

## ORIGINAL ARTICLE

## Towards safer neonatal transfer: the importance of critical incident review

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**Background:** Critical incidents are common during the inter-hospital transfer of sick patients, and infants are an especially vulnerable group.

**Aims:** To examine the effect of critical incident review on the number of adverse events during inter-hospital transfer of sick infants.

**Methods:** Critical incidents over an eight year period are reported from a single neonatal transfer service before and after major service changes were made. The changes were instigated as part of ongoing critical incident reviews.

**Results:** Changes made as a result of critical incident review significantly reduced the number of incidents contributed to by poor preparation, transport equipment or clinical problems, ambulance delays, and ambulance equipment failure.

**Conclusions:** The continuous process of critical incident reporting and review can reduce the number of adverse events during the transfer of critically ill infants.

Neonatal transfer services are an integral part of managed clinical networks for neonatal intensive care.<sup>1</sup> The transfer environment is potentially "hostile" and it is essential that critically ill neonates are not exposed to a greater risk of adverse events as a result of the transfer process. In a review of adverse events occurring during inter-hospital transfer of critically ill children, Barry and Ralston found that inadequate cardiorespiratory support, equipment failures, and drug administration errors were common.<sup>2</sup> There is a paucity of similar data regarding neonatal transfer, and those that exist focus on small numbers of specific types of transfer<sup>3</sup> or on changes in physiological parameters.<sup>4</sup> The purpose of this study was to examine the impact of critical incident review on the incidence of adverse events during neonatal and infant transfer over an eight year period.

### Population

The former Northern Health Region has a population of approximately 3.2 million, with a live birth rate of 31 000 births per year. Four centres within a managed clinical network provide long term neonatal intensive care. Sixteen infants per 1000 live births require emergency postnatal transfer. The Newcastle Neonatal Service performs approximately three quarters of these transfers. The service also receives referrals of infants less than 6 months of age requiring paediatric intensive care, including ECMO.

### Transfer service

All referrals are made via a dedicated "hotline". The calls are triaged and clinical advice regarding continuing care is provided. During this process clinical responsibility is transferred to the on-call neonatal consultant. The transport team consists of the neonatal Specialist Registrar (SpR) and a neonatal nurse. There is a specific section in the transfer documentation where staff must record contemporaneously whether problems did or did not occur (at any stage from referral to patient hand-over), and if so to provide a brief description of the incident. Transfer data (including problems) are entered into a database by a single operator

(ACF). All critical incidents (defined as occurrences that led to, or had the potential to lead to, an undesirable outcome<sup>5</sup>) are reviewed on an ongoing basis. Wherever possible the team involved in the transfer are debriefed within 24 hours after the incident occurred and if necessary a more comprehensive report is written. Serial data review suggested that there were key areas in which problems frequently arose, involving both staff inexperience in the transfer environment and the interface between the hospital and ambulance services.

In 2001 the ambulance service planned a phased introduction of new vehicles which would impact on our ability to respond to requests for transfer. We took this opportunity to establish an ambulance liaison group. The remit of this group was to address the recurring "system failures" detected by our critical incident review process. The outcomes of this liaison process included:

- Agreed scripted protocols for requesting transfers
- Agreed response times
- Joint funding of ambulance tail lifts
- Transport equipment compatible with all local ambulances.

The last of these points required a revision of our existing transfer equipment provision so that it was specific for our service requirements. We secured funding to develop two identical transport trolleys and associated equipment and established procedures for maintenance and readiness. To improve staff expertise in the transfer environment we established a core nursing team for transfers and developed transport specific training for both medical and nursing staff.

### METHODS

Details of critical incidents were reviewed and the periods 1997-2001 and 2002-August 2004 were compared. For ease of comparison the incidents were categorised retrospectively. Incidents deemed to be due to poor preparation include occurrences such as transport equipment being

incompletely charged or forgotten, or insufficient gas supplies. Logistical problems would include being unable to assemble the transport team or being unable to access the hospital on arrival. Poor communication could involve any stage of the transfer process. Ambulance delay was defined as the ambulance taking longer to arrive than agreed, according to the urgency of the transfer. Transport equipment problems cover the equipment being damaged or malfunctioning during the transfer, or staff having difficulty utilising the equipment adequately. Clinical problems include difficulties stabilising patients and clinical deterioration.

