Patient transportation

Skills and techniques

Update 2011

Module Authors (Update 2011 and first edition)

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LEARNING OBJECTIVES

After studying this module on Patient transportation, you should be able to:

1. Identify the risks and benefits of inter-hospital and intra-hospital transport
2. Effectively plan the transfer of a critically ill patient using a team approach
3. Safely conduct patient transfer and deliver needed interventions
4. Discuss appropriate pre-hospital care based on assessment of the patient’s condition

FACULTY DISCLOSURES

The authors of this module have not reported any disclosures.

DURATION

6 hours
INTRODUCTION

Transportation of the critically ill patient is inevitable in most health systems. Pre-hospital transportation may be necessary after major injury or as a result of life-threatening illness – for example, myocardial infarction, intracranial haemorrhage, or metabolic coma.

Critically ill patients may be transported between institutions or within an institution. Reasons for transportation may include a diagnostic procedure (e.g. CT or MRI scan), a therapeutic intervention not available at their original location or for tertiary Critical Care. The increasing cooperation between medical institutions and specialisation of institutions – such as the sharing of intensive care units or diagnostic devices and bed availability organisation – is likely to increase the need for transport of critically ill patients. This increased need might also be stimulated by the ongoing debate that high volume centres may have possible outcome benefits for patients.

Transportation of a critically ill patient requires the ongoing delivery of organ support in an unfavourable environment. Failure to prepare both the patient and the transport team may lead to sub-optimal delivery of care to the patient. This may constitute a threat to the patient and lead to avoidable adverse events and such experiences may lead to stress and possibly post-traumatic stress disorder in caregivers. Thus, risks and benefit of a transfer must be assessed during the planning phase, which must include:

- Full assessment of the patient’s condition
- Assessment of the perceived advantage of the transfer
- Initiation of appropriate support including the staff and resources, to achieve resuscitation and stabilisation
- Checking of transport equipment.

The principles of transport are identical for pre-hospital, inter-hospital or intra-hospital setting. It is particularly important that the expected benefits of the transfer for the patient are identified. Therefore the appropriateness of the transfer can be assessed and balanced against the risks.


This module focuses mainly on adult transport. However, the principles of transport are the same for paediatric patients. In this module, hospitals sending patients elsewhere will be described as referring (or referral) hospitals while those receiving patients from outside will be termed receiving hospitals.
1/ APPROACH TO TRANSFER OF CRITICALLY ILL — RISKS VS BENEFITS

The risks of transport should be offset by an expected benefit for the patient. Every transport needs a clear indication and if there is a patient deteriorating during transport, it may be necessary to abandon the trip and withdraw to the safety of an intensive care unit (ICU) (‘Plan B’).

Although there are differences between pre-, intra- and inter-hospital transfer (such as: indication, duration of transport, environment of transport, availability of help in the event of a complication, lighting, available space for work, equipment, and others), the main considerations and principles for preparation are similar. Pre-hospital or primary transfer will be discussed in more detail in the PACT module on Multiple trauma.

Inter-hospital transfer is often referred to as secondary transport and alludes to patient transfer from one health care institution to another. Intra-hospital transfer relates to patient transport within an institution, e.g., transfer of a patient from the ICU to a hospital diagnostic suite.

If an ICU bed is not available within an institution, a patient may be stabilised in the Emergency Department or the Operating Theatre while inter-hospital transportation to another facility is arranged. Such preparations may be associated with sub-optimal transport of a critically ill patient and the transport team should pay extra attention when starting a critical transport from an environment outside the ICU.

⚠️ It may seem that intra-hospital transport of an intensive care patient poses fewer risks than an inter-facility transport because the safe environment of the hospital is not abandoned. However, you could be stranded in the radiology department with a non-functioning gas supply. Accidental dislodgement of intravenous lines or endotracheal tubes might happen in any environment, such as hospital corridors or within an ambulance and are always an acute emergency. Further, specific risks may be encountered in intra-hospital transfer, e.g., in the MRI suite, which are not an issue in inter-hospital transfer. Thus, be prepared for the worst-case scenario and consider postponing an intra-hospital transport if necessary.

Patient transport is a clinical skill like placing a central venous line and requires a training process. Only experienced staff should accompany a critically ill patient. Benefits and risks should be weighed in every critically ill patient before transport.

*Sometimes the youngest resident is sent on a patient transport. This is suboptimum allocation of human resources and may suggest that those responsible for allocation of personnel have little experience themselves in patient transport and may not be aware of the possible mishaps. Proper 'hands-on' training, perhaps with competency certification on the use of the transport equipment should be provided. Such training should include a number of transports executed under close supervision.*
A young woman suffered from non-Hodgkins Lymphoma and developed progressive respiratory insufficiency. Due to her neoplasm, severe secondary amyloidosis was noted, including amyloid cardiomyopathy and extensive deposition of amyloid fibrils in her skin and oral cavity. Respiratory rate was above 30/min and transcutaneous oxygen saturation was around 85%. A 40 minute transfer was planned to a university hospital. Upon notification the physician at the receiving hospital suggested the patient be intubated before departure. However, the referring physician declared mechanical ventilation unnecessary as this was the patient’s chronic medical condition and the transport was started with two paramedics. However, the patient’s condition rapidly deteriorated and the young woman died during transport. In addition to the apparent tragedy to the patient, this episode caused severe psychological distress to the transport team, which was not trained to transfer such a patient. The situation was poorly assessed by the referring physician. Better planning might have saved the patient’s life and/or prevented distress for the transport team.

Local arrangements are normally in place to ensure that there is clarity regarding the identification of the physician/team responsible for the transport.

**Indications for transport in critically ill patients**

- Need for additional technical and professional expertise e.g. neurosurgery, interventional radiology, percutaneous transluminal coronary angioplasty, continuous renal replacement therapy, organ transplantation, and specific critical care interventions such as mechanical ventilation in prone position.
- Organisational aspects e.g. lack of available beds, massive influx of patients.

Due to increasing options for diagnostic and therapeutic interventions outside the ICU, there seems to be a growing need for **intra-hospital** intensive care transports to places such as the CT, MRI, angiography suite, radiation therapy department or the operating room.

Depending on the local situation – for example, small rural hospital vs. large specialist centre – the frequency of **inter-hospital** ICU transfers will vary considerably. But even in large specialist centres **inter-hospital** transfer may still be indicated in some circumstances e.g. transfer to undergo organ transplantation.

Potential benefits should be discussed by senior ICU staff members and any other relevant experts before a decision to transfer is made.

**Q. Why might an inter-hospital transfer between large specialist centres be indicated?**

A. Not every tertiary centre specialises in the same services. For a liver transplant or coiling of an intracranial aneurysm, inter-hospital transfer may be the only way to ensure that your ICU patient receives appropriate care. Furthermore, lack of availability of ICU beds is common in some jurisdictions, sometimes more common in larger units.
Ethical considerations

Lack of ICU resources as a reason for inter-hospital transport may pose an ethical dilemma for the entire team. A medicolegal consideration could be the existing doctor–patient relationship established with other patients before the last patient was admitted. In that case the rule ‘last in first out’ has sometimes applied.

However, as ICU physicians, we are not only are responsible for a single patient, but for the entire cohort of ICU patients and potentially, all patients within the hospital and health system. Therefore another approach might be to choose a less critically ill patient in the unit to be transported to another institution within a network of ICUs. This might constitute better allocation of overall ICU resources regionally. Such decisions are difficult and should be taken after senior discussion with the interests of the patient involved as the primary consideration.

Such a situation requires cautious communication with other members of the medical team, e.g. surgeons, and with family members who may focus only on their individual relative. The transfer creates the problem of exposing a patient to risks of transport without evident benefit to that individual, other than the patient being looked after at a more appropriate (or sub-specialised) level of ICU. A dedicated system such as a mobile intensive care unit (MICU, including specialised team and equipment), if available, should minimise the risks especially in these situations.

See the PACT modules on Ethics and Communication.

**Note** If an investigation requires intra-hospital transport, always consider whether the results will have clinical consequences. Often, a procedure can be postponed. It may be possible (and much safer) to perform such an examination if the patient is requiring less organ support. Often, the physician ordering a diagnostic or therapeutic procedure outside the ICU does not accompany the patient during transport and may be unaware of the associated risks. Thus they cannot fully perform a risk/benefit analysis for transport without advice.

With the introduction of digital picture archiving and communication systems (PACS) radiographic images may be transferred electronically, rather than transferring the patient.

An 82-year-old man was admitted to a small hospital. He had a GCS of 5 after suffering a severe intracranial bleed and was quickly transferred to a university clinic. When the patient arrived at the emergency department of the university clinic, the neurosurgeon refused any intervention based on the patient’s CT scan, age, and clinical presentation, and demanded that the patient be transported directly back to the referring hospital. Better communication between the two hospitals would have made the transfer unnecessary.

### Risks of transport of critically ill patients

- **Technical complications**: e.g. displacement of the tracheal tube, intravascular lines, drains etc.
- **Pathophysiological deterioration**: e.g. increased intracranial pressure as may occur from the lowering of a head-injured patient from semi-recumbent to recumbent position for a CT scan, arterial hypotension, decrease in oxygen saturation.
- **Inadequate monitoring of cardiovascular and pulmonary function** due to less sophisticated monitors or equipment/interference due to motion, etc.
- **Inadequate therapy due to lack of appropriate equipment** – many transportation ventilators cannot deliver the modes or levels of ventilation as a high-end ICU ventilator. (Note newer ICU ventilators may be used for transport and are even becoming MRI compatible).
- **Additional movements during transport** (acceleration forces during aeromedical or ambulance transport, tilting/lifting of patients from bed to trolley), may cause dislocation of fractures, fibrin clots, sutures, vascular emboli, etc.).
- **Lack of immediate access to additional investigations or therapy if needed** e.g. no chest X-ray in an ambulance to diagnose/exclude a pneumothorax or extra unit of packed cells/clotting factors in case of acute haemorrhage.
- **Limited number of people involved in the transport**, lack of more senior people immediately to hand.

Clinical studies on ICU transport have noted an incidence of up to one technical and/or clinical adverse event per transport. The large majority of these incidents are preventable and relate to equipment, patient care, communication, planning etc.

*Is the transport team familiar with a planned intervention, e.g. in interventional radiology? Not all ICU nurses or physicians will always know what to expect. Some interventions such as digital angiography need to be performed under apnoea, i.e. involving the use of muscle relaxation. A lack of medication and material may lead to a delay in the intervention*


Study the transport documentation for the last five patients transported within your hospital or between hospitals. Were there critical incidents during transport? How serious were they (minor or potentially life-threatening)? Could these critical incidents have been anticipated, and possibly avoided, with better planning? Be aware of under-reporting of critical events. Even though automated documentation of vital data and machine settings can be captured using a patient data management system (PDMS), such systems are only starting to be used outside the ICU.

