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Adverse events occurring during interhospital transfer of the critically ill

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Abstract

***Objective* – To determine what complications children have during interhospital transfer for intensive care, and how often these complications occur.**

***Design* – Observational study of all children transferred over a six month period, including interviews with patient escort, patient review, and severity of illness scoring.**

***Main outcome measures* – Timing and method of transport; complications occurring during transport; the equipment and experience of the escort; patient vital signs and paediatric risk of mortality score on admission; outcome and duration of intensive care.**

***Results* – Forty two (75%) of 56 children had adverse clinical events during transport. In 13 the event was life threatening. Inadequate circulatory and ventilatory support, inadequate monitoring, equipment failures, and drug errors were common. Children who subsequently died were more likely to have had complicated transfers than those who survived.**

***Conclusions* – Most children had adverse clinical events during transfer for intensive care. A number are transported by inexperienced staff with inadequate or malfunctioning equipment. Standards for patient management and monitoring during transfer need to be established. To reduce unsatisfactory care during transfer, it is necessary to establish dedicated and specifically trained paediatric transport teams.**

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Secondary transport is the movement of patients already in hospital to another hospital with more appropriate facilities for further management. A survey in 1988 estimated that over 10 000 adults with life threatening illnesses are transported annually between hospitals in the United Kingdom.[1] The number of equivalent paediatric transfers is not known.

Previous studies have suggested that it is common for patients to deteriorate during transport, especially when they are escorted by staff without adequate training and experience.[2 3] Ideally, patients should be supported in an intensive care environment during transport, with reliable and continuous monitoring of their vital signs. Patient deterioration should rarely occur, and should be related to the patient's illness, rather than the physical transfer. Equipment failures and iatrogenic morbidity should not occur.

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Table 1 Definition of adverse clinical events

Critical
Major cardiorespiratory compromise
Apnoea
Hypoventilation
Bradycardia
Hypotension
Inadequately positioned or secured endotracheal tube
Serious
Neurological deterioration
Poor temperature control
Inappropriate administration or non-administration of drugs
Procedures indicated but not performed, or attempted and failed
Loss of intravenous access

We undertook a six month prospective study to determine what medical complications children had during transfer to the paediatric intensive care unit at Birmingham Children's Hospital, and how often these occurred. The transfer of these children was organised and carried out by the staff of the referring hospital.

Patients and methods

All children admitted to the intensive care unit after transfer from other hospitals between 1 April and 30 September 1992 were studied. Children were included in the study if their first ward at Birmingham Children's Hospital was the intensive care unit, or if they were admitted there within six hours of arrival at the hospital.

Once the child was entered into the study, the escorting doctor was contacted directly or by telephone. A questionnaire was completed, which gave details of the timing and organisation of the transfer, the type of equipment carried and used, significant adverse clinical events occurring during the transfer, and information on the experience and training of the accompanying staff.

Each patient transfer was then classified in the following way. *Uneventful transfers* – these were defined as transfers completed without a single adverse clinical event. *Complicated transfers* – these were defined as transfers where one or more significant adverse clinical events did occur. The adverse events were further categorised as being either critical or serious in nature and defined as follows: critical – those

Table 2 Functioning equipment carried

	Available	*Not available*
Oxygen supply	54	2
Oximeter	41	15
Suction equipment	54	2
Electrocardiograph	40	16
Blood pressure monitor	11	45
Intravenous fluid pump	53	3
Temperature monitor	19	37
Blood sugar monitor	1	55

events which, if uncorrected, were likely to be fatal; serious – those events which were unlikely alone to be fatal, but may have affected mortality. Table 1 gives examples of each. *Transfers with inadequate monitoring or support* – The availability and integrity of essential support and monitoring equipment was recorded for each transfer. These were arbitrarily defined by the authors and are shown in table 2.

The admitting intensive care nurse and doctor were interviewed, and comments on the condition of the child on arrival were noted, as were the vital signs and immediate management on admission, the paediatric risk of mortality (PRISM) score[4] for the initial eight hours of intensive care, the length of stay in the intensive care unit, and the final outcome (death or live discharge from intensive care). All data were collected by the same researcher.

Fifty eight transfers were identified during the study. Two were not analysed as the accompanying staff could not be contacted. Table 3 gives the patient details.

Most of the patient transfers were by ground ambulance, with one transfer by helicopter and one by fixed wing aircraft. The maximum journey time was three hours, with a median time of 30 minutes (the duration was not recorded in six transfers). On all but four occasions there was more than an hour between the decision to transfer the child and departure from the referring hospital.

