INTRODUCTION

Transfers of patients have occurred throughout the ages, and may be divided into three categories. Primary transport is the transfer of patients from injury site to first hospital contact. Secondary transport is the transport of patients from one hospital to another for continuing clinical care (interhospital transfer), and intrahospital transport is the transport between departments within the same hospital. This chapter will focus on interhospital and intrahospital transports.

Twenty years ago, approximately 11,000 patients per year required secondary transfers in the United Kingdom (1). Nowadays, nearly 1 in 20 intensive care unit (ICU) patients in the United States are transferred to another hospital (2,3). Moreover, and perhaps more worrisome, it is estimated that in the United States every year 4,000 mechanically ventilated patients who lost their lives might have been saved had they been transferred to a better qualified hospital (4). This illustrates that interhospital transfer of critically ill patients has played an important role for decades and is still of major importance today; it also speaks to the need—infrequently discussed—for the regionalization of critical care services.

The significance of transporting critically ill patients also applies to intrahospital transfers, as the availability of diagnostic tools, such as computerized tomography (CT), magnetic resonance imaging (MRI), angiography, and so forth, increases the need for transfer of the ICU patient through the hospital. While the goal during all such transfers is, and should be, to continue or improve the clinical care of the patient, the risks as well as the benefits of each transport event should be considered carefully prior to its initiation.

Transferring ICU patients, whether within or between hospitals, is a potentially challenging exercise and is, in our eyes, essentially a medical specialty with its own demands. As the same key factors apply both for intra- and interhospital transfers, we will not, further herein, discriminate between these two types of transfer, unless otherwise stated.

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 together with the physician accompanying the transport and the intensivist of the receiving facility (in case of a interhospital transport). The transport may be comprised of three phases: the preparatory phase, the transfer phase, and postransport stabilization.

Preparatory Phase

This is generally the most significant stage as appropriate and detailed attention here minimizes problems in the other two phases. • Stabilization of the patient before transport is an obvious goal, although other priorities may make this difficult to achieve. In general, all anticipated procedures should be performed before transport is considered unless this cannot be safely performed. Careful assessment of the patient’s airway is critical, and adequate oxygenation and ventilation must be ensured. Patients who are combative, or who have decreased level of consciousness for whatever reason, are very carefully assessed for elective control of the airway before transport. The thinking that “…We will intubate once we get to the ICU…” may result in a patient with a compromised airway in the elevator. This is as true in patients with significant thermal injuries (especially inhalational injury), as it is in chest trauma, or respiratory distress. An apparently insignificant pneumothorax can progress rapidly—particularly with positive pressure ventilation—and tube 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 possible, vasoactive infusions are initiated in an attempt to obtain hemodynamic stability before any—and certainly before an elective—transport. Large-bore vascular access catheters should be in place, and volume resuscitation initiated in patients with shock, before transport is considered. When blood pressure cannot be stabilized, surgical exploration and control of bleeding must take precedence over any further diagnostic procedures.

• 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, handoff information from physician to physician and nurse to nurse regarding the patient’s condition, treatment, and management is mandatory. The reasons for the transport are adequately documented in the patient’s chart and, critically, the patient handoff should be carried out in a flawless manner. Timing of arrival and procedures should be confirmed with personnel at the patient’s destination, especially when CT, angiography, MRI, or nuclear medicine procedures are involved; 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. A responsible physician from the ICU team should accompany the patient during transport.

• As resuscitative and scheduled medications, fluids, monitors, life-support equipment, airway supplies—including equipment for intubation and ventilation—and an oxygen supply, as well as adequate personnel need to be assembled, a checklist should be used to assist in preparation.

Transport Phase

During the transport phase, we attempt to maintain essentially the same level of care as the patient had in the critical care area. As such, we strive for the following:

• Monitor the patient and maintain stability
• Continue ongoing management
• Avoid iatrogenic mishaps
• Reduce the transport duration to a minimum

While transporting an ICU patient to and from ancillary locations, every attempt should be made to continue monitoring and care at the ICU level. Even monitoring modalities that are difficult to continue during the transport process may be re-initiated/continued when in a stationary location. By adhering to the principles of thorough preparation and minimizing time spent during the transport phase, we should decrease the potential for complications.