Check your own equipment for ICU transport. Imagine clinical situations in a radiology room which you might not be able to handle, forcing your to return to the ICU. Consider updating or expanding the material on your transport unit.

Q. Which patients and situations face an increased risk of adverse events during transport, and why?

A.

- Paediatric patients: even small movements of the patient or associated equipment (e.g. endotracheal tube) may lead to disconnection or dislocation of the tubes and lines.
- Transfer at night: this may mean fewer staff or staff with less experience resulting in sub-optimal planning, preparation of conduct of transfer. Poor lighting may impair tasks and make correct dosage of medications or the recognition of complications more difficult.
- Patients with increased intracranial pressure: often it is not possible to elevate the upper body for transport and positioning of the patient e.g. in the CT or MRI suite.
- Patients with increased positive airway pressure (> 40–50 cmH₂O) during ventilation: many transport ventilators will not generate enough driving pressure or PEEP to sufficiently oxygenate very obese patients or those with severe ARDS.
- Abrupt change of clinical team: information may be lost if the transfer team has no connection with the team previously providing care and has not had sufficient time to get a proper clinical picture of the patient. Every handover of information poses the risk of information being lost.

Q. What should be done before transport to minimise the risk of critical events during transport?

A. Adequately stabilise the critically ill patient. Use checklists and guidelines. It is safer to intubate and mechanically ventilate a patient in respiratory distress in the ICU before transport than to wait for clinical deterioration and be forced to perform intubation in an elevator, ambulance or aircraft. The same holds true for starting vasoactive agents and, therefore, gaining central venous access.
A patient in cardiogenic shock at a local hospital was scheduled for a transfer of approximately 90 km to a university clinic after the nearby receiving hospital declined to accept the patient due to lack of the specific resources required for the patient. In spite of a poor weather forecast, the referring physician ordered a helicopter transfer, and the patient left the hospital with the helicopter team. The pilot in charge first considered weather conditions acceptable. However, after 15 minutes the weather conditions worsened, the clinical status of the patient deteriorated, and the transfer was abandoned. The patient died shortly after returning to the referring hospital. Discussions held subsequently suggested the need for better communication with the nearby receiving centre, including the use of triage and prioritisation of all patients/referrals. This might have made the mission unnecessary, eliminating an additional risk for the air transport team.

See the following references and the PACT module on Communication.


Guidelines

Many critical care medicine societies and specialty training bodies have guidelines dealing with indications for transport of critically ill patients. They are available online:


Electronic version of the Warren J et al. reference, see http://www.sccm.org [Click LearnICU/Administration/Administrative Guidelines]

College of Intensive Care Medicine of Australia and New Zealand – http://www.cicm.org.au/ [Click Resources/Policy Documents/]

The Intensive Care Society (United Kingdom) – http://www.ics.ac.uk [Click ICM Professional/Standards & Guidelines]


2/ PLANNING THE TRANSFER OF A CRITICALLY ILL PATIENT

The large majority of incidents relating to patient transportation are preventable with adequate planning.

Deciding to transport the patient

The decision to transfer a critically ill patient to another facility should be made jointly by the referring and receiving critical care physicians. This decision is influenced by multiple factors:

- Course of the disease, tendency toward improvement/deterioration, expected benefit for the patient from advanced treatment in the receiving centre.
- Staffing for transfer: medical, paramedical. (Seniority of the staff and their experience are key issues).
- Logistics: equipment, resources, e.g., patient weight/weight limit of stretchers, size capacity of CT trolley.
- Transport conditions: distance, route, weather.
- Alternative modes of transportation, e.g. fixed wing aircraft rather than helicopter in poor weather conditions, mobile Intensive Care Unit (i.e. ambulance) rather than helicopter when bulky equipment such as intra-aortic balloon is required for transfer.

Every transport poses an additional risk to the critically ill patient. If there is any doubt, the risk-benefit analysis must be reviewed with the senior member of the transport team, who carries final responsibility during transfer.

Immediately before commencing the intra-hospital transport of an ICU patient to the operating room or the radiology department, make a final phone call to ensure that the department is still ready to accept the patient as planned. Sometimes emergencies in the receiving departments make the acceptance of an ICU patient impossible despite prior arrangements, possibly made hours ago. With an unstable patient, have somebody reserve elevators and check that hallways are clear.

Lengthy procedures in the radiology department require even more meticulous preparation. Bring sufficient medication and fluids with you. Blood gas or other laboratory analysis should continue if required provided there is adequate assistance for transport of blood samples.

A so called ‘time out’ of the transport team before departure has successfully been used as a security check. Items on a checklist would include the following:

Even if a critical care patient is in severe cardiogenic shock due to ongoing myocardial infarction, the expected benefit of primary percutaneous coronary intervention could outweigh the high risks of inter-hospital transport. The balance between time-consuming pre-transport stabilisation and delaying the intervention is crucial.
• Patient’s name and complete list of diagnosis including reason for transfer.
• Complete documentation including radiography, laboratory, patient’s chart.
• Exact location of the destination e.g. the receiving unit within the receiving hospital. Also the shortest route from the landing pad/ambulance park to the unit or assignment of an escort to accompany the transport team.
• Final check of weather condition with respect to road/air transfer and planning of alternative transfer route/medical institution.
• Name, position and phone numbers of the senior physician responsible for the transfer and also the responsible physician at the receiving hospital, who will take over the care of the patient.
• Checking of all medical equipment for transfer including advance planning in case of deterioration. Advance preparation of medication and syringe pumps will be easier in the warmth of an ICU as compared to the close confines or a shaky helicopter or ambulance cabin with possibly poor lighting.
• Duration of the transfer and subsequent calculation of supply of medical gas, medication and other equipment (see Q on page 19).
• Advance knowledge of plan B with subsequent necessary medical equipment and medication.

Even though many of these tasks are the clear responsibility of a defined team member (road condition for the driver, medical condition to the physician) it is of mutual interest that the entire team is aware of the risks and alternative possibilities of the transfer.

Creating a specific transport checklist for your own department seems fairly easy but using a ‘checklist for checklists’ might help to address design and implementation issues which are sometimes unfamiliar for nurses and physicians.

- http://gawande.com/the-checklist-manifesto

During inter-hospital transfer, communication between the transport team and referring/receiving specialists may be required to address specific medical details or to ask for additional resources. It is also important that the transfer plan provides for appropriate communication between referring and receiving specialists.

Assign specific roles for specific members of the transport team, e.g. who is responsible for artificial respiration including ventilator settings and positioning of the endotracheal tube. Other necessary tasks such as administration of medication should be assigned to someone else.
Several transports occur in the middle of the night or during weekends. Pre-set roles and rules facilitate the transport at any time and prevent incidents.

Q. A 205 kg patient with suspected bacterial meningitis and decreased level of consciousness is scheduled for a 40-minute helicopter transfer from a local hospital to a university clinic for further diagnostic workup and medical management. As a member of the transport team, what preparations do you make before leaving to take over the patient at the referring hospital?

A. 1. Is the receiving clinic informed and ready to admit the patient; who is the responsible receiving physician?
2. What is the clinical status of the patient? (the ABC of ACLS/ATLS may serve as a guide to assess the clinical status). Is there a need for securing the airways or artificial ventilation? What are the settings on the ventilator, e.g. PEEP and FIO₂, the number and medication of syringe pumps.
3. Where exactly is the patient expected i.e. ICU vs. CT or MRI suite vs. emergency department? Is the team and necessary equipment ready to continue intensive care in that room? – remember weight limits of the CT trolley, number of syringe pumps etc.
4. What are the alternative modes of transfer? e.g. road ambulance vs helicopter. What are the needs and limits e.g. weight limit of the stretcher, legal requirements for fixation of the patient in a helicopter. Special heavy duty transport stretchers may be needed (possibly from the fire brigade). Such meticulous planning will take time but may help reduce the actual transport time.

Transporting the patient

Early versus late transfer – The need for stabilisation

In transporting critically ill patients there is always a delicate balance between speed and safety.
The time needed to stabilise a critically ill patient varies considerably and, occasionally, is not possible. In cases of acute myocardial infarction or cerebral stroke, an ICU patient should be transported as soon as possible to a cardiac catheterisation lab or a stroke unit. In other situations however several hours may be taken to optimise the patient and make proper preparations for ICU transport e.g. before transfer for renal replacement therapy.


THINK: Apart from a paramedic and/or an emergency physician, other personnel may be of help during transport e.g. midwife, paediatrician, extra-corporeal circulation technician. Do you know how to contact these personnel in your institution and how much advance notice they need?

Recognise which urgent treatments required by some critically ill patients are unavailable in your hospital, thus necessitating a transfer. Create a list of indications for immediate transfer.

Trauma patients, for instance, need to be referred to a trauma centre. For more about triage and the management and transportation of severe trauma patients look at the following flash conference:

ESICM Flash Conference: Mathieu Raux. Critical Care Refresher Course Trauma. Transportation of severe trauma. Barcelona 2010

The goal in transporting critically ill patients is to continue current ICU treatment as safely as possible and to provide additional treatment if necessary.
The transfer team

Providing critical care support within limited space and under difficult circumstances is considerably different from performing the same task in a hospital-based ICU. It requires – besides the usual professional skills – transfer experience. Randomised, controlled, prospective clinical trials addressing the transport of critically ill patients are lacking. However, there is circumstantial evidence that specialised transport teams provide better care, with decreased morbidity during and after transfer. Guidelines regarding the requirements for the transfer of an individual ICU patient, in terms of the competencies, specialty, grade and experience of the medical escort, are non-specific but the quality of the escorting personnel and the resources/equipment available to them are the most important determinants of the ‘transportability’ of a critically ill patient.

For inter-hospital (ambulance and air medical) transport, additional training is required for a physician to be able to adequately provide critical care support outside the ICU. The level of training of emergency medical technicians, registered critical care nurses, or employees of commercial air medical companies differs considerably between countries. It is recognised that continuing (para)medical education, quality audits, and regular professional experience in both hospital-based and transportation critical care are essential.


Transfer equipment

Trolley

Examples of custom-made intra-hospital trolleys for intensive care or anaesthesia transport.

In order to safely continue ICU treatment during transport, mobile ICU equipment is mandatory. This equipment may be mounted on a dedicated ICU transfer trolley, which is mechanically coupled with the ICU bed in the case of intra-hospital transfer. This coupling is often custom-made and should have a firm mechanical mounting and quick release mechanism. Careful design of such a tailor made trolley requires knowledge of the dimensions of essential elevators in the hospital and even those to remote locations. Mounting of equipment for use in ground or air ambulances may have to satisfy the special requirements of the relevant transport authorities.

