# **Retrieving critically ill children – the Scottish Paediatric Retrieval Service**

A brief description of the establishment and daily functioning of the Scottish Paediatric Retrieval Service is given, as seen from the perspective of a retrieval consultant. The article illustrates the process of initiating and completing the retrieval of a critically ill child and enables comparison with the service provided by the neonatal retrieval service.

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## **Key points**

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- 1. This is a national service supported and funded by the Scottish Executive.
- The service operates over a very large geographical area covering the whole of Scotland and occasionally across national borders to and from England, Northern Ireland as required.
- It is not a rapid response resuscitation service, but the provision of safe transfer of critically ill children from the referring unit to the receiving PICU.
- 4. The service operates from the philosophy of an 'intensive care bed on the move'.
- 5. The range of patients retrieved by the service varies greatly in terms of age, size and reason for retrieval.
- 6. It is staffed by senior clinicians and senior nursing colleagues well trained in the care and transport of critically ill children.

This article provides some background on the founding and operation of the Scottish Paediatric Retrieval Service (SPRS) which is responsible for the management and retrieval of critically ill children ranging from birth to 16 years of age, as well as contrasting it to a degree with the service offered by the neonatal retrieval service, on which various articles have appeared in this journal<sup>1-5</sup>.

# The establishment of SPRS

During the last decade there has been a drive to improve the outcome of critically ill children, by ensuring that these children receive the best possible care. It was the publication of the Scottish Paediatric Intensive Care Audit (SPICA) which indirectly led to the establishment of the SPRS. The SPICA report established that 1051 children received intensive care in 14 hospitals in Scotland during 1997. Seven hospitals treated less than 10 paediatric intensive care patients in that year and only two hospitals treated more than the 250 cases per annum, as recommended by the Paediatric Intensive Care Society.

Due to the SPICA report, paediatric intensive care services were centralised at two sites in the paediatric intensive care units (PICUs) of the Royal Hospitals for Sick Children in Edinburgh and Glasgow. This centralisation of services led to a marked increase in the secondary transport of critically ill or injured children from the presenting hospitals to PICU. The report entitled, "Standards of Practice for the Transportation of the Critically Ill Child", published in 1996 by the Paediatric Intensive Care Society (PICS)<sup>6</sup>, recommended that transportation should be undertaken by specialised PICU transport teams functioning as an 'intensive care bed on the move'<sup>7</sup>. It is also known that critically ill children transported by non-specialised teams suffer a greater incidence of critical incidents during transport than those transported by specialised teams<sup>8</sup>.

Accordingly the SPRS was established in April 2001 following recommendations made by a working group set up by the Chief Medical Officer for Scotland as part of the implementation of the national Acute Services Review (1998)<sup>9</sup>. The service is provided by two specialised teams based at the PICUs in Edinburgh and Glasgow working in close co-operation with the Scottish Ambulance Service. The service is nationally funded.

# The transport team

The main advantages of using specialised teams are:

- team members have training and experience in paediatric intensive care
- team members have training and experience in the transport of critically ill children
- dedicated equipment is available suited to the task
- the team can operate without depleting the staffing levels of either the referring unit or receiving PICU

The two teams of the SPRS differ in that the Glasgow team is led by a trainee and a senior nurse – supported by a PICU consultant at the Yorkhill base; whereas the Edinburgh team has for the last year been led by a retrieval consultant and a senior nurse. The doctor should ideally be at least a senior trainee with a minimum of two years' experience in anaesthesia, neonatal intensive care, adult or paediatric intensive

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care, including a minimum of three months' PICU experience. The Edinburgh retrieval consultants provide a fully consultant-delivered service and are fully accredited post Certificate of Completion of Specialist Training (CCT) consultants from different specialties, mainly anaesthesia, medical paediatrics and/or paediatric accident and emergency. The advantage of using a consultant-based service is that this provides greater expertise and experience at the referring hospital prior to the transfer commencing and also during transfer in accordance with the concept of an intensive care bed on the move. This also has the advantage of removing the duty of transfer coordination from the receiving PICU consultant, who is then able to concentrate fully on the management of the patients already in the unit.

The senior nurses have independent professional responsibility to the child and should have undergone PICU training (ENB 415 or the equivalent). They should also have a minimum of two years' PICU experience. Whereever possible team members undergo specific training in transportation of patients.