Thirty four patients left the referring hospital between 9 am and 5 pm, and 22 between 5 pm and 9 am the next morning.

Fisher's exact test was used to compare the characteristics of complicated and uneventful transfers.

Results

UNEVENTFUL TRANSFERS

Fourteen (25%) children were transferred without a significant adverse clinical event.

Table 3 Patient characteristics

Sex	
Boys	28
Girls	28
Age	
<1 Month	36
1–12 Months	10
>12 Months	10
Diagnoses	
Gastroschisis	9
Coarctation of the aorta	7
Road traffic accident (RTA)	6
Transposition of the great arteries	5
Anomalous pulmonary venous drainage	4
Necrotising enterocolitis	4
Tracheo-oesophageal fistula	3
Liver failure	3
Pulmonary atresia	2
Patent ductus arteriosus	2
Diaphragmatic hernia	2
Meningococcaemia	1
Persistent fetal circulation	1
Aortic stenosis	1
Tetralogy of Fallot	1
Cardiomyopathy	1
Atrial myxoma	1
Lupus erythematosus	1
Jejunal atresia	1
Head injury (non-RTA)	1

COMPLICATED TRANSFERS

There was a total of 95 adverse clinical events occurring in 42 (75%) of the transfers (figure). Nearly half of the children had two or more adverse clinical events. The distribution of critical and serious adverse clinical events is also shown in the figure.

Critical adverse clinical events

During 13 (23%) of the transfers there were major cardiorespiratory deteriorations. Six (11%) children required immediate intubation and ventilation on arrival, five (9%) were hypotensive, and two (4%) were transferred with poorly secured or incorrectly positioned endotracheal tubes.

Serious adverse clinical events

Twenty nine (52%) patient transfers were complicated by serious adverse clinical events (figure); for example, inappropriate intravenous fluid regimens were given in five – too little fluid for maintenance (two) or the wrong solution (three), such as 5% dextrose in a hypoglycaemic infant. Intravenous access was lost during four transfers; 14 children had temperatures of less than 36°C on admission; cyanosis, hypertension, or tachycardia complicated 18 transfers.

TRANSFERS WITH INADEQUATE MONITORING OR SUPPORT

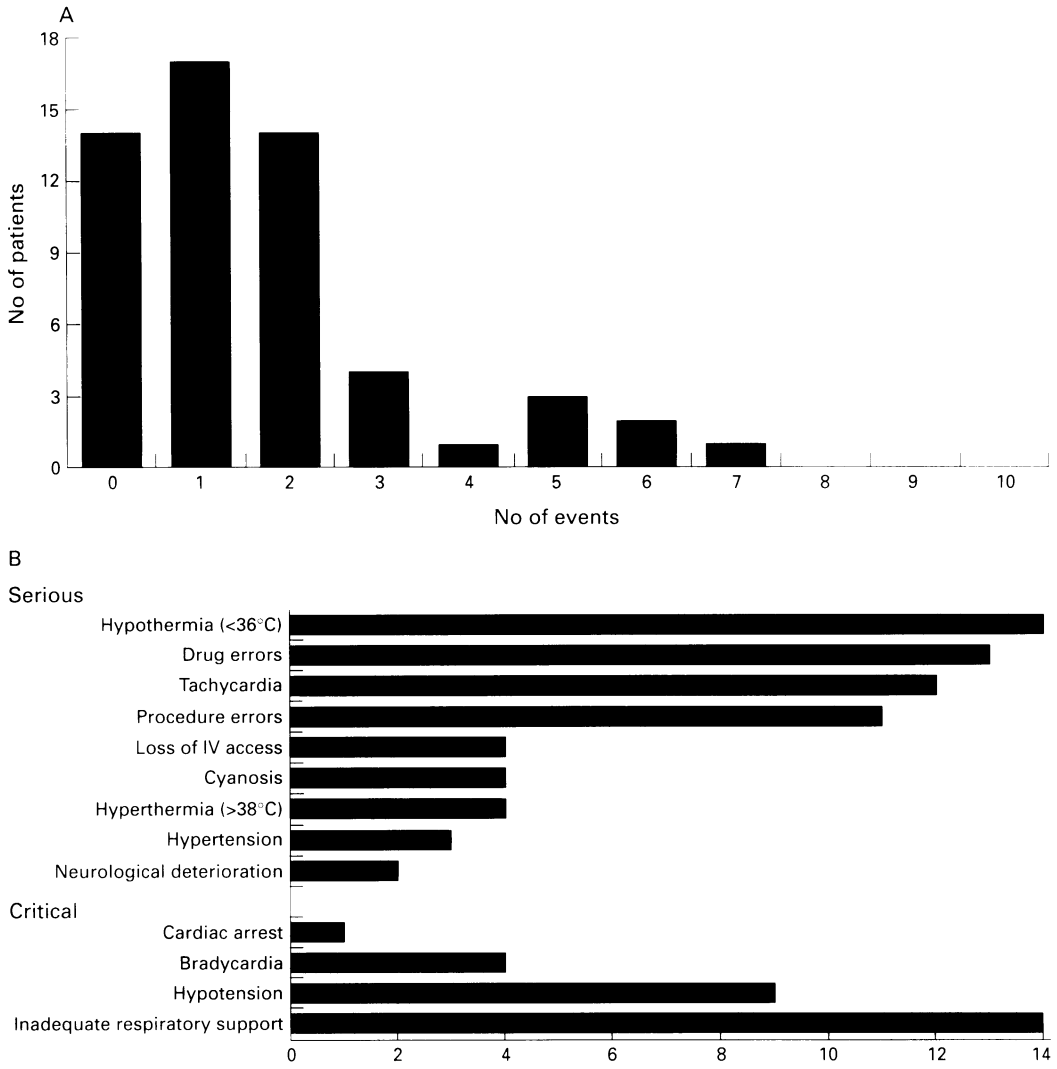
Six children did not have their vital signs monitored during transfer. Table 2 gives a summary of monitoring equipment carried. Equipment failure was common. The pulse oximeter did not work in five transfers, the intravenous pump in three, the suction apparatus failed in two, and the blood pressure and temperature monitors on one occasion each. Most of these events were related to battery failure. Oxygen supply was exhausted during one transfer and the ambulance broke down on another occasion. There was no documentation of vital signs in 46 (82%) of the transfers.