Newer transport equipment may be suitable even for MRI suites so that changing equipment is not necessary.
Task 2. Planning the transfer of a critically ill patient

Examples of an inter-hospital Mobile ICU trolley in combination with a dedicated Mobile ICU ambulance

Note the ergonomic quick coupling of trolley and bed, preferable at the foot for optimal access at the patient’s head

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Every change in monitoring or equipment poses a risk for the patient.

Anecdote A young woman with twin pregnancy in labour was successfully transferred to a university clinic. Contractions were diminished using tocolytic drugs. During handover of the tocolytic medication, the syringe was removed from the pump without closing the 3-way stop cock. The patient received a bolus of beta-stimulants and developed severe tachycardia leading to emergency caesarean section.

Equipment for monitoring and physiological support

All ICU equipment considered essential for monitoring and treating the critically ill patient should be used during transfer. Modern ICU equipment, e.g. high specification ventilators, is often suitable for use during transfer, with internal batteries for stand-alone use and options for data storage. It should be robust and firmly attached to the patient trolley to limit the risk of disconnection, dislodgement/damage or causing injury to patient/staff.
**What to monitor**

- Three-lead (or more) ECG with heart rhythm and assessment of the ST segment
- Invasive pressures (or if too time-consuming or not available, non-invasive blood pressure may be acceptable)
- Haemoglobin oxygen saturation
- End-tidal capnography
- Temperature.

**Note** During transfer of mechanically ventilated patients with serious head injury, monitoring end-tidal capnography is crucial to prevent hyper- or hypocapnia with possible cerebral vasodilation or constriction and consequent changes in intracranial pressure or ischaemia. Increased mortality has been reported after severe hypocapnia (PaCO2 < 3.5 kPa or 27 mmHg).

**Note** End-tidal CO2 (PetCO) at 20 minutes post intubation has been shown to be predictive of mortality in blunt trauma, ventilated patients. Only 5% of patients with PetCO2 < 3.25 kPa (24 mmHg) survived to discharge – another reason for using end-tidal capnography to monitor and guide management of trauma patients during transport.


Inadvertent hypoventilation with hypercapnia in a patient with pulmonary artery hypertension may lead to acute right heart failure, especially early following cardiac surgery. Capnography with close alarm limits is important to a successful transport from the operating room (OR) to the ICU.


**Defibrillator/pacemaker**

Today’s advanced automatic external defibrillator/pacemaker no longer requires a bulky screen and paddles, and is easy to store. Attention should be paid to ensure disposable paddles, with the appropriate connections, are replenished after use.
Mechanical ventilator

ICU patients with severe respiratory dysfunction requiring high levels of PEEP may be transferred more safely by remaining on their ICU ventilator, if it is portable, rather than changing to a simple transport ventilator. However, ICU ventilators usually need an electricity supply and a compressed air supply, which may not be available in all ambulances. If a patient's oxygenation is dependent on high PEEP with severe respiratory failure, clamping the endotracheal tube before disconnection and changing the ventilator quickly may be essential to avoid lung collapse.

**Q. How could you find out before transport whether your portable mechanical ventilator is suitable for use during transport of patients with severe respiratory insufficiency?**

A. In many portable ventilators the airway pressure is dependent on the pressure of the oxygen cylinders. When this pressure is insufficient to deliver the necessary Pmax and/or PEEP, hypoventilation or desaturation may occur in patients with severe respiratory insufficiency. Before transfer of the patient on the MICU trolley, a short period on the portable ventilator (10–15 mins) should prove its suitability (trial period).

Benchmark reports are currently available for transport ventilators. These may be of assistance when deciding which machine to purchase.


Cylinders with pressurised oxygen and air

The number of oxygen bottles that must be transported to ensure an adequate supply is dependent on the duration of transfer and the size/capacity of the cylinders. Ensure all cylinders are full before transport. Hoses and adapters for the supply must be compatible in the facility, ambulance and aircraft (wall connections reduce the number of cylinders that can be transported). Cylinders are indispensible for transit in elevators and corridors. Ground and air ambulances may have pressurised oxygen and air.

The hoses and plugs for oxygen and pressurised air on transport trolleys are more prone to wear and tear than equivalent stationary fittings in the ICU. Therefore annual maintenance and premature replacement of vulnerable parts should be integrated in the safety management system of your intra- and inter-hospital transport system.
**Q: How do you calculate the time a cylinder with pressurised oxygen will last?**

**A:** The barometer of the cylinder displays the pressure e.g. 200 bars (200 times the normal ambient pressure). For a five-litre cylinder, the amount of oxygen available will be 5 litres x 200 = 1000 litres. If the patient is ventilated with 15 litres/min and FIO2 of 50% you need 7.5 litres O2/min. The time for the cylinder to empty is 1000/7.5 = 133 min. With many portable ventilators you will also need additional pressurised air.


**Syringe pumps**

As more drugs are available with a very short duration of action and better titratibility, syringe pumps are increasingly being used for administration of sedatives, analgesics or vasopressor support.

Before any transport, the staff check:
- If enough spare syringes are available to cover the patient’s needs during transport
- For special and adequate tubing, depending on the type of pump
- For battery power and number of wall sockets available in the ambulance or at the receiving site
- Which medications are indispensable and which may be interrupted temporarily.

**Note** Different hospitals may use different modes of calculating and applying medication in syringe pumps, e.g. mcg/kg/min, mcg/min, mg/hour, ml/hour, or even number of drops/minute in infusion pumps. In addition, the concentration of medication in the pumps may differ from one ICU to another or even within a hospital.

The above may be the root cause of an adverse event during changing of pumps. Be aware of the differences in concentration and have someone check the correct dosage together with you. If in doubt, draw new syringes with the concentration you are used to, rather than taking over some awkward concentration at the referring hospital. Remember you will need to communicate the correct dosage at the receiving unit.
In many helicopters the ceiling is not high enough to guarantee a sufficient spontaneous flow (due to gravity) for i.v. fluids. Thus, pressure bags or additional infusion pumps may be needed for every infusion. Glass bottles should be replaced by non-breakable plastic containers which allow the application of external pressure. Beware of the risk of air embolism in any intravenous line in a pressure bag.

**Suction equipment**

For critical care purposes, machines should be capable of suctioning fluid at a rate of at least 25 l/min. If the unit is used for suction on a pleural drain, another unit should be available for other indications, e.g. suction of tracheal or oral secretions.

**Emergency kit**

Additional equipment that does not require a lot of space, such as intubation material, is often stored in an emergency kit. A separate emergency medication kit should be easily accessible and stocked before each trip with patient-specific and refrigerator-kept drugs as needed.

Bring a limited, standard set of disposables instead of storing all possible items in a bulky emergency suitcase. If stabilisation prior to transfer is adequate, the material is seldom used. The case could be sealed – allowing for for quick inspection prior to departure combined with weekly checks on expiration dates, battery capacity etc. Clear labelling increases awareness of where specific material is stored, and avoids time-consuming searches for material in an emergency.

Finally it is advisable to tick off a comprehensive transport checklist before each departure. The record is important to medical management and to the transfer of care and may subsequently be requested for medicolegal purposes. The last item on the checklist should be the replenishment of all used/opened materials once the team has returned to base (preparation for the next transport).

Put together an emergency kit including equipment and drugs for your ambulance with the minimum medications you consider indispensable for transport of a critically ill patient. How many ampoules of which drugs would you include?

A final check of the emergency case is mandatory before you leave a relatively safe environment such as the emergency department or ICU. Be sure to check batteries, cylinders and expiration dates!

**Additional equipment**

Some ICU treatments, such as continuous veno-venous haemofiltration, are not designed to be mobile and are rarely indicated during transport. However, with
adequate preparation, treatment with an intra-aortic balloon pump or extra-corporeal cardiac or respiratory assist device is feasible.

If a transport is expected to take longer than two hours, a mobile point-of-care laboratory might be helpful to evaluate mechanical ventilation or medication therapy like insulin or electrolytes and blood glucose.

Find out what equipment is needed to perform inhalation therapy during transport (e.g. inhaled prostacyclin or nitric oxide). Can your transport respirator deliver these therapies?

A list of recommended minimum transport equipment is given in the sources below. Click LearnICU/Administration/Administrative Guidelines on the SCCM website to access the electronic version.


Q. What should you ask yourself when deciding whether to use additional (non-essential) equipment during transport?

A. 
- How useful to patient care during the transport is the device?
- What are the risks for the patient if the device is displaced unintentionally (e.g. blood loss)?
- What is the battery capacity and what are the risks to the patient if the device shuts down?
- Is it safer to uncouple the device during transport because the risks outweigh the benefits?
- Do weight, size, possibility of firm attachment to ambulance or legal restrictions preclude the use of a device, especially in aeromedical transport?


Find out the technical limitations of equipment used during transport outside the ICU. What are the weight limits or patient size limits for stretchers being transported by ambulance or helicopter, and for CT or MRI patient trolleys? What are the maximum limits of the transport ventilator (peak inspiratory pressure, PEEP, minute ventilation)? Check the electrical current in your transport vehicle: is a 220 Volt AC current available, and how many sockets are installed? What is the maximum ampere limit of the electrical fuse and battery capacity of your equipment? Do you have replacement batteries? Find out what kind of equipment you may use during transfer, and which medical monitoring devices may interfere with the electronic equipment of your ambulance/air ambulance. Which specialised interventions can be performed in your ambulance (defibrillation in a helicopter, intra-aortic balloon counterpulsation in an ambulance, extra-corporeal cardiac assist device)?
3/ CONDUCT OF THE TRANSFER

The optimum is for a trained team to conduct the transfer according to pre-defined rules and protocols.

Safety

The transfer trolley and equipment should be checked before and after each transfer, with checklists to be signed for quality audit. Regular checks by members of other departments do not preclude an additional check by the intra-hospital transport team before the patient leaves the ICU to ensure that all equipment is functioning properly.

The use of a dedicated checklist just before departure (analogous to a ‘time out’ in the operating room) supports a systematic safety check of equipment and drugs.

Set appropriate alarm limits and ensure the alarm volume is loud enough to be heard.

A patient suffered from severe hypoxic brain injury during transport from the operation room to the ICU. The ventilator was functioning satisfactorily when checked while connected to mains electricity. However when not connected to the mains supply, it required pressure from the oxygen cylinder to function. However, the oxygen cylinders had not been checked and were empty; furthermore, the alarms were ignored during transport.

Special environments

Special arrangements must be made when in close proximity to MRI scanners which produce magnetic fields several times greater than that of the earth. All ferromagnetic material is attracted by such magnetic fields, which are active even when no scans are being performed. Transfers for MRI scans require specially designed, non-ferromagnetic equipment, which is usually available in/near the MRI suite. A less satisfactory alternative, using standard equipment secured outside the range of the magnetic field with long hoses and monitoring leads to the patient, may be used in some scanners.