The team members function very closely, with overlap between the roles of the doctor and nurse. The team members all contribute skills and knowledge as required to optimise the condition of the patient and make the retrieval process as uneventful as possible.

There has been recognition in the last decade that if a child (or for that matter an adult) is critically ill, the retrieval itself should be conducted as if the patient has been admitted to a critical care unit and the same standards of care applied - hence the 'ICU on the move' philosophy. In practical terms there are always limitations which preclude the use of certain intensive care procedures or therapies during transport, for example renal replacement therapy. It is thus imperative that the patient be optimised fully before transfer unless precluded by an urgent need for a specialist service available only at the receiving centre, in which case the rapid and safe transport of the patient should be initiated without delay.

# **Operation of the service**

The referring clinician need make only one call to the service. If one of the units is unable to accommodate the referral, it is passed to the other unit directly. The PICU



**FIGURE 1** The Ministry of Defence Sea King helicopter.

consultant discusses the patient with the referring clinician and a management plan is decided upon. If it is apparent that the child will need to be retrieved, the retrieval process is initiated, but not all referrals result in the retrieval of the patient. The teams are happy to provide advice and support on the management of any severely ill child.

## **Triggers of referral**

These vary greatly, ranging from trauma patients, non accidental injury, sepsis, meningitis, burns and a large proportion of seasonal bronchiolitic patients. The retrieval workload also shows marked seasonal variation with the highest workload during the winter months.

Referrals should be made early and as soon as it is evident that the child is critically ill, as they compensate remarkably in the early stages of critical illness, only to suddenly and rapidly deteriorate once their capacity for compensation is exceeded.

The main criteria for referral are:

- Deteriorating airway patency
  - chest wall recession
  - see-saw breathing patterns
  - stridor
- Respiratory distress
  - rate >60/min
  - chest wall recession
  - oxygen saturation of arterial blood SaO<sub>2</sub> < 94% or partial pressure of oxygen in arterial blood PaO<sub>2</sub> < 8kPa on high flow face mask oxygen
  - carbon dioxide partial pressure PaCO<sub>2</sub> in arterial blood >6 or <3.5kPa</li>
- Shock
  - heart rate >180 or <80/min (<5 years) or >160 or <60/min (>5 years)
  - absent peripheral pulses
  - cold peripheries
  - capillary refill time >2 sec
  - systolic blood pressure <70 + (age in years x 2) mmHg</li>



**FIGURE 2** The Scottish Ambulance Service King Air.

- Deteriorating level of consciousness
- Recurrent seizures or status epilepticus
- Burns >10% body surface area

 Multiple trauma The retrieval team does not operate as a rapid response service, as this is logistically impossible. The team is usually mobilised within one hour of the initial contact and will take a variable length of time to reach the referring hospital depending on location and mode of transport. During this time the PICU teams are available to advise and support the referring team on the continued management of the child. The referring hospital remains responsible for the resuscitation and stabilisation of the child until the transport team arrives. This should be undertaken by the most senior staff available in accordance with APLS or PALS principles at an appropriate location in the referring hospital equipped for critical care management - usually ICU, HDU, theatre or theatre recovery. It is also the responsibility of the referring clinician to ensure that the retrieval team is kept updated on any changes in the condition of the patient.

Patients are fully assessed by the retrieval consultant or fellow on arrival at the referring unit. If any interventions are required to improve conditions or stabilise the patient, these are initiated before transfer is initiated. This has the effect of minimising the need for intervention during transit and also reduces the risk of adverse incidents during transfer.

Once the child has been thoroughly assessed and stabilised, they are then transferred to the transport equipment and reassessed for stability and optimum 'packaging' prior to departure from the referring hospital.

# **Patient packaging**

The confined spaces of the ambulance and especially of the aircraft make it mandatory

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FIGURE 3 Retrieval bags – packed and ready to go.

that the patient is as well secured as possible and protected from the environment, while still allowing easy access to intravenous lines and the airway. It is also important for the patient's and team members' safety that all equipment is secured to prevent loose items acting as missiles during sudden acceleration or deceleration of the vehicle.

## **Modes of transportation**

Various forms of transportation are utilised including the Scottish Ambulance Service A&E ambulance, mobile PICU



**FIGURE 4** One of a range of harnesses used for securing patients large and small.



**FIGURE 5** A BabyPod II is suitable for transferring smaller infants.

ambulances, helicopter (FIGURE 1) or fixed wing craft (FIGURE 2).