Non-parametric variables are presented using medians and ranges. Statistical analysis was performed using the Mann-Whitney U test. Differences in incidences during the two time periods were compared using a  $\chi^2$  test.

## RESULTS

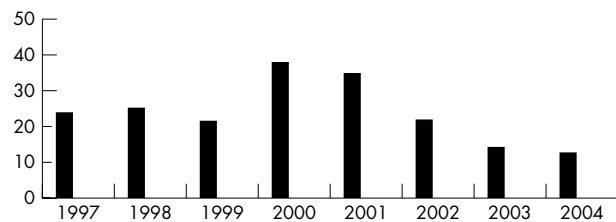
During the study period there were a total of 2402 transfers, of which 562 were associated with at least one critical incident. The number of transfers per annum has gradually increased from 262 in 1997 to 359 in 2003, with 299 transfers taking place in the first eight months of 2004.

The median gestation of the neonates transferred was 32 weeks (range 23–42 weeks) and their median birth weight 1850 g (range 455–5610 g). One hundred and twenty eight transfers involved moving patients across the regional boundary. Infants referred for ECMO comprised 113 of the total transfers. Sixteen patients improved sufficiently that they did not require transfer; 10 patients were deemed too ill to transfer and a further 29 patients died before the arrival of the transfer team or prior to departure from the referring unit. In one case the parents declined transfer of a child with a major congenital abnormality.

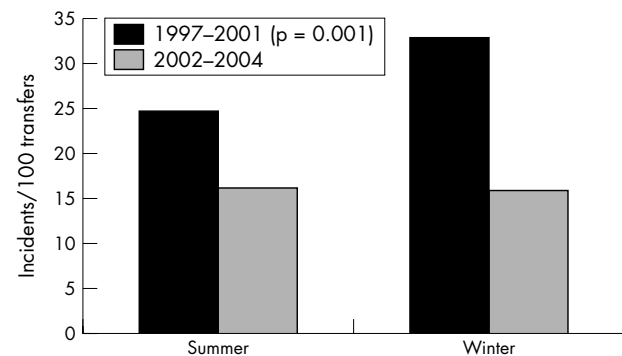
The median time spent on transfer was 2 hours and 50 minutes (range 10 minutes–45 hours) and the median time taken to stabilise the baby was 60 minutes (range 5–840 minutes). This did not alter significantly between the two periods examined.

Since 2001 there has been a progressive decrease in critical incidents (fig 1). A total of 395 incidents occurred during 1381 transfers between 1997 and 2001 and 167 incidents on the 1021 transfers between 2002 and 2004 ( $p < 0.001$ ). Ambulance and equipment related problems comprised the major part of critical incidents in both time periods, with significant reductions in several areas in the second time period examined (table 1).

Between 1997 and 2001 there were less incidents during the summer months (fig 2). Ambulance delays contributed in part to the increase seen over the winter, although the patient population was also different at this time, with more paediatric intensive care transfers (predominantly bronchiolitic-type illness). There was also a small increase in



**Figure 1** Number of transfers with critical incidents per 100 transfers by year.



**Figure 2** Transfers on which incidents occurred per 100 transfers by season.

critical incidents relating to clinical problems at the time of intake of new SpRs, although the numbers are small (fig 3). In the second time period (2002 to date) there is little variation in number or type of critical incident throughout the year.

Other incidents include the ambulance being involved in a road traffic accident, a member of staff sustaining a laceration to the face while the transport incubator was being moved from a helicopter, and problems securing endotracheal tubes and venous lines.

Incidents were described retrospectively using the National Patient Safety Agency (NPSA) risk assessment tool.<sup>6</sup> Briefly, a catastrophic incident is one that has the potential to contribute to the death of a patient, and a major incident is one that may result in permanent injury. Recurrence is described on a scale of five levels from rare to almost certain to recur. An error is an accidental or non-intentional failure.

In the first time period there were 42 major incidents compared to 16 in the second time period ( $p < 0.03$ ).

