICU. They should not be experiencing cardiovascular or respiratory instability and may be expected to continue a process of improvement. Major concerns are alterations in level of consciousness and development of airway problems.

**Transfer to Critical Care Areas (from Emergency Department or Ward)**

Patients moving to critical care areas present a different set of challenges. Physiologic status may change rapidly, as in the patient with sepsis who has deteriorated on the ward, or the trauma victim who is being resuscitated in the emergency department (ED). In this setting, the potential for adverse events or secondary insults likely will increase through the transport process, and the breadth of monitoring and preparation required is increased. Clearly, the data in head-injured patients point out the importance of vigilance in this scenario. Andrews et al. (8) studied 50 head-injured patients who required intrahospital transfer; 35 were transported from the ICU (to CT scan or OR) and 15 from the ED (to CT scan and then to ICU or OR). They found insults in a greater proportion in patients transferred from ED than in the ICU patients, despite similar injury severity scores. Although these authors did not clearly explain this finding—66% versus 80% patients with insults after transport—it may be that in such patients optimal preparation, monitoring, and resuscitation are more easily obtained with neuro-ICU-trained physicians than ED physicians.

**Round-trip Transfer from Critical Care to Noncritical Care Areas (i.e., to CT Scan)**

This is probably the most neglected part of intrahospital transport and perhaps one of the most dangerous. Critically ill patients journey outside of the ICU for various diagnostic and therapeutic interventions and for an undetermined period of time. Adverse events or mishaps during transport may be related to physiologic changes or to technical or equipment problems (Table 14.1). Minor changes in heart rate or blood pressure may have little impact; however, unplanned extubation of the airway or loss of intravenous access for pressor support can have lethal consequences. Problems may occur and must be anticipated for any organ system. Early detection of such changes and rapid intervention are critically important to outcome.

**Transfer between Critical Care Areas**

The transfer of patients between critical care areas (from the OR to ICU or from the ICU to OR) are unlikely to isolate patients in remote areas of the hospital with limited resources. Issues involving the transport process itself are still relevant, however, and the nature of events leading to such transports puts these patients at significant risk. Much as Insel et al. (9) demonstrated hemodynamically significant changes in adults during transfer from the OR to ICU, Venkataraman and Orr (7) described major cardiorespiratory changes in children going from the OR to the ICU. Many of them required significant interventions such as ventilator changes or vasoactive infusions for stabilization (10–14). Petre et al. (15) noted that patients undergoing complex cardiothoracic procedures could leave the OR with multiple isotropic or vasoactive infusions, invasive monitors, pacemakers, and even intra-aortic balloon pumps or ventricular assist devices, but all required monitoring and adjustment during the transport process. They observed that patients were frequently unstable when they arrived in the ICU.

The same potential for physiologic deterioration is present when patients are transferred from the ICU to the OR, frequently compounded by the fact that these transfers are urgent or emergent. The transport and transfer process may be thought of as an extension of our care and clearly places patients at risk for physiologic changes that are at least as great as in the areas between which they are being transported.

**ADVERSE EFFECTS**

Deterioration in respiratory, cardiovascular, and other physiologic systems is a potential complication of any patient transport. This may be due to the movement of the patient or may be related to equipment dysfunction. Apart from physiologic changes, problems may arise from organizational and system efficiencies.

**Overall Complications during Intrahospital Transport**

Studying factors related to mishaps, Smith et al. (13) prospectively followed a series of 125 intrahospital transports from the ICU. Mishaps were defined as events having a detrimental effect on patient stability (e.g., ventilator disconnection, tracheal extubation, intravenous catheter infiltration or disconnection, vasoactive infusion disconnection, invasive monitor or catheter-related mishap, or monitor failure). Twenty-four percent of patients were believed to be less stable on return to the ICU. Eleven percent of transports had multiple misadventures, and more than one third involved at least one mishap. This series revealed several interesting trends. Transports to the CT scanner were more likely to involve mishaps than any other destination, particularly if any delays occurred at the site. Contributing factors were believed to include the physical isolation...
### Chapter 14: Intrahospital Transport of Critically Ill Patients