There are a multitude of factors which determine the choice of transport to be used, including:

- Time of day
- Distance to and from referring centre
- Road conditions
- Weather conditions
- Urgency
- Injuries/condition of patient
- Availability of vehicles and/or crews The service utilises air-based retrieval for areas which are too distant (usually distances greater than 75 miles) or where there is the need to cross large bodies of water, for example the Highlands and Islands or even Northern Ireland. By far the most commonly used mode of transport is the Scottish Ambulance Service road ambulance. Only on rare occasions is there an advantage in using aero-medical retrieval, as the rapid organisation and door-to-door capabilities of road transport makes this a very efficient option.

#### Equipment

The teams are self sufficient, carrying with them a great deal of equipment, drugs and the full range of consumables for babies and children, as most referring units do not routinely stock all such seldomly used items. The contents are checked and sealed after returning to the PICU base to ensure that they are fully stocked and ready for use. The Edinburgh team have three bags divided into airway, circulation and drugs (FIGURE 3).

Equipment needed varies due to the great variation of patients that the service has to accommodate. The Edinburgh team has a variety of harnesses (FIGURE 4) suitable for securing patients ranging from newborn infants to 6 foot 2 inch 16-year-old boys, and a BabyPod II (CooperSurgical, Inc) infant transfer pod suitable for the smaller infants (FIGURE 5 and 6).

These harnesses all have five point locking devices and attach securely to the trolley in order to ensure that the patient is secured safely. The BabyPod II is a specialised lightweight carbon fibre shell lined with a shock absorbent foam inner layer. It has transparent shields to allow viewing of the baby and ports to allow intervention during transit. The pod is attached to the trolley base with rapid release straps. The infant is secured inside with a safety harness. It is suitable for the transportation of patients up to a weight of 9kg. The pod itself weighs only 9kg, which makes it easy to handle by even a single team member.

For the last year the Edinburgh team has been using a CCT6 transfer trolley for retrievals (**FIGURE 7**) and they also have an aero-sled for aero-medical retrievals. The aero-sled is visible as the red sled mounted on top of the old



FIGURE 6 Here the BabyPod II is mounted on the CCT6 trolley.

retrieval trolley (FIGURE 8).

There were various reasons for moving to the new trolley, not least being the standardisation of the Scottish Ambulance Service ambulances to the Ferno 2 point locking devices to secure the ambulance trolleys. Unfortunately the existing trolley in use in Edinburgh was not compatible with the Ferno locking devices and could not be modified either. However the CCT6 trolley has proved to be very versatile and compact. The aero-sled is unfortunately not compatible with the CCT6 trolley and requires the use of the old trolley base or the Scottish Ambulance Service trolley to transport it to and from the airport.

## **Practical issues**

The issues of isolation, unfamiliar environments, ambient pressure at altitude, temperature control, acceleration, deceleration, excessive ambient noise and vibration are all problems during the retrieval of patients and even more so during aero-medical retrievals.

#### Movement

Acceleration, deceleration and head up/ down tilts can have marked physiological effects especially in patients who are relatively unstable or hypovolaemic. These effects are of even greater import when transporting head-injured patients, as these forces have the potential of exacerbating the injury or even inducing secondary insults. The effect of these forces can be minimised by good communication with the driver of the vehicle, thereby ensuring a smooth journey at a fast but stable and safe speed. The use of police escort vehicles to facilitate and smooth transit through trafficcongested areas can also be very useful.

#### **Excessive ambient noise and distraction**

This makes verbal communication and the monitoring of audible alarms difficult, and in the case of helicopter transport virtually impossible. Auscultation with a stethoscope is impracticable and constant vigilance of visual alarms is essential. Fatigue due to the constant vigilance can be a problem during long transfers.

The distraction of a unfamiliar environment and alternative stimulation (eg looking at the aircraft and instrumentation, or view through the aircraft windows) is very dangerous. When combined with the reduced efficacy of audible alarms this can lead to a delay in



FIGURE 7 The Edinburgh team's new CCT6 transfer trolley.



FIGURE 8 The aero-sled is the red sled mounted on top of the old retrieval trolley.

noticing developing problems.

Copious padding of the patient and the use of earmuffs provide some relief against the problems of vibration and high noise levels. Excessive vibration can also lead to problems with devices that measure noninvasive blood pressure via oscillotonometry and also automated external defibrillators, leading to inaccurate observations or loss of measuring capability in total and even in some cases to inappropriate direct current cardioversion being delivered.