**Table 1** Type of incident and comparison to published data for the transport of sick children<sup>2</sup> and neonates.<sup>3</sup>

Type of incident	No. 1997–2001 (% of transfers)	No. 2001–2004 (% of transfers)	Holt <sup>3</sup> (% of transfers)	Barry <sup>2</sup> (% of transfers)
Poor preparation	41 (3.0)*	15 (1.5)*		
Logistical problems	22 (1.6)	9 (0.9)		
Poor communication	14 (1.0)	20 (2.0)		
Ambulance delay	158 (11.4)***	40 (3.9)***		
Ambulance/ambulance equipment failure	72 (5.2)**	26 (2.5)**		
Transport equipment problems	60 (4.3)**	19 (1.9)**	(10.1)	(21.4)
Clinical problems	87 (6.3)*	42 (4.1)*	(3.6)	(75)
Other	22 (1.6)	14 (1.4)		

\* $p < 0.05$ , \*\* $p < 0.005$ , \*\*\* $p < 0.001$ .

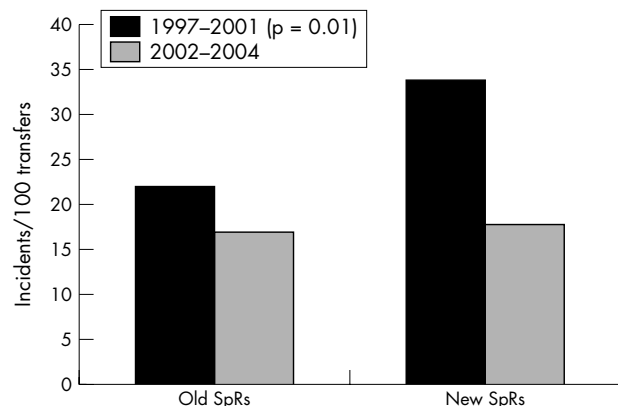
Between 1997 and 2004 there were eight potentially catastrophic incidents, all of which were felt to be unlikely to recur, and none of which were contributed to by an error. Six of these incidents occurred between 1997 and 2001. These eight incidents consisted of five cases where the patient required cardiopulmonary resuscitation; extreme ambulance vibration contributing to the deterioration of a patient; a patient with a persistent metabolic acidosis which the team were unable to correct; and difficulty ventilating a patient with abdominal problems when the monitoring equipment failed and the ambulance was delayed. The five cardiopulmonary arrests were secondary to a blocked endotracheal tube in one case; on transfer between ventilators in two cases; on induction of anaesthesia during an “away-day” ligation of a patent ductus arteriosus in one case; and on transfer to the ambulance in the fifth case.

Between 1997 and 2001, 95 transfers experienced critical incidents that were contributed to by an error in contrast to just 41 errors during 2002 and 2004 ( $p = 0.004$ ). A common example of these errors would be leaving the transport incubator system with electrical equipment uncharged.

**DISCUSSION**

Our experience shows that critical incidents are common during neonatal transfer and that a large proportion of these are potentially preventable. With improved training of our staff and implementation of guidelines for maintenance and readiness of equipment, the number of critical incidents contributed to by poor preparation, transport equipment problems, and clinical problems has significantly reduced. Liaison with the ambulance services and the use of a script when requesting an ambulance has dramatically reduced the number of ambulance delays. The reduction of ambulance vehicular and equipment failure could have been contributed to by the increased familiarity of ambulance staff with our equipment.

The increase in incidents seen from 1999 to 2001 coincided with increased awareness among staff of the need to report any problems encountered, and so may at least in part reflect an increase in the rate of reporting, rather than a true increase in the number of problems encountered. All incidents were part of routine reporting and as such will be biased towards the more unusual and serious events. It is possible that some frequent, minor problems may have been missed. The method of reporting of incidents via the transfer documentation has remained unchanged and so is unlikely to have produced any bias in either under- or over-reporting in either time period.