#### Table 14.1: Potential Complications During Transport

<table>
<thead>
<tr>
<th>CARDIOVASCULAR</th>
<th>RESPIRATORY</th>
<th>NEUROLOGIC</th>
<th>OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physiologic</td>
<td>Physiologic</td>
<td>Physiologic</td>
<td>Technical</td>
</tr>
<tr>
<td>Hypertension</td>
<td>Hypoxemia/desaturation</td>
<td>Increased ICP</td>
<td>Pulled nasogastric or feeding tube</td>
</tr>
<tr>
<td>Hypotension</td>
<td>Hypercapnia/respiratory acidosis</td>
<td>Decreased cerebral perfusion press</td>
<td>Pulled Foley catheter</td>
</tr>
<tr>
<td>Hypervolemia/bleeding</td>
<td>Hypocapnia/respiratory alkalosis</td>
<td>Inadequate cerebral blood flow</td>
<td>Pulled surgical drain/catheter</td>
</tr>
<tr>
<td>Arrhythmias</td>
<td>Tachyypnea</td>
<td>Seizures</td>
<td>Tangled infusion and monitoring catheters</td>
</tr>
<tr>
<td>Congestive heart failure/pulmonary edema</td>
<td>Bronchospasm</td>
<td>Herniation</td>
<td>Loss of hyperalimentation source</td>
</tr>
<tr>
<td>Decreased cardiac output/insufficient tissue perfusion</td>
<td>Loss of functional residual capacity</td>
<td>Cerebral edema</td>
<td>Compression stocking malfunction</td>
</tr>
<tr>
<td>Ischemia/Infarction</td>
<td>Increased airway pressure/hemodynamic compromise</td>
<td>Hemorrhage</td>
<td>Bed malfunction</td>
</tr>
<tr>
<td>Compromise of vascular anastomoses/graft/bypasses</td>
<td>Cheek tube occlusion or loss</td>
<td>Stroke</td>
<td>Transport elevator malfunction</td>
</tr>
<tr>
<td><strong>Technical</strong></td>
<td><strong>Technical</strong></td>
<td><strong>Technical</strong></td>
<td><strong>Technical</strong></td>
</tr>
<tr>
<td>ECG lead disconnect or artifact</td>
<td>Loss of unprotected airway</td>
<td>ICP monitor loss or malfunction</td>
<td>Pulled nasogastric or feeding tube</td>
</tr>
<tr>
<td>Monitor failure</td>
<td>Extubation/endotracheal tube obstruction</td>
<td>Inability to maintain adequate head-up positioning</td>
<td>Pulled Foley catheter</td>
</tr>
<tr>
<td>Arterial catheter/central venous catheter disconnect</td>
<td>Loss of gas supply</td>
<td>Errors with pentobarbital infusion during induced coma</td>
<td>Pulled surgical drain/catheter</td>
</tr>
<tr>
<td>Vasovagal drug infusion error or disconnect</td>
<td>Inability to fit IABP into elevator or ancillary location</td>
<td>Loss of electrophysiologic monitoring capabilities</td>
<td>Tangled infusion and monitoring catheters</td>
</tr>
<tr>
<td>Pacer malfunction</td>
<td>Lack of house gas lines at remote or diagnostic locations</td>
<td>Difficulty in temperature control</td>
<td>Loss of hyperalimentation source</td>
</tr>
<tr>
<td>IABP malfunction</td>
<td>Ventilator malfunction</td>
<td></td>
<td>Compression stocking malfunction</td>
</tr>
<tr>
<td>Loss of invasive monitoring catheters</td>
<td></td>
<td></td>
<td>Bed malfunction</td>
</tr>
</tbody>
</table>
| **ECG**, electrocardiogram; IABP, intra-aortic balloon pump; ICP, intracranial pressure.**

of the patient during the procedure and the transfer of the patient from the bed to the scanner and back. Overall, 75% of mishaps occurred at the remote study site. Surprisingly, emergent transports were not more likely to have mishaps, nor was a correlation observed between the number of catheters and monitors and the incidence of mishaps.