Posttransport Stabilization

When a patient returns to the ICU from a transport, no less attention should be paid to the posttransport stabilization phase than to the initial components of the process. Patients may continue to be at increased risk of secondary insults through the first 4 hours after return (5). Additional issues may have arisen during the transport/procedure, and therefore, handoff communication is essential. The primary team may not be aware 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, thus a careful handoff is critical, and transport team members must review these issues with the critical care team, including the nurses, who are/will be caring for the patient. This communication is especially important for the trauma patients, who may have physicians from several disciplines involved in their care.

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:

• Continuous monitoring with periodic documentation of electrocardiogram and pulse oximetry
• Intermittent or continuous measurement and documentation of blood pressure, respiratory rate, and pulse rate
• Mechanically ventilated patients should have capnography to monitor ventilation. Airway pressure should be monitored and alarms set 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, and these must be available during transport.

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 is quite sensitive to secondary injury. Although the primary injury cannot be reversed, secondary injuries are prevented by optimal oxygenation (SpO2 greater than 90%), eucapnia, systolic blood pressure no less than 90 mmHg, head of bed elevated at 30 to 45 degrees, and head in a neutral position. While these patients may require transport for diagnostic procedures not available in the ICU, transport may adversely impact intracranial pressure (ICP) or mean arterial pressure, resulting in compromised cerebral perfusion pressure and increasing risk of secondary ischemic injury.

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.

Adverse Events

Irrespective of the type of transfer, there should always be an assessment of the benefit–risk ratio. Before the start of a transfer, one should always consider the risk of an adverse event occurring and, as noted above, plan the transport with care. A transfer should only take place if one can answer the following question in a positive manner: Does the indication for the transfer warrant the risk of an adverse event?

It is important to note that, depending on the definition of an adverse event, the incidence varies from 3% to as high as 75% (6,7). These events may be medical—most likely cardiovascular or respiratory in origin—or technical. The most common cardiovascular adverse events, with an incidence of up to 24%, are hypertension and hypotension, bradycardia and tachycardia, and dysrhythmias. Respiratory events are most often related to inadequate ventilation or desaturation, with an incidence as high as 15% (8–12).

Equipment failure or technical problems are common, occurring with an incidence of up to 36% (8,2–14). In fact, such misadventures may account for 46% of all incidents (15–17). The most common technical events are problems with the gas or electricity supply, defective equipment or, if transport is taking place outside of the institution, problems with the transport vehicle (13).

Prevention of Adverse Events

The impact of an adverse event during transfer may be more profound than in the ICU, because backup equipment and/or personnel may not be readily available. Efforts to minimize the incidence of adverse events, as well as to mitigate the effect of those events that do occur, are therefore of pivotal importance. Of note—and related to the detail above related to the Phases of Transport—with a skilled crew and teamwork, pretransport equipment checks, and careful examination of the patient, between 52% and 91% of adverse events may be prevented (11,16,18). This is most easily achieved by using a specialized transport team, specific transport training, and implementing preventive programs.
Mitigation of Adverse Events

Specialized Retrieval Teams Versus Standard Transportation

Ideally, the personnel accompanying a transported patient should comprise at least an experienced critical care physician and critical care nurse team. For intrahospital transports, both the patient’s critical care nurse and physician often accompany the transport. There is evidence to suggest that, as with specialized interhospital transport teams, dedicated transport teams may do a better job with intrahospital transports, as well.

Studies comparing specialized with nonspecialized retrieval teams have shown lower adverse incident rates, decreased morbidity, and a reduction in acute physiologic abnormalities and mortality (11,12,19–23). Although, these data come primarily from retrospective cohort studies, there are other advantages of specialist transport teams as well:

• They are more familiar with transport-specific procedures and equipment (24).
• They do a better job in stabilizing the patient prior to the transfer (25).
• Front-end discontinuity is better addressed by an expert transport team. That is, there is less information loss, better treatment continuity, and less disruption of physiologic parameters during transfer (26,27).
• Nonspecialist teams have a higher incidence of dissatisfaction and stress (28).
• It is easier to maintain the expertise and training of a specialist team (24).