Q. Before starting a transfer to the MRI suite, what limits and contraindications must be considered?

A. An absolute contraindication is the presence of ferromagnetic material in or on the body since it may vibrate, become hot or dislodged e.g. freshly implanted stents may be dislodged. Extra-corporeal metal such as ECG leads or splints used to secure an intravenous line may become hot enough to cause burns. Nowadays many implanted materials are non-ferromagnetic and thus compatible with MRI.

In many institutions it is the responsibility of the staff requesting MRI scanning to determine whether foreign bodies are compatible. Theoretically, information concerning MRI compatibility must be obtained for every single foreign body from the manufacturer. In everyday practice this is often not feasible, because it is unknown which device precisely is implanted, e.g. which model of a hip prosthesis. Based on clinical experience most implanted devices (such as stents, prostheses) without electronic control are suitable for MRI. Electronically controlled devices, such as...
pacemakers or infusion pumps, may not function properly during and after MRI and a need for their presence precludes MRI scanning. Standard medical devices such as ventilators or infusion pumps are not compatible with MRI and special arrangements/equipment must be used.

A relative contraindication to MRI is claustrophobia due to the narrow space inside the scanner and sedation or even general anaesthesia may be required for susceptible patients.

An example of what can happen when a metal object is placed in the MRI environment: In this case, a cleaner entered the MRI scanner room with a polishing machine, after removing all metal objects from his pocket. Fortunately no patient was being scanned at the time as the patient trolley of the MRI was completely destroyed.

Reproduced with the permission of the Academic Medical Centre, University of Amsterdam, Department of Radiology © 2004

Choosing the transport vehicle

For inter-hospital transfer, no scientific data are available to support a preference for ground vehicles (ambulance) over helicopters (rotary wing) or aircraft (fixed wing). The choice between ground and air transport depends on many factors, such as availability, staffing, infrastructure, costs, geography, and weather conditions. In many cases, ground ambulances could be a safer mode of transporting a critically ill patient because they often offer more space for diagnostic or therapeutic equipment and less noise and vibration than an air ambulance. In other cases, the time benefit with air medical transport may be considered more advantageous. Ground and air ambulances may be equipped to offer a similar level of care to a modern ICU.


Air medical transport

Indications

The use of air medical transport in Europe, the United States and Australia differs dramatically and is influenced by distances between hospitals, the history and development of medical services, cooperation with the military, geography, and insurance policies.

Choice of aircraft

The choice between rotary wing aircraft (helicopters) or fixed wing aircraft should be made following a risk and cost vs benefit analysis using criteria like travel distance, landing infrastructure, weather conditions, and clinical emergency. Medical staff, untrained in air medical transport, should not accompany such a transport, which is best handled by someone with expertise.


For more information regarding the choice of aircraft read the following reference:


Altitude effects

With increasing altitude, barometric pressure and temperature decrease and therefore the partial pressure of oxygen drops. Air ambulance cabins are usually pressurised to a pressure equivalent to 2000 m above sea level. Without supplemental oxygen, this may lead to hypoxia in critically ill patients. Even this moderate altitude may exacerbate decompression sickness.

Gas contained in a fixed space will expand with increased altitude/decreased pressure, according to Boyle’s law (P ∞1/V). In the case of intracranial, intrapleural or intra-abdominal air, this expansion could cause clinical deterioration and therefore air transport could be unsuitable. The air in the endotracheal cuff also expands, with possible tracheal damage. Therefore the endotracheal cuff volume should be adjusted. Some choose to deal with this issue by replacing the air with saline.
Acceleration/deceleration forces

When a supine patient is exposed to the force of sustained acceleration or deceleration in a vehicle or aircraft, blood flow is directed to the feet or the head depending on the patient’s orientation. Theoretically, this may cause cerebral underperfusion or excess perfusion (if the force exceeds cerebral autoregulation) with a risk of deterioration in patients with intracranial pathology. Cardiac preload and afterload may be influenced by such forces and may cause deterioration in haemodynamically compromised patients. In a ground ambulance, forces on the patient due to deceleration are usually greater than those due to acceleration. Studies on the deleterious effects of such forces are limited to air force pilots, and the clinical relevance for critically ill patients during medical transport remains to be determined. However, an understanding of dynamics and physiology keeps you aware of possible consequences.

Q. In which clinical situations might air medical transport pose an increased risk for the patient?

A. Air medical transport, with the increased height above sea level and decreased ambient pressure, may cause closed air spaces to increase their size, according to Boyle’s law e.g. an undrained pneumothorax, ileus/megacolon or intracranial air after open head injury. Patients with decompression sickness following diving mishaps may also deteriorate due to the use of air transport.

Q. What are the presumed advantages and disadvantages of airborne rescue compared with transport by ground ambulance?

A. Depending on weather, road conditions and distance, helicopters may arrive faster on the scene, and transport back to the hospital may also be faster. However, the available space is much smaller in a helicopter, it may carry less equipment, and in case of an adverse event with the patient, unlike a ground ambulance, the helicopter cannot just stop by the road to allow the transport team a calm moment to perform an intervention.

The answer to this question will be very dependent on the factors above and the jurisdiction and environment in which the question arises. In Australia, for example, it has been suggested that distances greater than 200km were faster served by air transport. A recent retrospective study of trauma patients observed that 5.61 more lives were saved per 100 patients in the group transported by air vs road transport.

For more information about the transport of patients with severe trauma, see ESICM Flash Conference: Mathieu Raux. Critical Care Refresher Course Trauma. Transportation of severe trauma. Barcelona 2010

Treating the patient during transport

Depending on the level of equipment mounted on the intra-hospital trolley (connected to the ICU bed) or the inter-hospital trolley/stretcher, treatment of the patient during transport may be similar to treatment in the ICU. For inter-hospital transfers, all the required supplies must accompany the patient. In contrast, for intra-hospital transport, many supplies will be available in, or can be delivered to, locations such as angiography or CT suite.

Pick a patient in your ICU and compile lists of medications and additional supplies you would take with you for intra-hospital and inter-hospital transport. Evaluate the differences.

A mobile ICU team was asked to transfer a 28-year-old morbidly obese male from a regional hospital to a specialist centre. The patient had pneumonia with severe respiratory insufficiency despite maximal mechanical ventilatory support using 100% O₂. Despite recruitment manoeuvres, clearance of bronchial airways and increasing PEEP and peak pressure, oxygenation did not improve. At the team’s suggestion, prone position ventilation was commenced and led to a dramatic improvement in oxygenation. The patient was transported on a stretcher in the prone position with pressure-controlled (PC) ventilation, FIO₂ 80%, Pmax 38 cmH₂O and PEEP 18 cmH₂O without complications.

Problems during transfer

What may happen

Adverse events (e.g. desaturation, persistent hypotension) or specific transport-related events (e.g. unintended extubation, loss of intravascular access) should be handled according to standard critical care practice. If required (and possible) the transport vehicle can be stopped to facilitate any procedure required by the situation. If the transport team is not part of the referring team, full knowledge of all medical details is essential for the treatment of such events.

Depending on the level of equipment and monitoring (for example, continuous pulmonary artery pressure monitoring), diagnostic clues to the cause of a particular event may be present. If a life-threatening event is unmanageable during transport, it is essential to go to the nearest ICU equipped for the advanced diagnostic and therapeutic procedures necessary.
Strategies to combat problems

Before leaving the safe environment of an ICU, plan for possible deterioration of the critically ill patient by organising appropriate additional therapy (i.e. medication, transfusions) to be taken along. Even a simple medical intervention such as placement of an intravenous line may not be possible in the close confines of a helicopter or an ambulance.

NOTE
Unborn babies should be transported in utero whenever possible. Consider taking along a midwife.

ANECDOYE
An ambulance team was called to transfer a pregnant woman with intractable bleeding after laparoscopic cholecystectomy for acute cholecystitis. After several laparotomies, which failed to improve the situation, it was decided that she should be transported to a specialist centre for further treatment. However, her blood pressure (90/60, mean 68 mmHg) was still dependent on fluid resuscitation including transfusion of red blood cells. What the patient needed was surgery first and admission to critical care later. When the ambulance arrived at the receiving hospital, the patient was admitted directly to the operating room. Careful evaluation, communication and synchronisation made a smooth reception possible; with the operating room, surgeon, anaesthesiologist and blood bank ready to play their role.

NOTE
Before transporting a patient after resuscitation for haemorrhagic shock, check that red blood cells and clotting products (platelets, fresh frozen plasma or concentrated factors) are available. However, if testing of blood takes too much time, remember that cardiovascular stabilisation depends more on the amount than on the type of fluid. Do not lose precious time waiting for blood products. However, remember that anticipating such a dilemma is the key to avoiding it!

Stabilisation of the patient

Even though stabilisation of a patient is desirable before starting a transfer, it is not imperative in all cases. Severely compromised patients may decompensate acutely with induction of anaesthesia and intubation.

Q: You are asked to conduct a 45-minute transfer of a 65-year-old man from a small country hospital to a university clinic. The obese, diabetic patient had felt uncomfortable and had experienced tachycardia and dysrhythmia for three days. Although the family physician had noted a subacute myocardial infarction on the ECG, the patient said he felt fine and did not need any help. You note supraventricular tachycardia with a frequency of 150–170 with a blood pressure of 90/60 mmHg (see ECG strip). His oxygen saturation is 88 % with a respiratory rate of about 25/min. How do you proceed?
A: This patient was taken to the cardiology suite without prior stabilisation where the transport physician was greeted with barely disguised scepticism by the cardiologists. However, when the patient was intubated for cardioversion he developed third degree AV block, (see ECG strip 2) and went into severe cardiogenic shock, necessitating immediate introduction of a pacemaker. An attempt at stabilisation before starting the transfer would have lead to the cardiogenic shock in the small hospital without the necessary resources for stabilisation.

ECG 2

**NOTE** If stabilisation of a critically ill patient is questionable, a scoop and run approach may be more appropriate. However, there is no universally accepted approach to such patients and personal experience including ‘gut feeling’ is important.

Q: You are asked to conduct a 30-minute transfer of a young pregnant (12th week of pregnancy) woman with suspected pulmonary embolism and cardiogenic shock and a previous history of severe obesity. Shortly after your arrival in the referring clinic the woman requires CPR due to electro-mechanical dissociation. On handover the physician-in-charge tells you that the woman has recently had laparoscopic bariatric surgery and had suffered from vomiting which was attributed to her pregnancy. A chest X-ray taken just
before your arrival shows a complete opacification of the left hemithorax. The patient’s haemodynamic status remains severely unstable despite administration of fluids and inotropes. How do you proceed before transfer?