Indeck et al. (16) reported, in a prospective evaluation of 103 consecutive transports carried out for diagnostic studies, that 68% of all transports experienced serious physiologic changes and that each of these required increased levels of support to the patient. These investigators also found that only 24% of the transports resulted in a change in patient management within 48 hours. They concluded that the decision to transport patients must be weighed carefully in the face of a 75% chance that the study result will not alter management.

Changes in patient management amounted to 39% in the experience of Hurst et al. (17), who studied a group of 81 surgery/trauma patients transported for a total of 100 diagnostic procedures. The examination with the highest efficiency included angiographic and abdominal CT scanning, which resulted in therapeutic consequences in 57% and 51% of patients, respectively. They also found that physiologic changes—defined as a blood pressure ± 20 mm Hg, heart rate ± 20 beats
per minute, respiratory rate \( \pm 5 \) breaths per minute, or oxygen saturation \( \pm 5 \% \) for 3 minutes duration—occurred in 66\% of transported patients. These authors further demonstrated that while physiologic changes are frequent during transport, they are also frequent in ICU patients as a consequence of the severity of illness. They concluded that, if appropriate monitoring and ventilatory support are provided during transport, the frequency of life-threatening complications is quite small.

This is confirmed by the study of Sem et al. (18), who studied 203 intrahospital transports. They reported only 12 serious complications, including marked hypoxemia, cardiac arrest, hypotension, cerebral infarction, pneumothorax requiring chest tube placement, and rupture of an infected arteriovenous fistula, without any transport-related deaths. It could be thus concluded that, even though intrahospital transport of the critically ill patient is associated with increased complications, the large variation of their incidence (ranging from 6\% to 68\% in the literature) may be attributed to differences in patient population and/or to definitions used.

Specific Complications during Intrahospital Transport

Cardiocirculatory Events

Cardiovascular changes seem to be common. Insel et al. (9) studied patients being transferred from the OR to the ICU after either major general or vascular surgery, carotid endarterectomy, or coronary artery bypass, comparing them to ICU patients undergoing diagnostic or other nonoperative procedures. In the major postoperative groups, significant lability in blood pressure and pulse were noted. Despite continuous arterial blood pressure monitoring, 20\% of patients in the major vascular and general surgery group required vigorous fluid resuscitation for hypotension on arrival to the ICU, whereas 36\% required either nitroglycerin or nitroprusside for control of hypertension.

A prospective study of medical patients monitored, in addition to the standard electrocardiogram monitor, with a continuous 12-lead ST-segment analysis, showed that cardiac events that cannot be seen with the usual monitoring may occur (19).

It has been reported that the accuracy of noninvasive blood pressure monitoring is limited (20). Direct intra-arterial pressure measurements were taken in 44 transported patients as a gold standard and were compared with readings from four portable automatic oscillotonometers—the Dinamap 8100, Lifestrat 100, Propaq 102, and Takeda UA711. All underread systolic pressure (by 13\%, 21\%, 19\%, and 13\%, respectively) and overread diastolic pressure (by 15\%, 5\%, 27\%, and 15\%, respectively) as compared to direct pressure measurement.