**Figure 3** Effect of SpR changeover on critical incidents.

**What is already known on this topic**

- Adverse events are common during paediatric transfer
- There is a paucity of comparable neonatal data

**What this study adds**

- Critical incidents are common during neonatal transfer
- Contemporaneous critical incident review can dramatically reduce the frequency of such events

Our findings are in keeping with previously published studies. Barry and Ralston found that 75% of paediatric intensive care transfers involved adverse clinical events and that in 40% of cases clinical deterioration was potentially preventable; these included cardiorespiratory deteriorations and admission temperatures of less than 36°C as well as loss of intravenous access.<sup>2</sup> However, this report is of ad-hoc transfers and not of a dedicated transfer service. The use of a specifically trained transport team has been shown to improve the outcome of transported infants in other studies.<sup>4,7</sup> Equipment failure was common, although we experienced this less frequently than other authors. However, Holt and Fagerli included aircraft problems within their definition of equipment failures (table 1). The number of isolated clinical concerns is comparable to that in other neonatal series, but is less than that found on transfer of paediatric patients.

Whitfield and Buser suggest that a comparison of transport stabilisation is a useful tool for evaluating transport services.<sup>8</sup> Our median stabilisation time of 60 minutes is less than that described by Broughton *et al* but is comparable to that of Holt *et al*.<sup>3,9</sup> These differences are likely to reflect differences in the study populations. Broughton *et al* only included infants that had two blood gas measurements performed during retrieval and so their population was biased towards the sickest infants. That study also found that the greatest improvement in a modified Clinical Risk Index for Babies (CRIB) score occurred between the initial phone call and the transfer team arriving. Our use of this time period to advise local teams on continuing management will also contribute to the reduced stabilisation time.

It is essential that reporting of critical incidents continues. Our report clearly shows that the continuing process of critical incident reporting and review may reduce the number of adverse events during the transfer of critically ill infants. The sharing of information and experiences with other services will contribute to improving the standard of care of neonates transported between hospitals. It is likely that other services experience the same problems that we found to be frequent, and common solutions can be devised in conjunction with one another. A common neonatal transfer dataset would allow comparison of critical incidents between transfer services using a risk assessment tool such as NPSA categorisation.

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Competing interests: none

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## ARCHIVIST .....

**Integrated management of childhood illness**

The Integrated Management of Childhood Illness (IMCI) strategy was proposed by the World Health Organization in the mid-1990s. It sought to improve the health of children in developing countries by improving health systems, family and community care, and the skills of local health workers. The governments of almost all developing countries have adopted IMCI, apparently with varying degrees of commitment. The effectiveness of IMCI is to be measured by Multi-Country Evaluation (MCE) with studies in Bangladesh, Brazil, Peru, Tanzania, and Uganda. Reports from Tanzania and Bangladesh have been published (Joanna RM Armstrong Schellenberg and colleagues. *Lancet* 2004;**364**:1583–94; Shams El Arifeen and colleagues. *Ibid*: 1595–602; see also Comment, *ibid*: 1557–8).

In Tanzania, between 1997 and 2002, two districts with facility-based IMCI were compared with two districts that had not yet introduced IMCI. In the IMCI districts >80% of child health workers attended an 11-day training course and information tools were provided from the Tanzania Essential Health Interventions Project. Over a period of 2 years mortality in children <5 years was 13% lower in IMCI districts than in control districts (3.8 fewer deaths per 1000 child-years). There were improvements in the provision of and access to satisfactory health care and IMCI did not increase the cost of child health care.

In Bangladesh 20 first-level outpatient facilities were randomised to IMCI or control groups. In the IMCI facilities a higher proportion of sick children (19% vs 9%) were taken to a health worker, and the number of visits per child increased more than threefold (0.6 vs 1.9 visits per child per year). Children in IMCI facilities were more likely to receive appropriate treatment (“index of correct treatment” on a 0–100 scale, 54 (IMCI) vs 9 (control)).

The introduction of IMCI in Tanzania and Bangladesh has been followed by improvements in the quality, availability, and uptake of child health services. Government enthusiasm for implementing the strategy seems to vary and implementation of the household and community arm seems particularly challenging. Dr Davidson R Gwatkin in his *Lancet* commentary remarks that in most countries the basic health system is too weak to allow for more than nominal execution of IMCI.