Transport Training

A small crew accompanying a critically ill patient during transport/transfer must not only be able to treat this patient with, at least, the same level of care as given at the referral ICU, but it must also be trained to deal with transport-specific problems. These problems include relative isolation, with little or no backup, inaccessibility of additional ICU equipment and treatment options, and working in a small moving compartment with significant noise (i.e., an ambulance, helicopter, or plane). Moreover, the crew must be able to deal with equipment failure, which means that technical knowledge of the equipment used is required. Therefore, the training of such a crew should focus on five items (29):

• Preparation: Thorough examination of the patient, review of laboratory results, EKG’s, chest x-rays, and other results. In this way, one might be able to anticipate problems before they actually occur.
• Teamwork: Working with a small crew requires good communication skills; crew resource management training may be of value.
• Equipment: Equipment used is often different from the equipment used in the ICU because of its design for the transfer process. Additionally, there is the possibility of equipment failure. Hence, technical knowledge of the transport equipment is required.
• Mobility: Treating a patient while moving may be complicated. Consideration must be given as to what is possible while driving and what is not.
• Safety: Training for treating a patient while wearing a seat belt, communicating with the driver, and stowing unused equipment in a safe manner must all be simulated.

Although it has long been recognized that transfer teams should be trained before taking responsibility (13,30,31), training programs are not common in practice. In fact, only a few local training initiatives have been described (32,33), including one detailed crew resource management simulation training (29). This may lead to obvious problems alluded to above.

Implementing Preventive Programs

As an additional aid in preparation before transport/transfer, several pre-movement scoring cards and checklists have been developed (34–36). Just as the pre-flight checklists in aviation, the aim is to visualize potential transport/transfer risks so they can be acted upon before initiating the move. The scoring card developed by Berube for intrahospital transfers even showed a 20% reduction in adverse events when it was used (34). A checklist for intrahospital transports was published recently. This checklist covers all three phases of transport and can easily be adjusted for local use (Fig. 11.1) (37).

Equipment

The equipment used in the transport/transfer must comply with both ICU and transfer standards. As regards ICU standards, the equipment must meet ICU specifications, as one wants to maintain, minimally, the same level of care during a transport/transfer as while the patient is in the ICU. A standard equipment complement should be available for most critical care transports.

Suggestions for the kind of required equipment have been made (38–41). In general, an ICU monitor (for EKG, invasive/ noninvasive pressures, capnography, and SpO2 display), an ICU ventilator—preferably turbine driven and therefore independent of compressed air—a defibrillator, suction device, and airway management equipment, including a self-inflating resuscitation bag—to allow ventilation in the event of a malfunctioning ventilator—masks, oral airways, and a functioning laryngoscope with appropriate blades and endotracheal tubes, are mandatory. In certain cases, arterial and central venous lines and chest tubes are warranted. Basic resuscitation drugs such as epinephrine, atropine, and antidysrhythmic agents, as well as scheduled and anticipated medications (e.g., insulin, antibiotics, sedatives, and muscle relaxants) should also accompany the patient.

With regard to transfer standards, all electrical equipment should have prolonged battery life, and remaining charge should be properly displayed on the monitor. The equipment must be able to withstand vibration and shock, and thus be suitable for dealing with different transfer conditions—intrahospital as well as interhospital via ambulance, rotary-wing, or fixed-wing aircraft. The mounting of the equipment should follow national or international regulations. Preferably, all equipment are mounted on the transfer stretcher and, for safety, below the level of the patient. For intrahospital transports, a trolley or bed attachment to carry all equipment and drugs above is highly recommended.

Modes of Transport

The most common modes for interhospital transfers are by ground (ambulances) or air (fixed-wing or rotary-wing aircraft). In general, transfer by helicopters (rotary-wing aircraft) is considered for transfer distances greater than 80 km (50 miles) and fixed-wing aircrafts are used for distances greater
than 240 km (150 miles). Although transfer by air may seem faster, one should bear in mind that mobilization times may be longer and transport by air often creates the need for additional transportation between landing site and hospital. These factors should be taken into consideration when deciding which mode of transport is going to be used. Furthermore, although transport by air might generate a reduction in transfer time, this has not been translated in a mortality reduction (42).

Apart from differences in transfer time, other issues must be considered when a transfer mode is to be chosen. These include risk, cost, mobilization time, influence of noise, vibrations and weather conditions, and the space required for patient care. Compared with air transport, ground transport has lower costs, more rapid mobilization times, lower risks—especially compared to rotary-wing transport—less noise and vibrations which could affect both patient and equipment, is less influenced by weather conditions and, in general, there is more space for patient care (again, especially compared to rotary-wing craft).

**Organizational and Legal Aspects**

The referral and the receiving team should make the assessment of the transfer risk–benefit ratio together, after which this should be discussed with the patient—if possible—and relatives. During transfer, the accompanying physician is responsible for both the patient’s safety and treatment. This physician will have the best understanding of the risks of the transfer and will be the one to give the “go/no-go” decision for the transfer.