Respiratory Events

It has been noted that \( \text{O}_2 \) saturation can drop significantly when sedated patients are moved to and from the operating room (OR) or postanesthesia care unit (PACU). Hensley et al. (21) found that 60\% of patients prepared for coronary bypass surgery became hypoxic, with a \( \text{SpO}_2 \) less than 90\%, during placement of invasive monitors after a standard premedication with morphine and scopolamine on their way to the OR, despite normal mental status. Tyler et al. (22) report that in a series of adult patients recovering from anesthesia, 12\% desaturated to a \( \text{SpO}_2 \) of less than 85\% and fully 33\% of patients had a \( \text{SpO}_2 \) of less than 90\% during transport from the OR to the PACU. Healthy pediatric patients are no less at risk. Despite administering 100\% oxygen for 3 minutes after surgery, Kataria et al. (23) found a significant age-related fall in \( \text{SpO}_2 \) during a 120 to 180 second transfer to the PACU, with the mean \( \text{SpO}_2 \) being 88\% in children younger than 6 months of age. Studying healthy children with American Society of Anesthesiologists physical status I or II, Tomkunas et al. (24) found that 24\% became hypoxic (\( \text{SpO}_2 \) less than 90\%) during the first 10 minutes after termination of anesthesia. Significantly, clinical signs of respiratory compromise such as cyanosis or upper airway obstruction correlated poorly with measured hypoxemia.

For nonoperative mechanically ventilated patients, similar results have been shown. Waydhas et al. (25) found, in a study of 49 trips for 28 patients, that the arterial partial pressure of oxygen (\( \text{PaO}_2/\text{fraction of inspired oxygen} (\text{FiO}_2) \) ratio dropped more than 20\% after 21 of the transports. For ten of the patients studied, changes in the \( \text{PaO}_2/\text{FiO}_2 \) persisted for more than 24 hours.

Because the possibilities for treatment are reduced during the transfer period, two studies were undertaken to evaluate predictors that could identify patients whose respiratory function might deteriorate to allow the weighing of the benefit against the hazards of transfer before the actual transport takes place. Marx et al. (26) investigated 98 mechanically ventilated patients. In 34 transports (35\% of studied patients), there was a decrease in the \( \text{PaO}_2/\text{FiO}_2 \) ratio, and a decrease of more than 20\% from baseline was noted in 23 of the transferred patients (24\%). Predictors for respiratory deterioration included age greater than 43 years and a required \( \text{FiO}_2 \) greater than 0.5. In a second study, 88 intrahospital transports involving 62 patients were analyzed (27). In 56 transports (64\%), the \( \text{PaO}_2/\text{FiO}_2 \) ratio decreased by more than 20\% from baseline. A high pretransfer \( \text{PaO}_2/\text{FiO}_2 \) ratio (greater than 200) was the only factor predictive for respiratory deterioration in multivariate analysis. Neither Marx et al. (26) nor Mohammeda et al. (27) have found a relationship between the duration of transfer and respiratory deterioration.

Manual bag ventilation of ICU patients transported to OR, or to other hospital locations, appears to be common. Small, older studies showed that such manual positive pressure ventilation is reasonable for short-term transit care, such as transferring an ICU patient to the OR just down the corridor. Weg and Has (28) compared parameters among 20 patients transported either with a mechanical ventilator or ventilated by bag mask. They found no significant hemodynamic changes and only transient variations in \( \text{PaCO}_2 \) between the two groups. Gervas et al. (12) compared manual ventilation with and without spirometry for tidal volume monitoring, and mechanical ventilation with a portable device that allowed tidal volume to be set but had no capacity for measurement. Both groups without spirometry developed significant decreases in \( \text{PaCO}_2 \) and increases in pH. When manual ventilation with tidal volume monitoring was used to approximate the minute ventilation patients received in the ICU, no significant changes were observed. By way of contrast, in a prospective study of ventilator-dependent patients who underwent procedures outside the ICU, Braman et al. (11) examined changes
in arterial blood gas partial pressures and hemodynamic parameters in two treatment groups. Group 1 was ventilated manually during transport, and group 2 was ventilated by a portable volume-limited ventilator (with settings matched to the bedside ventilator). Significant changes in PaCO₂ (greater than 10 mm Hg) and pH were common in both groups, as was hypotension. However, the rate of occurrence was clearly greater in the manually ventilated group (73% vs. 44%), and two of the group 1 patients developed new cardiac arrhythmias. Blood gas deterioration correlated strongly with the development of hypotension and new arrhythmias. A similar but more recent study confirms these findings. After transport, 5 of 11 patients in the manually ventilated group, compared to 1 of 14 patients in a mechanically ventilated group, showed a significant deterioration in the PaO₂/FiO₂ ratios. The mean tidal volume and positive end-expiratory pressure in the manually ventilated group showed significantly larger variation than in the mechanically ventilated group (29). The authors concluded that the use of a transport ventilator provides more stable ventilatory support than does manual ventilation.