PATIENT ESCORTS

The escort was a senior house officer doing a paediatric house job in 20 (36%) cases, a paediatric registrar or consultant in 17 (30%), and an anaesthetic senior house officer or registrar in 10 (18%) cases. For nine (16%) patient transfers a nurse or midwife was the sole escort. Twenty of the medical escorts had less than one year of paediatric experience. Medical escorts had been on call for a mean of 12 hours before the transfer, with 13 having been on call for 24 hours or more. One medical escort had been on call for the previous 44 hours.

OUTCOME

There were 11 deaths and 45 live discharges from the intensive care unit. There were no deaths during transport. Admission period PRISM scores predicted 10·04 deaths. Eight of the children who died were boys and three girls.



(A) Number of adverse events for each patient. (B) Number of adverse clinical events by type (IV=intravenous).

ANALYSIS

Patients who subsequently died were significantly more likely to have had complicated transfers than the survivors (p=0·05). Those escorted by senior house officers and those with a PRISM score greater than 10 were also more likely to have undergone complicated transfers (p=0·06). There was no relation between complicated transfers and referring hospital type, age of patient, time taken for the transfer, or the time of day at which the patient was transferred (table 4).

Table 4 Comparison of satisfactory and complicated transfers

	No (%) satisfactory (n=14)	*No (%) complicated (n=42)*	*p Value (from Fisher's exact test)*
Referring hospital			
District general hospital	9 (64)	24 (57)	0·76
Teaching hospital or neonatal intensive care unit	5 (36)	18 (43)	
Time leaving referring hospital			
0900–1700	10 (71)	24 (57)	0·53
1700–0900	4 (29)	18 (43)	
Time taken for transfer			
Less than one hour	8 (80)	27 (68)	1·0
More than one hour	2 (20)	13 (32)	
Grade of escort			
Senior house officer	2 (14)	23 (55)	0·06
Other medical staff	7 (50)	15 (36)	
Nurse	5 (36)	4 (10)	
Age of patient			
Neonate	10 (71)	26 (62)	0·75
Non-neonate	4 (29)	16 (38)	
Risk of mortality			
Less than 10%	14 (100)	21 (50)	0·06
Greater than 10%	0	21 (50)	
Outcome			
Live discharge from intensive care unit	14 (100)	31 (74)	<0·05
Death on intensive care unit	0	11 (26)	

Discussion

In this study, 75% of critically ill children transferred from a referring hospital to the intensive care unit at Birmingham Children's Hospital had significant clinical complications during the transfer. Inadequate cardiorespiratory support, equipment failures, and drug administration errors were common. In over 20% of the transfers studied, the adverse clinical events were felt to be life threatening.