Chest X-ray

A. The transferring (ambulance) physician suspected a fluid filled hemithorax of unknown origin and decided to introduce a thoracic drain. Approximately 3 litres of stomach contents were drained and the haemodynamic situation stabilised immediately. The transfer to the university clinic was then uneventful and the women survived without sequelae. The decision to ‘stay and play’ or ‘scoop and run’ often remains difficult and in this case the decision for action was correct as the patient’s haemodynamic situation could not be stabilised. Further investigation revealed that the stomach had herniated through the diaphragm with repeated vomiting and a gastric perforation had occurred leading to a collapse of the left lung, displacement of the mediastinum and cardiogenic shock. Possibly a small laceration in the diaphragm caused by the previous laparoscopic surgery was the initial port for the herniation.

THINK: how much time will be saved if an ambulance drives at maximum possible speed for a 40 km transfer between hospitals, e.g. for transfer of a patient with myocardial infarction and to what extent will the time saved influence the patient’s outcome? In comparison, how could you improve the process of care to save a comparable amount of time? Thus what are the possible risks and benefits of driving with emergency siren and flashing lights?


4/ PROVIDING PRE-HOSPITAL CARE

Successful pre-hospital care depends on early recognition of clinical problems, provision of basic life support, the skills of the transport team and the interventions it performs, rapid and efficient transport arrangements and the preparedness of the receiving unit.

The call out

Early access to emergency medical services (EMS) is important for rapid management of the critically ill or injured patient. Short, standardised numbers such as 112 in most countries in the European Union and 911 in the USA are the simplest way to provide rapid access. The dispatcher may then alert additional services, such as the police, fire service, helicopter service or specialists in assessment of dangerous substances such as chemicals or oil. A physician at the dispatch centre may be of particular help for efficient distribution of patients in case of multiple victims.

When receiving the initial notification of an emergency or while en route to the accident site, try to get as much information as possible from the alerting person. Use the transfer time to mentally prepare possible interventions, e.g. size of tracheal tube or dosages of medications for paediatric victims.

Q. Imagine you are the dispatcher receiving the call for help. What should you ask the person calling from the accident site? Six items of information are suggested here.

A. The more information you have, the better you can react. Important information includes:
1/ Who is calling and how this person can be reached in case additional questions arise
2/ What happened, i.e. type of incident
3/ The number of victims and their type of illness or injuries
4/ Kinds of victims (e.g. children, pregnant women)
5/ Where the accident happened and how to get there
6/ Whether additional rescuers are needed in addition to medical help, e.g. to extricate persons trapped in a car, to extinguish a fire, to secure the site e.g. risk of ongoing shooting.

Additional helpful information includes weather and road conditions and obstacles to air rescue.

Pre-hospital teams and their skills

Provision of pre-hospital care differs greatly between countries. Different specialists with different levels of training may be involved, such as emergency medical technicians (EMTs), paramedics, physicians and, in some systems, emergency clergy workers, psychologists and others.

The safety of the rescuers is important and must be considered first. Even moderate injury to a member of the pre-hospital team has two immediate effects; firstly it reduces the help available at the scene and secondly it produces an additional patient who requires assessment and treatment.

Good communication is the key to the success of a transfer team. Unless there is a severe shortage of personnel, the team leader should not get involved in direct patient care; his/her role is to give precise instructions to specific individuals. As in aeronautics, closed loop communication can be used to ensure successful transmission of tasks: i.e. the person who receives instruction repeats it to make sure that the instruction is understood.

For more information see the PACT module on Communication.

Whenever possible, a member of the pre-hospital care team should attend to the needs of relatives and bystanders, who may be severely traumatised by the events.

Q. A six-year-old boy was watching a rotating slicing machine cutting cabbage at a farm when the arm of his jacket got caught, pulling his arm into the machine. When you arrive at the scene, you determine that the boy has no serious A, B, or C problems, but his hand has been severely injured. The boy’s mother is standing by. Would you take the mother along for the 50 km ambulance ride? Explain your decision.

A. Providing the mother is reasonably calm and cooperative and there is sufficient room in the ambulance, it is advisable to take her along. Separation of the child from the family will cause additional stress for the child and the mother. A family member may be the best analgesic and sedative for the boy. Further, the mother can provide important information on the child’s health status, and she will understand that all efforts have been undertaken to save her child’s hand.


Patient assessment and care on the scene

The first step is to determine the patient’s status using the ABCDE system from the advanced life support algorithm. The most important initial question is: ‘Is there any serious A, B or C problem i.e. is the cardiorespiratory situation stable or unstable?’ If the patient is stable and there is no urgent need for transport, any D (neurologic disability) and E (exposure) problems can be investigated and...
comfort care e.g. good analgesia may be considered. This is the ‘stay and play’
approach.

If the patient is unstable, the second step is to decide if the problem can be
solved with simple means on the scene, e.g. extrication of a foreign object from
the pharynx or relief of a tension pneumothorax with a drain. If there is no fast
solution, as in the case of penetrating chest injuries, it is imperative not to waste
time, and the patient should be referred to an appropriate emergency centre,
e.g. a trauma centre. This is known as the ‘scoop and run’ approach.

In many emergencies, a ‘play and run’ approach may be appropriate: fast relief
of the most urgent problems e.g. insertion of a chest drain without orotracheal
intubation and fast transport to a trauma centre with minimal delay.

Q. Consider the following serious emergencies requiring a ‘play and
run’ approach: 1/ a toddler with third degree burns from a portable
heater; 2/ a factory worker with alkali liquid splashed in her eye; 3/ a
motorcyclist with a crush injury. What crucial treatment would you
perform before transporting each of these patients to the hospital?

A. 1/ In burn injuries immediate cooling of the burned body area is more important
than transport. However, beware of whole body hypothermia!

2/ Immediate and extensive flushing of the eye with plain water is the single most
important therapeutic intervention; examination by an ophthalmologist can follow
later.

3/ In crush injuries with extensive destruction of muscle tissue, generous and early
administration of crystalloids is needed to prevent acute renal failure.

Weighing the relative importance of transport time vs type of injury may be very
difficult and requires considerable experience/expertise. If extended transport
time is expected, treatment of life-threatening injuries must begin on the scene
and be continued during transport.

Injuries due to blunt trauma or medical emergencies may be more difficult to
diagnose than penetrating injuries. There may be no visible abnormalities, and
only minor clues. Furthermore, rescuers may react more quickly to obvious
injuries particularly if associated with significant blood loss. It is hardly
surprising, therefore, that blunt trauma has (statistically) a worse prognosis
than penetrating trauma.

See the following references and the PACT module on Multiple trauma.

Salomone JP, Ustin JS, McSwain NE Jr, Feliciano DV. Opinions of trauma
practitioners regarding prehospital interventions for critically injured

Excellent interactive sessions are available under
http://www.trauma.org/resus/moulage/moulage.html

There is no definitive evidence in the international literature on trauma
demonstrating the superiority of the ‘stay and play’ or the ‘scoop and run’ approach.

Some North American studies found that severely injured patients have a better chance of survival if they are transported as quickly as possible by private means (bystanders or police) without any medical treatment on the scene at all. However, the needs of an inner city penetrating trauma victim versus those of a patient suffering myocardial infarction on a hike are different. For myocardial ischaemia patients, the ‘stay and play’ involving basic and advanced life support as indicated has been shown to be effective. A compromise for immediate measures at the scene that has been suggested is: ‘do, but do it fast – and only if needed’.


Review the pre-hospital care report for the last five patients admitted to your ICU. Check if a decision was made concerning cardiorespiratory stability and note the procedures performed at the scene and the time spent out of the hospital. Evaluate the strategy adopted in light of later events in hospital and the final diagnoses.

The acceptable goals for vital parameters e.g. blood pressure during transport are decided on an individual basis for each patient.

Q: What is the minimum acceptable blood pressure in a patient following myocardial infarction compared to that in a patient who has suffered an acute ischaemic stroke?

A: A mean blood pressure of 65 mm Hg may be sufficient in the first patient, however, a mean blood pressure goal of at least 100 mm Hg may be considered in a patient with stroke.

See PACT modules on Acute brain ischaemia (Task 1 – immediate treatment/circulation) and Hypertension

Triage

In cases of multiple casualties, it is imperative to triage patients according to the ABCDE of the advanced trauma life support algorithm. Triage is a structured process used to recognise those victims in acute danger and those most likely to benefit from acute care. If the resources available are sufficient, triage will result in those who have the most serious conditions being treated first. If resources are limited and the facility is overwhelmed, triage may target those who need only simple or short interventions for treatment and those with severe injuries may only receive comfort care. The principles of triage apply not only to trauma victims but also to those with a medical emergency, e.g. myocardial infarction or...
diabetic coma. Similar principles apply to allocation of ICU resources as to allocation of resources in the pre-hospital setting or in the emergency room.

Imagine a bus accident with ten seriously injured patients. They will be admitted to your hospital within the next 15–120 minutes. On which criteria would you admit a patient to your ICU or send him on to the next institution. Would you transfer any of your presently admitted patients to another institution or to a normal ward in order to make room for one of the new patients?

For more information regarding triage and transportation of severe trauma patients look at the following flash conference:

**ESICM Flash Conference**: Mathieu Raux. Critical Care Refresher Course Trauma. Transportation of severe trauma. Barcelona 2010

For the ethical aspects related to triage see the PACT module on Ethics – Task 4 (admission and discharge policies).

**Other pre-hospital procedures**

**Immobilisation after trauma**

Although immobilisation of the spinal column after trauma is an integral part of the ATLS manual, there is debate over how much stabilisation is appropriate. Much time can be lost in extensive medical interventions (the ‘stay and play’ approach), such as fixation of the patient on a spine board. Further, the effect of spinal immobilisation on mortality, neurological injury, and spinal stability remains uncertain. Under no circumstances must a spinal immobilisation, especially of the cervical spine lead to compromise of airway patency, increase in intracranial pressure or agitation and panic due to claustrophobia with too tight an immobilisation.

Furthermore, spinal immobilisation, if prolonged can cause significant problems in critically care. Appropriate imaging and a proper assessment of risk v benefit should allow spinal immobilisation to be discontinued early in most patients.