However, only a few comparative studies regarding portable ventilators have been published. Zanetta et al. (30) reported, in a bench model, that the performance of five transport ventilators, and three ICU ventilators that can be used for this purpose, set in a volume-controlled mode and submitted to various combinations of resistive and elastic loads, were very inhomogeneous. Although many data have accumulated with respect to mishaps during transport, less is known about adverse long-term effects. Kollef et al. (31) found that, in a group of 273 ventilated patients who were transported, the incidence of ventilator-associated pneumonia was 24.4% compared with 4.4% in 248 nontransported patients with a similar severity of illness. A risk-adjusted matched cohort study showed a ventilator-associated pneumonia (VAP) rate of 26% in transported patients compared with 10% in the matched nontransported patients (32). This study was designed to examine the impact of intrahospital transport (IHT) on the occurrence of VAP, not to explore its mechanism. However, the authors proposed some explanations: the supine position during IHT, the frequent manipulations of the ventilator circuits needed during IHT that increase the risk of aspiration of gastric content or of contaminated secretions, and the fact that technical difficulties are often encountered when suction of airways is needed during transport. However, the ICU mortality rate was similar in both groups of patients.

Neurological Events

The population of transported patients in whom physiologic variation poses the greatest clinical threat are those with head trauma, which requires tight regulation of oxygenation, blood pressure, and intracranial pressure (33). Secondary insults such as hypoxia, hypotension, or decreased cerebral perfusion pressure are devastating in head-injured patients. Gentleman and Jennett (34) found that “suboptimum care” was responsible for most avoidable deaths after head trauma, and that more than one third of deaths in neurotrauma patients had avoidable factors. In a large audit of head-injured patients, these investigators report compromised airways in over 25% of victims arriving in the neurosurgical unit, with 15% to 22% demonstrating hypoxemia. Andrews et al. (8) report secondary insults occurring in 47% of neurotrauma patients during transport from the ER and that fully 80% of patients had insults within the first 4 hours after transfer.

CONTRIBUTING FACTORS

In a cross-sectional analysis of intrahospital transfer incidents reported to the Australian Incident Monitoring Study in Intensive Care system, Beckmann et al. (33) identified 176 reports of 191 incidents relating to intrahospital transportation from 37 ICUs. Clinical management errors accounted for 61% of the problems (the most common patient/staff management issues identified were communication and liaison issues between the ICU and sites of destination or origin), with equipment failure responsible for the remainder. Factors contributing to the incident were classified as system-based factors (work practices, equipment, physical environment structure) in 46%, and human-based factors (knowledge-based, rules-based, skills-based, or technical error) in 54%. Many of these human-based contributing factors suggest that personnel involved may not have had adequate training. From these data, the authors developed recommendations for intrahospital transport and a checklist for documenting the processes of care before, during, and after the transfer period, which are further discussed.

The Three Phases of Transport

Preparation begins with careful evaluation of the risks and benefits of the transport. The decision to move a patient should be made by the senior medical practitioner of the critical care team. The transport may be broken down into three phases: the preparatory phase, the transfer phase, and posttransport stabilization.

Preparatory Phase

This is probably the most important stage. Adequate attention to this first phase minimizes problems in the other two.