Other workers have shown a high frequency of avoidable insults during the secondary transfer of critically ill patients.[5–7] These insults relate most commonly to poor airway control,[5] and respiratory arrest during transfer is not uncommon.[7] Iatrogenic complications during transfer have been shown to worsen mortality and morbidity in adult patients,[5 8 9] and may lengthen the total hospital stay in children.[3]

Our data indicate that many of the medical escorts were inexperienced in the care of the critically ill and incapable of performing necessary basic resuscitative measures. Although it did not reach statistical significance (possibly due to the small numbers involved), this may

Table 5 Checklist for secondary transfer of sick children

1 Airway
- Intubation needed?
- Secure endotracheal tube?
- Position?
- Suction available?
- Sufficient oxygen for more than anticipated length of journey?

2 Circulation
- Adequately perfused?
- Blood pressure satisfactory?
- Ongoing circulatory losses to be considered?

3 Temperature
- Blankets/prewarmed incubator available?
- Ambulance heating on?
- Working temperature monitor available?

4 Procedures
- Reliable intravenous access established (preferably two intravenous lines in situ)
- Nasogastric tube (if bowel obstruction/ileus, ventilated or air transport)
- Urethral catheter (unconscious/sedated and diuretics)

5 Monitoring
- Check availability and function of
  - Electrocardiograph
  - Pulse oximeter/transcutaneous oxygen monitor
  - Blood pressure monitor
  - Temperature monitor
  - Blood sugar monitor (small infants/hypoglycaemia anticipated – that is, liver disease/long journey)

6 Equipment
- Check all equipment before leaving. Is it working and are the batteries charged? Spare batteries where possible

7 Drugs/fluids
- Maintenance fluid – appropriate type and rate
- Ensure availability of
  - Emergency drugs
  - Adequate sedation
  - Special drugs which may be needed (that is, prostaglandins in congenital heart disease)

8 Communication
- Which hospital and ward are you going to?
- Is there a special entrance?
- Phone destination unit: time leaving, anticipated time of arrival, update on the child's condition

have contributed to morbidity during patient transfer. Others have also shown that complications occur more often with junior and inexperienced staff,[2 3] while current American Academy of Pediatrics guidelines suggest that doctors undertaking paediatric transports should be in their third year of paediatric training.[10] They emphasise that all members of the transport team should be trained in the specific details and hazards of the transport environment.

It is not possible to directly relate mortality to iatrogenic morbidity from this study. Critical adverse events along with inadequate monitoring and support during transfer were more common in the patients judged to be the most severely ill on admission. Also, children who subsequently died had more adverse events during transfer than those who did not.

Adequate intensive care before and during interhospital transfer is known to reduce complications and improve prognosis[11–13] and our findings support the need for skilled resuscitation before the transfer, adequate monitoring of vital signs by well maintained apparatus and experienced staff during transfer, and appropriate intervention where necessary to stabilise the child before arrival at the admitting unit. A number of specific points in patient management are outlined in the accompanying checklist (table 5), and this may be used as an aide-mémoiré in the management of these patients.

Minimum standards for patient monitoring during secondary transport are continuous monitoring of heart rate, oxygenation, temperature, and blood pressure. Palpated measures of heart rate and blood pressure are inaccurate and invasive monitoring may be preferable.[14] Monitoring is difficult during transport with limited space, high ambient noise, and poor lighting. Dedicated and specially designed monitoring equipment that is robust, lightweight, and has a long battery life should be used.[15] Most equipment failures in this study were related to battery failure, and when not in use equipment should be recharged.

Recommendations are increasingly being made for dedicated transport teams to be organised by regional centres.[16 17] In contracting for specialist services, districts have been advised to ensure that adequate transport arrangements are made for children who may be very sick, including the provision of appropriate specialist staff to accompany them to the specialist centre.[18]

We have identified a high incidence of significant adverse clinical events occurring during the transfer of critically ill children. These events will occur as long as children continue to be transferred after inadequate stabilisation and escorted by inexperienced doctors using inadequate or malfunctioning equipment. It would be more appropriate, therefore, if the transfer was undertaken by fully trained specialist staff. Such transport teams should be established as a priority.

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