Kwan I, Bunn F, Roberts I, on behalf of the WHO Pre-Hospital Trauma Care Steering Committee. Spinal immobilisation for trauma patients. Cochrane Database Syst Rev 2001; (2): CD002803. PMID 11406043. DOI: 10.1002/14651858.CD002803, update Jan 2009


http://www.cochrane.org/reviews/en/ab002803.html

**Prevention of hypothermia**

Hypothermia is one of three parameters along with coagulopathy and acidosis (the lethal triad) associated with poor outcome. Many factors contribute to
hypothermia in severe trauma patients. Monitoring of temperature, prevention of hypothermia or restoration of normothermia must be performed in all patients using ‘space blankets’, electrical blankets, infusion warming systems and other devices. Even though outcome may be improved with modest/moderate hypothermia following cardiopulmonary resuscitation, there is no evidence of benefit from moderate hypothermia in head trauma patients.

**THINK:** Crystalloids are the main fluid for intravenous infusion. How can delivery of crystalloids influence the lethal triad and what could be done to prevent possible side effects?


See also PACT on Multiple trauma

**Securing an airway**

Airway management may be difficult during transfer and there is little evidence on the effectiveness of pre-hospital intubation on outcome. See the PACT module on Airway management.

**Q.** You are about to start a 50 km transfer of an obese patient with acute coronary syndrome. The patient is sleepy and nauseated but cooperative, following intravenous morphine. His blood pressure is stable with a mean pressure of approximately 75 mmHg. In which situations would you consider securing the patient’s airway before departure?

A.

- Difficulty keeping the airway open, e.g. obesity and increased sleepiness following morphine. Airway protection deserves special consideration in case of increased nausea or vomiting.
- Difficulty ventilating, e.g. heavy snoring, worsened sleep apnoea with obesity and morphine.
- Difficulty oxygenating, e.g. pulmonary oedema in left ventricular failure.

**Q. What are the disadvantages of orotracheal intubation?**

A. Intubation may render the situation more difficult: the patient will need sedation with risk of increased cardiovascular instability. In the case of accidental extubation, the situation may really get out of hand, as airway control is even more difficult outside the safe confines of the ICU.

**The receiving unit**

The choice of the receiving hospital may be as important as pre-hospital care. There is some evidence that patients referred to centres with higher numbers of
emergency admissions may have better outcomes than those referred to smaller hospitals. However, stabilisation of vital parameters at a smaller institution with secondary transfer to a (larger) receiving hospital may be appropriate when the total transfer distance or time is great.

Be particularly suspicious if a patient does not present with the signs and symptoms you would consider appropriate to the injury e.g. insufficient rise in heart rate in a patient with substantial bleeding or minimal pain with obviously severe injuries. There may be serious underlying or accompanying conditions or injuries. When in doubt, suspect the more serious differential diagnosis of illness or injury and transfer the victim to a large centre rather than a small hospital.


Q. You arrive at the scene of an accident approximately 60 minutes after it has occurred. A 66-year-old previously healthy woman has suffered a closed head injury. Now she has a GCS of 14 and is fully alert and cooperative. However, she does not remember the accident and has since vomited twice. As she feels fine, the patient demands to go home, rather than being transferred to a trauma centre. Will you admit the patient? Where? How do you justify your decision?

A. This patient with a closed head injury and amnesia together with repeated vomiting has an increased likelihood of intracranial injury requiring neurosurgical intervention. You may have to insist that she be taken to the trauma centre to rule out any serious injury. The paper by Stiell et al. gives an excellent basis for deciding which patients need a neurological work up after an apparently minor injury.


Contacting the receiving unit early and providing extensive information helps them prepare for patient admission and activate appropriate services, e.g. the trauma team or stroke unit. In addition, the CT suite may be reserved for a patient in urgent need of diagnostic work up.

Question the local EMS dispatcher about the protocol currently used for the referral of trauma patients to hospitals in your area. Note if ‘Trauma Centres’ are formally designated. Assess if a physician is involved in the choice of hospital and how the receiving unit is informed.
The handover

The handover of the patient at the receiving unit deserves special attention. It is a point at which information may be transferred accurately, inaccurately or lost. Even though written information – including laboratory results and radiological images – is imperative for correct documentation and later reference, an oral report is faster and allows for emphasis of specific findings. In addition, an oral report allows the receiving crew to question contradictory findings and to clarify information. Ideally a handover follows a checklist such as the ‘ABCDE’ for primary survey and ‘AMPLE’ (allergies, medications, past history, last meal and events) for history. Even though these mnemonics were first developed for the trauma setting, they also allow a structured handover in the medical setting. Such a structured transfer of information is not only imperative after pre- or inter-hospital transport, it also applies to intra-hospital transport, e.g. was the trip to the radiology suite uneventful and what were the findings of the scans etc?

Full documentation of patient data and interventions is obligatory and an integral part of patient care. Future development will hopefully simplify documentation using a patient data management systems. However, electronic monitoring equipment outside hospital may suffer malfunction due to mechanical damage or weather conditions. Even today paper documentation is still standard, see the sample record sheets in the Appendix.
CONCLUSION

Transport of critically ill or injured patients – whether within or between hospitals – requires planning and analysis of the risks and benefits. Numerous decisions must be made by the professionals involved in patient care at every stage in the process, whether at an accident site, in a vehicle en route to the hospital, or during transfer to another department for diagnostic work up. Through the cooperative efforts of multiple team members with varied backgrounds and skills, we improve the chance that critically-ill patients will not only arrive safely at the hospital, but will also be discharged in a state that allows them to enjoy the trip back home.

Although the content of the following flash conference lecture does not correspond in all detail with this module, it provides a good overview of the module and is a suggested revision mechanism.

**ESICM Flash Conference:** Gavin Lavery (Belfast). Competency teaching I: How I transport critically ill patients? Berlin 2007
APPENDIX

Example 1. Form for documentation of patient data. Reproduced with the permission of Swiss Air Rescue.

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Method</th>
<th>Range</th>
<th>Sample Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fever</td>
<td>Normal</td>
<td>36.5°C</td>
<td>38.2°C</td>
</tr>
<tr>
<td>Heart Rate</td>
<td>Normal</td>
<td>60 BPM</td>
<td>100 BPM</td>
</tr>
<tr>
<td>Blood Pressure</td>
<td>Normal</td>
<td>120/80</td>
<td>160/100</td>
</tr>
</tbody>
</table>

**Key:***
- **Head**: Documentation of patient data.
- **Body**: Vital signs and medical history.
- **Foot**: Medication and treatment plan.

*Appendix Example 1 continues with detailed patient records and medical notes.*
Example 2. Record and checklist
SELF-ASSESSMENT QUESTIONS

EDIC-style Type K

1. Before undertaking the medical accompaniment of an ICU patient being transported from one hospital to another it is important to:
   A. Bring the necessary documentation
   B. Check of the medical equipment
   C. Personally check the tyre-pressure on the ambulance
   D. Make sure a relative can follow the transport

2. ‘Closed loop’ communication is understood to mean:
   A. That the team leader repeats all tasks several times
   B. That each person goes through all details in their mind before the mission
   C. That each person repeats his/her task when given one
   D. Communication between a computer and the operator

3. Regarding evidence from randomised controlled prospective clinical trials (RCTs) addressing the transport of critically ill patients, the following is known:
   A. A combination of a doctor and a nurse is the most cost-efficient use of personnel
   B. Specially trained paramedics may be allowed to transport stable intubated patients
   C. RCTs in this area of medicine are lacking
   D. Hypoxaemic patients usually deteriorate during transport

4. During transport of a mechanically ventilated patient with a severe head injury, it is important to
   A. Keep SpO₂ > 95%
   B. Keep end-tidal CO₂ as low as possible to avoid increased ICP
   C. Keep MAP above 65–70 mmHg
   D. Let the patient be as lightly sedated as possible in order to monitor cerebral function

5. Contraindications to transporting a patient to an MRI include:
   A. All patients with hip-prostheses
   B. Patients with implanted pacemaker
   C. Patients with Hickman catheters
   D. A patient with freshly implanted coronary stent
6. **The effect of altitude during transport:**

   A. Is negligible at altitudes < 10000 feet (3000m)
   B. May lead to the air volume in the endotracheal tube cuff to shrink, hence more air must be refilled
   C. May increase a pneumothorax
   D. May lead to hypoxaemia in spontaneous ventilated patients

7. **Important, recognised adverse events (iatrogenic) which happen in association with transport in the critically ill are:**

   A. Loss of intravascular access
   B. Displacement of the endotracheal tube
   C. Pressure sores in the heels
   D. Intensive care delirium

**EDIC-style Type A**

8. **A recognised lethal triad (three parameters associated with poor outcome) of emergency medicine is?**

   A. Hypothermia, hypotension and hypoglycaemia
   B. Hypothermia, hypotension and acidosis
   C. Hypotension, hypoglycaemia and acidosis
   D. Coagulopathy, acidosis and hypotension
   E. Coagulopathy, acidosis and hypothermia

9. **Regarding the indications to perform intubation in the pre-hospital setting, which statement is INCORRECT:**

   A. Patients with GCS < 8
   B. Patients with obstruction of the airway
   C. Patients with severe hypotension
   D. Patients with severe hypoxia
   E. Patients with acute respiratory acidosis

10. **A transport medical checklist often includes the following EXCEPT:**

    A. ID of the patient
    B. Target hospital and unit
    C. Check of medications
    D. Who will pay for the transport
    E. Estimated transport time
11. A patient with cardiogenic shock is to be transferred to a cardiothoracic unit in another hospital. He is intubated and mechanically ventilated and receiving vasoactive drugs (multiple). The following monitoring during transport is required EXCEPT

A. Continuous cardiac output  
B. Continuous arterial BP monitoring  
C. Pulse oxymetry  
D. Three-lead ECG monitoring  
E. End-tidal CO₂

12. You plan to transport a patient with severe ARDS to a tertiary hospital. He is on 80% oxygen and the minute volume is 15 litres. The transport is expected to last 120 minutes from ICU to ICU. You have a 10-litre oxygen cylinder with the pressure of 120 bar. For how long will this oxygen last?

A. 40 minutes  
B. 60 minutes  
C. 80 minutes  
D. 100 minutes  
E. 120 minutes

13. Which of the following treatments is not necessary to maintain during transport:

A. Veno-venous ECMO  
B. Intra-aortic balloon pump  
C. Suction on a thoracic drain because of bronchopleural leak  
D. High flow CVVHD  
E. Inhalation of NO

14. The main reason to choose air transport instead of ground transport is:

A. Better trained EMS personnel  
B. More available equipment  
C. Shorter transport time  
D. Less movements during transport  
E. Better patient survival
Self-assessment answers

**Type K**

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**Type A**

8. Answer E is correct
9. Answer C is correct
10. Answer D is correct
11. Answer A is correct
12. Answer D is correct
13. Answer D is correct
14. Answer C is correct
PATIENT CHALLENGES

While on call in the 14 bed intensive care unit of a 300 bed regional hospital, you receive a call from the central office of the local ambulance service telling you that an ambulance will arrive in approximately 20 minutes with a near-drowned, possible multiple trauma victim.