1. Stabilization of the patient before transport is an obvious goal, although overruling priorities may make this impossible. As a rule, all anticipated procedures should be performed in the critical care area before transport. Careful assessment of the patient’s airway is critical, and adequate oxygenation and ventilation must be ensured. In patients who are combative or show decreased levels of consciousness for whatever reason, careful consideration should be given to effectively securing the airway before transport. Similarly, elective intubation should be entertained in patients with significant burn injuries (especially inhalational injury), chest trauma, or respiratory distress. An apparently insignificant pneumothorax can progress rapidly—particularly if the patient is receiving positive pressure ventilation—and tubo thoracostomy should be considered. Once in place, chest tubes may be transported under water seal, and then, ideally, reattached to suction during any therapeutic or diagnostic procedure. If necessary, vasoactive infusions should be addressed to obtain a steady state before any elective transport. Intravascular volume resuscitation should be well under way in patients with shock caused by trauma, and large-bore vascular access catheters should be in place before transport...
movement. When blood pressure cannot be stabilized, surgical exploration and control of bleeding must take precedence over any further diagnostic procedures.

2. Communication and coordination are essential to the safe conduct of transport. When a patient is transferred to or from the critical care area, or between critical care areas, information should be passed from physician to physician and nurse to nurse regarding the patient’s condition, treatment, and management. Timing of arrival and procedures should be confirmed with personnel at the patient’s destination, especially when CT, angiography, or nuclear medicine studies are involved; this is of particular importance as mishaps are more likely when delays occur in these areas. Ideally, patient escort or security may arrange to clear the transport route and to have elevators standing by. If the responsible physician does not accompany the patient, the physician must at least be aware when the transport is taking place. The reasons for the transport should be documented in the patient’s chart. It is of critical importance that the patient “handoff” be carried out in a flawless manner and that documentation be complete.

3. Resuscitative and scheduled medications, fluids, monitors, life-support equipment, and adequate personnel need to be assembled. Airway supplies, including equipment for intubation and ventilation and an oxygen supply, are essential. A checklist should be used to assist in preparation.

Transport Phase

The goal during the transport phase is to maintain the same level of care as the patient had in the critical care area. As much as possible, we should strive to achieve the following:

1. Maintain patient stability through monitoring.
2. Continue the present ongoing management.
3. Avoid iatrogenic mishaps.
4. Reduce to a minimum transfer duration.

In transports from the ICU to and from ancillary locations, every attempt should be made to return monitoring and care to the ICU level during the procedure. Modalities such as pulmonary artery pressure, which may be difficult to follow in a moving patient, can again be monitored in a stationary location. Modalities such as pulmonary artery pressure, which may be difficult to follow in a moving patient, can again be monitored in a stationary location. Modalities such as pulmonary artery pressure, which may be difficult to follow in a moving patient, can again be monitored in a stationary location.

Posttransport Stabilization

When a patient returns to the ICU, no less attention should be paid to the posttransport stabilization phase than to other components of the process. Patients may continue to be at increased risk of secondary insults through the first 4 hours after return (34). Additional issues may arise, and communication is thus essential. The primary team may be unaware of all of the problems that began in the OR/ED or during the transport, or important new findings may follow from a diagnostic procedure. The transport team members must review these issues with the full critical care team, including the nurses who will be working with the patient. This communication is especially important for the trauma patients, who may have physicians from several disciplines involved in their care.

MINIMUM STANDARDS

Accompanying Personnel

Adequate and appropriate personnel should be gathered to accompany the patient, including a minimum of two people, one of whom is the patient’s critical care nurse. Nursing care plays a vital role in the ICU and must be continued throughout the transport process to ensure proper administration of scheduled medications, titration of vasopressive infusions, and accurate record keeping. A trained physician must accompany any unstable patient who requires extensive acute interventions. This dedicated team should be available for the entire duration of the transport and needs to be familiar with all equipment.