## **Motion sickness**

Due to a mismatch of afferent visual and vestibular information, this is a common problem compounded by reading during transit. It occurs in both the team and especially non-sedated patients; antiemetics for example the anti-histamines or 5HT receptor antagonists are usually effective in minimising the problem.

#### **Temperature control**

Various methods are used to minimise the problem of hypothermia – including the use of TransWarmer chemically-activated infant warming packs<sup>10</sup>, gamgee padding, vacuum mattress, simple blankets, foil blankets, hats and head covering. These are usually sufficient to compensate and maintain the body temperature of infants over 1.5 kg body weight. The smaller the infant the worse the problem of hypothermia during transit due to a large surface area-to-weight ratio, a large head, thin skin and inability to shiver. The problem is exacerbated during the winter months and where multiple transfers from

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one vehicle to the next are necessary, as is the case in air-based retrievals.

## Isolation and communication

The transport team is frequently isolated from assistance and working in unfamiliar surroundings as well as very physically constrained spaces (FIGURE 9).

Constant communication between all parties is essential and involves multiple phone calls during various stages. There are dedicated lines for use of the retrieval service at both the PICUs. When the team is ready to depart the referring unit is informed of their departure and estimated time of arrival. Communication en route can be problematic due to noise, but the team has a mobile phone preprogrammed with relevant numbers for making and receiving calls. However the use of mobile phones are frequently prohibited in aircraft.

# **Critical incidents in transit**

The very act of transferring a patient is fraught with risk for critical incidents, especially where patients require multiple transfers between various vehicles Commonly occurring critical incidents during transport of children are listed as follows<sup>8</sup>:

## **Physiological changes**

- Hypoxia
- Cardiac dysrythmia
- Hypotension
- Deterioration in Glasgow Coma Scale scoring
- Hypothermia
- Hypoglycaemia

## **Equipment problems**

- Tracheal tube blocking or kinking
- Accidental extubation
- Loss of intravenous access
- Loss of monitoring
- Ventilator malfunction
- Exhaustion of oxygen supply

Thorough documentation of any incidents is invaluable and discussion during risk management meetings helps to develop procedures to minimise the chances of a similar incident occurring again.

# Documentation

It is imperative that detailed and exact records are kept from the first contact by the referring hospital or clinician until the patient is safely ensconced into their PICU



**FIGURE 9** Cramped conditions with all the equipment stowed inside the Sea King.

bed and handed over into the care of the receiving PICU consultant. This is necessary for debriefing, audit and risk management. This can be very difficult to achieve in the back of a moving vehicle, but complete documentation is essential. A final check list before departing the referring hospital is an invaluable tool and key in preventing critical incidents during transfer.

# **Delineation of responsibility**

There is some overlap with the neonatal transport service (in that the SNPRS does retrieve neonates) and almost half of the patients are aged less than one year of age. Any neonate who has been discharged home will usually be retrieved by the SPRS. The SNPRS teams tend to retrieve most of the patients referred to them whenever possible.

# Parental/carer consideration

Whenever possible a parent or carer will be transferred with the patient, especially when patients are retrieved while conscious. It is unfortunately not always possible due to limitations in the vehicle capacity used for retrieval. Another issue which has been raised is the legal accountability of the service for any injuries or detriment to the person of the accompanying parent or carer, who have to be advised that they are travelling at their own risk.

In all cases, the process and what to expect is explained to the parents or carers and they are given directions to the PICU. Parents are encouraged to make a safe journey to the PICU and strongly advised not to 'chase' the ambulance.

Once they arrive at the PICU, care is taken to welcome them and keep them informed as to the progress of their child. They are encouraged to see their child as soon as possible after admission to minimise parental anxiety.

## The area covered

The service as delivered by the two teams, covers the whole of Scotland – the Highlands and Islands and also on occasion Northern Ireland. During the period from 2001 to 2007, 2,037 referrals resulting in 1,434 retrievals were conducted from 43 hospitals, including two referring units in Northern Ireland.

Numerically the total number of retrievals conducted by the Glasgow team versus the Edinburgh team varies but in general the numbers are comparable between the two teams. There is also crossover in that the Edinburgh team occasionally will retrieve patients to the PICU in Glasgow and the converse is also true. This is usually due to the lack of bed availability in the receiving unit and/or the inability of the other unit to field a retrieval team.

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