Following a previous critical incident of substantial delay in ICU admission, it is standard of care in your institution that the intensivist, the anaesthesiologist and the trauma surgeon on call are called to the emergency department (ED) for major trauma patients.

An elderly lady fell into the water while her husband tried to manoeuvre his motor yacht into a small berth. As far as the ambulance’s central office is aware, the ambulance team had to intubate the patient; however, they still seem to be having problems with oxygenation and ventilation. No other details concerning the patients are known.

The call out

Q. You still have 20 minutes left to prepare for the arrival of the patient. You may want to recall the handling of previous polytraumatised patients and what you learned. What organisational aspects of the current situation need to be considered?

A. Were there critical incidents? Were there mishaps you wish not to repeat? What was done well? How can you get additional information? Are there any safety issues that need to be addressed? What if other critically ill patients arrive and there is a need for triage, i.e. prioritising different patients? What resources are likely to be required e.g. free operating room, availability of an ICU bed, clinical specialists who may need to be called from inside or outside the hospital for help?


One’s own safety

Q. In the emergency room (ER), you meet the anaesthesiologist and trauma surgeon, who, in this institution, is the team leader. Specific tasks need to be undertaken by specific people. How can you use the time until the patient arrives in the ER to ensure that the team is fully ready to deal with the patient?

A. The anaesthesia resident’s position is at the head of the patient to take care of the airway and to operate the ventilator or anaesthesia machine (if required), the CRNA (certified registered nurse anaesthetist) or equivalent will take care of lines and
infusions while the surgeon and team will take care of the traumatic injuries according to ATLS standards. However, all of the trauma team may be required depending on the most pressing requirement and your task as the intensivist in the ER in this scenario is to assess the patient’s medical status, participate/help with immediate priorities and plan for continued care in ICU.

Q. What other specialty assistance may be required?

A. Additional personnel may be needed depending on the expected injuries, e.g. neurosurgeon. A radiologist needs to be available e.g. for CT scan or FAST (focused assessment sonography in trauma) and should be informed early so that the CT suite is ready.

Medical treatment started in the ER will often need to be continued in ICU. Therefore it is useful to be involved in decision-making including the timing of interventions deemed necessary e.g. CT scans or angiography as some may be more efficient if performed early i.e. before transfer to ICU. You may be dealing with the consequences of decisions days or weeks later.

**Note** Role assignment of different medical professionals may differ greatly between hospitals or countries and may depend on human resources, logistic issues or on historical or cultural factors. The team leadership demands advance planning (gouverner c’est prévoir).


**Note** Repeated transfer of information from one team to another increases the risk of information being lost or distorted and disturbs the continuum of care. Thus, early collaboration with other team members and handing over information to the follow-up team is a crucial step in care. Exact written documentation may be critical and may be legally important.

**Learning Issues**

**Handover of information**

Q. When the ambulance team arrives, the young emergency physician is quite stressed and describes extensively the scene on the port. He emphasises how difficult ventilation was with poor oxygen saturation at an Fio2 of 1.0 and 10 cm H2O PEEP. What would you like to know first? How should you react?

A. Follow normal routine. Insist on following established checklists for handover in order to prioritise medical needs and complete information.

**Learning Issues**

*Pre-hospital care*
Q. You ask the emergency physician to proceed with a structured handover following the ABC of the ATLS manual. How might s/he proceed?

A. With Airway and Breathing details first, then Circulation.

‘A’: The patient was intubated at the scene. Two attempts were required as the patient had vomited and there were large quantities of sputum and saliva. Oxygenation was poor with spontaneous breathing although transcutaneous oxygen saturation readings were unreliable due to poor perfusion of the fingertips. After endotracheal intubation, gastric contents were aspirated from the tube, even though the view of the vocal cords was good and the tube was considered to be positioned correctly.

‘B’: Breathing is being controlled by manual inflations and in the ER and the patient is being transferred to an ED room transport ventilator. Abundant frothy oedematous fluid appears in the endotracheal tube with every expiration; the transcutaneous oxygen saturation reads 80%.

The receiving unit

Before you proceed with ‘C’ and ‘D’ problems, you return your attention to the ‘A’ problem until it is resolved. Even though a tracheal tube is in place, this does not necessarily mean that the airway is secured. Both you and the trauma surgeon auscultate the patient’s chest. Symmetrical breath sounds can be heard over both lung fields and the capnography trace shows regular expiration although with a strong obstructive pattern. Finally you and the Anaesthesiologist confirm the correct position of the tube between the vocal cords by direct laryngoscopy.

Risks of transfer, risk of dislodgement of lines and tubes

Double-checking is a sign of teamwork and professional care, not a sign of distrust.

PACT module on Airway management

Q. The patient has obvious pulmonary oedema. What is your working hypothesis regarding its aetiology?

A. The patient may have a pulmonary oedema due to A: drowning, B: aspiration of gastric contents, C: lung contusion D: fluid overload after initial resuscitation, E: previously compromised cardiac function or F: other cause.
One of the team disconnects the tracheal tube in order to aspirate the oedematous fluid. S/he also reduces the PEEP setting on the ventilator to 5, as compromise of the haemodynamic situation due to high external PEEP is suspected.

Q This may be ill-advised. Give reasons.

A. When aspirating the pulmonary oedema, surfactant will be removed from the lungs together with the oedema, worsening lung collapse, ventilation and oxygenation. Furthermore, the loss of external end-expiratory pressure may lead to further alveolar collapse.

Q If cardiovascular instability is a clinical issue, how might it be better addressed?

A. If persistent, by judicious intravenous volume loading and (potentially) the use of vasopressor.

PACT module on Respiratory failure

The transfer team and the receiving unit

Reducing PEEP on the transport ventilator, which is now attached, appears to have exacerbated pulmonary oedema and the oxygenation. However, attempts at reinstituting higher PEEP on this ventilator are poorly attained and have limited benefit.

Q. Could there be a problem with the transport ventilator and would an ICU ventilator, together with a battery pack and oxygen/air bottles, be better?

A. Many simple transport ventilators may not be able to provide an adequate amount of PEEP (up to 20 cmH₂O or more). Therefore you request a (sophisticated) ventilator from the ICU, which may provide a much higher driving pressure and more PEEP.

Q. As there is a danger of loss of PEEP (with exacerbation of oxygenation) during the transfer to the new ventilator, how might this be managed?

A. If disconnection from the ventilator/PEEP is inevitable e.g. during change of ventilator, the tracheal tube may be briefly clamped at end inspiration, the ventilator disconnected, the new ventilator connected and then the clamp removed.

The change of ventilator under these conditions needs to be carefully planned to avoid undue prolongation of the clamping (at end inspiration) with the accompanying risk of hypotension and even barotrauma.
Q. The team leader wishes to continue with the ABC. What is the next step?

A. ‘C’, the circulation.

The cardiac rhythm is reported to have been atrial fibrillation (AF) from the time that monitoring started. You note a ventricular response of approximately 140/min and a systolic blood pressure of 90 mmHg. However, at this point we have no information about the previous medical history of the woman and whether she had pre-existing, chronic AF.

Q. Even though hypovolemia should be suspected in trauma victims, what other causes of cardiac compromise and AF may pertain?

A. Consider as differential diagnoses cardiac contusion, congestive heart failure, pneumothorax, and others.

The patient had been intubated using midazolam, ketamine and rocuronium, thus neurologic function is hard to assess at this point. However, pupil size seems to be symmetric.

Q. What else would you like to know from the emergency physician?

A. More needs to be known about the accident as well as more information about the previous medical history of the victim.

The emergency physician explains that apparently, the boat operator (husband) confused reverse with forward gear when he tried to berth his motor boat. Consequently the 80-year-old woman fell from the boat onto the pier and from there into the water. She was pulled out several minutes later.

Later a more complete history revealed that the woman had no allergies, did not take any medication regularly and did not have any significant past history. She had had breakfast a few hours prior to the accident and when the emergency physician arrived, she was in severe respiratory distress and had a GCS of 12 (E 3, V 3, M 6).
Other than the difficulty with oxygenation and the Atrial Fibrillation, the transport itself was uneventful.

**Learning Issues**

*Special environment*

**PACT module on Traumatic brain injury**

Q. What are the differences in medical transport between a road ambulance and a rescue helicopter?

A. Besides a large number of organisational e.g. difficult communication and safety issues (blades, limited equipment, confined space), several medical aspects need to be considered with patient transport.

Q. According to Boyle’s law, the product of pressure and volume are constant for a given volume of gas under constant temperature. Thus, with increasing altitude, i.e. decreasing ambient pressure, there may be patient consequences at altitude. Please summarise the immediately important factors.

A. Any confined gas (pneumothorax, endotracheal cuff, intracranial gas, etc) will increase in volume. In the cranium or thorax, this may cause compression of related structures. In the case of the tracheal tube cuff, the cuff pressure may increase above 30 mbar with consequent mucosal damage.

For more information on aeromedical transportation read the following reference:


**Learning Issues**

*The transport vehicle*

A chest radiograph is taken which shows the tracheal tube in correct position, several rib fractures and bilateral diffuse infiltrates. However, no immediately treatable cause of respiratory insufficiency such as a pneumothorax was seen. The haemodynamic situation has deteriorated even further. Following insertion of a radial arterial cannula, the systolic blood pressure now reads only 85 mm Hg.
Q. What are the next diagnostic steps?

A. More information may be obtained from a CT scan and the surgeon suggests that the patient should now go to radiology.

The patient is now ventilated with a sophisticated ICU ventilator, an F\textsubscript{1}O\textsubscript{2} of 1.0, I:E of 1:1 and a PEEP setting of 14 mmHg. Peak inspiratory pressure is 34 mmHg and there are no signs of intrinsic PEEP. The haemodynamic situation has not improved, however, and then the patient needs to be stabilised before transport.

**Learning Issues**

*Planning of the transfer, stabilisation of the patient*

Q: How do you plan to stabilise the patient?

A. Now that you are reasonably confident that the patient does not have chronic AF and that this episode is acute in nature, and also that it causing hypotension in a patient that is already sedated on a ventilator, you opt for synchronised cardioversion.

Following synchronised cardioversion, the ECG shows sinus rhythm of 110/min and systolic blood pressure has increased to 115 mmHg. The patient may now be stable enough to travel to the CT suite.

**PACT module on Arrhythmia**

Q. What organisational checks/decisions need to be made before starting the transfer?

A. Duration of the transfer? Role assignment of the team. Space for all the equipment. Connections to tubes and lines. Is the CT suite ready for the procedure and are the corridors clear?
Preparation is of the essence for a successful transport. Have a Plan B in case there is a mishap during transfer. Consider limiting the size of the transport team each with specific roles assigned to take care of the patient.