Equipment

A standard set of equipment should be available for most critical care transports. Basic resuscitation drugs such as epinephrine, atropine, and antiarrhythmic agents, along with a cardiac monitor and defibrillator, are appropriate for most transfers to or between critical care areas. Airway support supplies, including a self-inflating resuscitation bag (to allow ventilation in the event that a temporary interruption of the compressed gas source occurs), masks, oral airways, and a functioning laryngoscope with appropriate blades and endotracheal tubes, are mandatory. An adequate oxygen supply should allow full support during the anticipated duration outside the ICU, with a 30-minute reserve time. Intravenous fluids should include maintenance requirements, as well as isotonic crystalloids, colloids, and blood products as indicated for resuscitation. Medications given by infusion should be continued by battery-operated volumetric pumps to avoid unnecessary interruption of life-supporting drugs (e.g., vasopressors). All scheduled and anticipated medications (e.g., insulin, antibiotics, sedatives, and muscle relaxants) also should accompany the patient. All battery-operated transport equipment should have charge indicators and backup batteries. Regular servicing and checking of transport equipment is essential. A trolley or bed attachment to carry all equipment and drugs above is highly recommended.

Monitoring

Perhaps more than any other patients, the critically ill demand that we individualize monitoring schemes, support systems, and the transport process. Guidelines have been set as the minimum acceptable standards (task force):"
Intermittent measurements of central venous pressure, pulmonary artery occlusion pressure, and cardiac output

Intubated patients receiving mechanical ventilation should have airway pressure monitored. If a transport ventilator is used, it should have alarms to indicate disconnects or excessively high airway pressures.

**SPECIAL CIRCUMSTANCES**

**Hemodynamically Unstable Patients**

The importance of stabilization before transport cannot be overemphasized. Adequate large-bore venous access, resuscitation fluids, and blood products must be available throughout the transport. One person may need to be assigned the sole task of managing blood and fluid administration, especially if any significant amount of time is to be spent at an ancillary location. Patients with cardiovascular collapse may require multiple vasopressor and inotropic infusions that must be available for adjustment during transport and may, at times, be moved to the OR with cardiopulmonary resuscitation in progress.

**Neurotrauma Patients**

Head injury is common in all age groups and remains a leading cause of morbidity and mortality in young adults. Once injured, the central nervous system has very small reserve for recovery. Although the primary injury cannot be reversed, secondary injuries are prevented by optimal cerebral perfusion pressure. These patients frequently require transport for diagnostic procedures not available in the ICU. However, transport can have an adverse impact on cerebral perfusion pressure by increasing intracranial pressure (ICP) or decreasing mean arterial pressure, or both, leading to secondary ischemic injuries. Patients with severe head injuries or other causes of increased ICP should be intubated to protect the airway and control ventilation. Management may include positioning with the head up 20 to 30 degrees, moderate hyperventilation, adequate hemodynamic management, and sedation. The ICP monitoring should not be interrupted during transport, and changes in posture of the patient should be avoided, but, if inevitable, very carefully performed.

**Magnetic Resonance Imaging**

MRI can provide invaluable diagnostic information but poses multiple management problems for the critically ill because of the effects of the magnetic field on monitoring and life-support equipment, physical isolation of the patient, and the frequently remote location of the scanner. If MRI is deemed necessary, careful planning is essential. With minor modification, most monitoring techniques are adaptable to the MRI suite. Because of patient isolation during the scan, particular attention should be paid to airway assessment.

Intrahospital transport, a seemingly mundane event with a standard process, is actually one of the most risk-ridden actions we undertake in the ICU. As stated above, it is incumbent on us to ensure that these transports—needed to provide high-quality care—are indicated and carried out in the safest manner possible. The closest coordination between ICU nursing, the respiratory therapists, and the physicians is needed. Particular attention must be paid to monitoring. If these caveats are attended to, the transport can be carried out in the safest manner possible.

**References**