Since the transport/transfer is a continuation of the treatment, one is obliged to document all changes in the patient’s physiology and in treatment; this record becomes part of the patient’s medical record. During the formal handoff, the clinical situation before, during, and after transfer—as well as

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**FIGURE 11.1** Example of an intrahospital transport checklist developed by Brunsveld-Reinders et al. (From Brunsveld-Reinders AH, Arbous MS, Kuiper SG, de Jonge E. A comprehensive method to develop a checklist to increase safety of intra-hospital transport of critically ill patients. Crit Care. 2015;19:214.)
Chapter 11  Transferring Critically Ill Patients

**During transport**

<table>
<thead>
<tr>
<th>At destination</th>
<th>YES</th>
<th>NO</th>
<th>NA</th>
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<tbody>
<tr>
<td>Plug in oxygen</td>
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<td>Plug in air</td>
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<tr>
<td>Switch off oxygen &amp; air on trolley</td>
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<tr>
<td>Plug in transport trolley</td>
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<tr>
<td>Check visibility on monitor during procedure</td>
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**Medication and fluids administered**

<table>
<thead>
<tr>
<th>Medication</th>
<th>Dosage</th>
<th>IV fluids</th>
<th>ml</th>
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<tbody>
<tr>
<td>Phenylephrine</td>
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<td>Saline solution</td>
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<tr>
<td>Midazolam</td>
<td></td>
<td>Voluven</td>
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<tr>
<td>Propofol</td>
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<td>Ringer’s lactate</td>
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</table>

*Only the clinical parameters that are also recorded in ICU*

<table>
<thead>
<tr>
<th>Vital signs</th>
<th>Pre-transport</th>
<th>20 min</th>
<th>40 min</th>
<th>60 min</th>
<th>Post-transport</th>
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</thead>
<tbody>
<tr>
<td>Time</td>
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<tr>
<td>HR/Rhythm</td>
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<td>BP</td>
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<td>MAP</td>
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<td>CVP</td>
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<tr>
<td>PAP</td>
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<tr>
<td>Vent mode</td>
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<tr>
<td>FIO₂</td>
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<tr>
<td>PEEP/PS</td>
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<td>RR</td>
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<tr>
<td>Tidal volume</td>
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<td>Minute volume</td>
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<td>SpO₂</td>
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<td>ETCO₂</td>
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<td>GCS</td>
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<tr>
<td>Pupil L/R</td>
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**During transport**

<table>
<thead>
<tr>
<th>Connecting patient</th>
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<th>NA</th>
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<tbody>
<tr>
<td>Turn on humidifier</td>
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<tr>
<td>Stop extra sedatives</td>
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<tr>
<td>Start enteral nutrition</td>
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<td>Start enteral insulin</td>
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<tr>
<td>Untangle i.v. tubes</td>
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<tr>
<td>Switch patient in PDMS to “Back in ICU”</td>
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<tr>
<td>Check level i.v. pump with PDMS</td>
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<table>
<thead>
<tr>
<th>Transport trolley</th>
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<th>NO</th>
<th>NA</th>
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<tbody>
<tr>
<td>Complement transport bag</td>
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<tr>
<td>Change Oxygen tank if level &lt; 50 bar</td>
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<tr>
<td>Change HME filter</td>
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<tr>
<td>Plug in transport trolley</td>
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<tr>
<td>Report procedure in medical chart</td>
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<td>Change suction If used</td>
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<tr>
<td>Report incidents</td>
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Specify:

Physician: ...................................... Signature: .....................
Nurse:  ...................................... Signature: .....................

FIGURE 11.1 (Continued)
as treatment given—should be extensively discussed. It is only after this formal handoff that the transfer has been completed. For quality purposes, the transfer organization should keep record of all transfers.

Conclusion

Transporting critically ill patients is crucial to the public health system and will continue to be of vital importance in the future. Although every transport is a potential risk for our patient, it can be performed safely when circumstances are optimized. Transport teams with both experience in treating critically ill patients as well as insight into risks related to the actual transfer can provide such a safe transfer; this is as true with inter- as with intrahospital transports/transfers.

Key Points

- Interhospital transfer of critically ill patients should be carried out by specialized retrieval teams.
- All involved in transport should receive transfer training.
- Transfer training should focus on preparation, teamwork, equipment, mobility, and safety.
- Equipment used should meet both ICU and transfer standards.

Acknowledgment

The authors thank the previous edition’s authors for their contributions.

References