**Planning of the transfer, special environments**

While you are still in the ER, the medical emergency team (MET) contacts you to request an ICU bed for a patient with myocardial infarction who had to be resuscitated on the ward. Furthermore an ER colleague wants to transfer a young woman to ICU after attempted suicide with an overdose of benzodiazepines. Together with two planned admissions from the operating room, this could mean no available ICU bed for your patient.

Q. How do you proceed?

A. First of all, consider if the planned admissions are immediately necessary and consider practical, holding solutions until the larger picture is clearer and the senior staff in ICU have had the opportunity to review and prioritise.

Other practical options within the institution are being explored. For example, the ER colleague is being asked to manage the patient in the ER for the moment or to consider referral to other options that may be available in the hospital e.g. asking the OR manager to have the young woman managed in the post anaesthesia care unit with or without flumazenil reversal. The MET team is making a cardiology referral as the patient may need to be transferred directly to the cardiology ‘catheter’ laboratory. Furthermore the overall situation in ICU is being reviewed as it may be possible to request intermediate care for the most stable of the patients referred or already in ICU – thereby ‘buying’ some time to see the trends and allowing the best overall decisions to be made in the circumstances.

**Triage**

Q. Is it ‘worth’ admitting a critically injured elderly lady to the ICU or may care be futile?

A. At this point it is far too early to decide. We do not have enough information to assess this point.

**Ethical considerations**

PACT modules on Ethics and Clinical outcome
The radiographic workup shows a small subarachnoid haemorrhage, rib fractures 6–9 on the left side, severe lung contusion (differential diagnosis: aspiration) on both lung fields, stable fracture of the 12th thoracic vertebrae, and fracture of the left scapula and glenoid. On secondary assessment you note skin lacerations and abrasion over the left arm and right thigh.

Q. How do prioritise the care of these injuries – and the critical illness of the patient?

A. You discuss the injuries in a team together with the radiologist, the trauma surgeon and the anaesthesiologist.

At this point, the patient does not need any major intervention and it is decided to transfer the patient directly to the ICU. The skin lesions can be taken care of in the ICU and you avoid an unnecessary transfer to the OR for the sutures of the wounds. On the way back, when you are near to the ICU, the haemodynamic situation deteriorates again as the sinus rhythm reverts to atrial fibrillation with a ventricular rate of approximately 130/min and a systolic blood pressure of 90. In addition, one of the infusion lines gets caught while moving the trolley and is pulled out. Fortunately, no vasoactive drugs are running on that line.

Q. Should you perform cardioversion during transport?

A. Given the short distance to travel to ICU, you decide in this case to continue the transport and perform cardioversion, either electrically or pharmacologically, in the ICU.

Depending on the distances, haemodynamic situation, resources and staff, an intervention might be appropriate during transfer.

**Learning issues**

Problems during transfer

**Note** Don’t get so wrapped up in manual tasks that you lose the overview over the vital threats – e.g. don’t fumble with the infusion while forgetting to oxygenate the patient.

Q. What needs to be considered during the transfer from the transport trolley to the ICU bed? Which therapeutic modalities are most likely to give trouble in the transfer?

A. This is always a moment of potential risk and needs increased awareness. Changing ventilators (with possible loss of PEEP), syringes on pumps or other therapeutic equipment pose hazards. Frequent pitfalls include three-way stopcocks left in the wrong position and errors with syringe pumps containing vasopressors.

**Learning issues**

Equipment

Q. What are the standards with respect to transportation?
A. Many learned societies and specialty training bodies have issued guidelines for transfer of patients. As a general rule, the standards applied to planned patient transport of the critically ill should be similar to those to any patient under anaesthesia, including required equipment, monitoring, setting of alarms, training and education of staff, etc.

**Learning issues**

*Guidelines for transport of the critically ill*

In the ICU, a pulmonary artery catheter is inserted and shows a cardiac output of 1.6 l/min and a S\textsubscript{O\textsubscript{2}} of 42 %. After a bolus of amiodarone the atrial fibrillation is successfully converted to sinus rhythm. Low dose dobutamine leads to an improvement in cardiac stroke volume and cardiac output. Ventilatory support has been slightly reduced - the F\textsubscript{I\textsubscript{2}}\textsubscript{O\textsubscript{2}} is 0.75 with 12 cm H\textsubscript{2}O PEEP. Sedation has been gradually reduced and one hour later the patient starts to awaken and open her eyes to command. The husband has now arrived and feels both anxious and somewhat guilty about what has happened to his wife.

Shortly afterwards the bedside nurse noticed asymmetry of the patients’ pupils and calls you and the neurosurgeon who requests immediate return to the CT suite for a further scan. In addition, the husband, who has heard this conversation, wants everything to be done for his wife.

Q. How do you respond?

A. Before embarking on another transfer, you examine the patient for updated clinical information.

She still opens her eyes and squeezes both hands and raises both lower limbs equally to command and there is no facial asymmetry. You also notice an implanted lens in her left eye. Her husband confirms that she has had cataract surgery on her left eye. You therefore convince the neurosurgeon that little additional information is likely to be gained from a further scan and weighing this against the potential hazard of another scan, it is better to cancel the scan.

**Learning issues**

*Indications for transportation.*

**Note** Always weigh the risks of a transfer against the possible benefits of additional information.

The patient from the cardiology ‘catheter’ lab arrives and takes the last bed in the ICU.

Q. Have you space for any other patient? How do you proceed?

A. Even though the first duty is to care for the individual patients presently within one’s care, you review all the patients in the ICU to establish who might be suitable for discharge in the event of need e.g. an emergency.
It is also important to prepare for possible future requests for emergency admissions and to know the status of all patients in ICU and know which are suitable for discharge, if any. Unfortunately, all your remaining patients are on ventilator support, and none appear suitable for transfer to a regular ward before the following day at least.

Q. One of the patients is on intermittent non-invasive ventilation following congestive heart failure and it is felt that he could be ready for discharge to a regular ward the following day. Would this patient be suitable for transfer if an emergency arrived? Outline possible options.

A. If a further ICU bed is required, the patient could, after consultation, be transferred at short notice to certain other facilities in the hospital e.g. a medical high-dependency or respiratory non-invasive ventilatory facility or the post anaesthesia care unit.

You make the necessary provisional arrangements with your colleague from one of these facilities, although for now the patient remains in your unit. There is also a drug addict patient who is stable but is a ‘slow wean’ following long-term ventilation due to aspiration pneumonia. As it is early in the afternoon, you explore the possibility of transferring him back to the ICU in a smaller regional hospital, nearer his home.

Q. Which is the appropriate hospital for the young addict?

A. One that is suitable to care for him.

You consider the appropriate medical capabilities, e.g. is there a dedicated intensivist to care for the patient? Do you know that the ICU has experience in dealing with patients who are difficult to wean from ventilation? There is evidence that centres who deal with certain diagnostic groups frequently, e.g. victims of major trauma, achieve better than expected outcomes. Other parameters may include distance to his home (for relatives travelling to visit) or, in certain jurisdictions, his insurance status.


Q. Will you transfer the patient by road ambulance or by helicopter emergency medical service (HEMS)?

A. The choice of transport depends on a number of factors including distance, road and weather conditions, urgency of transport, availability of a HEMS, staffing, and perhaps insurance status. A HEMS may be indicated to support a local road ambulance service under pressure.
In an inner city setting, it may be more appropriate to keep a road ambulance ready for emergencies and have a helicopter make the transfer of a relatively stable patient. A helicopter often cannot land in a city and collaboration between different professionals is important. As the HEMS base is located some 50 km away and there are a few emergencies, you decide to call a road ambulance.

**Learning Issues**

*Choosing the transport vehicle*

**Q. Who should accompany the patient on the trip?**

**A.** The ICU nurse who is presently taking care of him should accompany him on the transfer, if possible. This provides continuity of care and more accurate transfer of information. There needs to be the ability to treat any complications during transport e.g. accidental extubation or cardiorespiratory deterioration. In most health systems this will require the additional presence of a doctor with skills in reintubation/critical care support.

**Learning Issues**

*The transfer team*

**Q. Who and what should be considered in planning the transfer?**

**A.** The transfer team must establish that the institution is prepared to accept the patient. The patient, if awake, and the patient’s next of kin should be consulted and, ideally, they should be agreeable to the transfer (this may not be required but such a situation does raise ethical issues). The admitting physician (if there is one) and the receiving physician in the receiving hospital need to be consulted and appraised of the patient and organisational issues.

The transfer itself should not pose an additional risk to the patient as the same standard of care will be provided as within an ICU. A sufficient supply of oxygen/air, to cover for unforeseen events e.g. delays due to a traffic jam, appropriate medications, monitoring and equipment. Even though many modern transport ventilators are capable of pressure support or assisted ventilation, thought should be given to the safest mode for transfer. The best option might be deep sedation and muscle relaxation, in case the patient starts to fight the ventilator or becomes agitated, delirious or claustrophobic.

**PACT module on Communication**

**PACT module on Ethics**

**Learning Issues**

*Early versus late transfer – the need for stabilisation*

Over the course of the next 4 days, the condition of the elderly lady slowly stabilised. $F_{\text{IO}_2}$ was reduced to 0.5 and PEEP to 6 cm H$_2$O. Dobutamine was discontinued and noradrenaline weaned to 4 mcg/min and she remained in stable sinus rhythm. She required minimal sedation with propofol and with daily interruption of sedation, she could slowly follow commands. After a further 2 days, she was transferred uneventfully by mobile ICU to an ICU in her home town – some 60 km away. After a
prolonged stay, including tracheostomy for difficult weaning and subsequently a thrombosis of her left arm, she was discharged to a rehabilitation unit 6 weeks later.

**On-reflection:** in inter- and intra-hospital transport, the key to providing quality critical care is preparation: plan ahead so that the care you provide in a foreign environment is as similar as possible to the care you provide in your unit. By focusing on teamwork, communication, planning, and preparedness for possible complications and by including ample reserves of medication and time, you can optimise the care you provide.

In retrospect, direct transport of the elderly woman to a trauma centre was indicated and the final outcome was positive. This patient experienced pre-hospital, intra-hospital and inter-hospital transport. All three types of transport have their own risks and must be planned accordingly. Pre-hospital care and primary transfer seems exciting and often attracts younger members of staff. However, since optimum management of the primary problems and the possible complications during transfer may significantly influence outcome, the most experienced physicians with substantial knowledge of transport of the critically ill are best closely involved with this challenging area.

The challenges presented during patient transfer may be complex and time-critical. It is important that all the escorting staff be skilled, able to function independently and also exhibit good team-working.

Consider whether the terms ‘scoop and run’ and ‘stay and play’ could ever be applied to transfers within the hospital. Why or why not?