An analysis of inter-healthcare facility transfer of neonates within the eThekwini Health District of KwaZulu-Natal, South Africa

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Objectives. To investigate delays in the transfer of neonates between healthcare facilities and to detect any adverse events encountered during neonatal transfer.
Methods. A prospective study was conducted from December 2011 to January 2012. A quantitative, non-experimental design was used to undertake a descriptive analysis of 120 inter-healthcare facility transfers of neonates within the eThekwini Health District (Durban) of KwaZulu-Natal Province, South Africa. Data collection was via questionnaire. Data collection was restricted to the Emergency Medical Services (EMSs) of eThekwini Health District, which is the local public ambulance provider.
Results. All transfers were undertaken by road ambulances: 83 (62.2%) by frontline ambulances; 35 (29.2%) by the obstetric unit; and 2 (1.7%) by the planned patient transport vehicles. Twenty-nine (24.2%) transfers involved critically ill neonates. The mean (standard deviation (SD)) time to complete an inter-healthcare facility transfer was 3 h 49 min (1 h 57 min) (range 0 h 55 min - 10 h 34 min). Problems with transfer equipment were common due to poor resource allocation, malfunctioning equipment, inappropriate equipment for the type of transfer and dirty or unsterile equipment. The study identified 10 (8.3%) physiologically related adverse events, which included 1 (0.8%) death plus a further 18 (15.0%) equipment-related adverse events.
Conclusions. EMS is involved in transporting a significant number of intensive care and non-intensive care neonates between healthcare facilities. This study has identified numerous factors affecting the efficiency of inter-facility transfer of neonates and highlights a number of areas requiring improvement.

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The inter-healthcare transfer of neonates is an integral component of neonatal care and is often driven by a lack of local neonatal cots or the need for specialist intervention. Inter-healthcare transfer can result in clinical deterioration, which impacts directly on neonatal morbidity and mortality.[1] To maintain the continuum of care, neonatal transfer requires careful planning, skilled personnel and specialised equipment. One of the main focus areas of the World Health Organization's Millennium Development Goal 4 is maternal and child health, yet in sub-Saharan Africa, infant mortality remains high, with one child in every eight dying before their 5th birthday (129 per 1 000 live births). South Africa (SA) set a target to reduce infant and child mortality rate to 20 deaths per 1 000 live births by 2015.[2,3] These initiatives are, however, largely focused on improving hospital and clinic facilities as opposed to emergency medical services (EMSs).[3] The EMS in the eThekwini Health District of KwaZulu-Natal (KZN) Province is the provincial ambulance service providing prehospital care and inter-hospital transfer for ~3.5 million people in a geographical area of over of 2 291 km^2.[4] All referrals are co-ordinated via a central EMS communication centre dispatching both road and aeromedical ambulance services. Ambulances are staffed by emergency care providers registered with the Health Professions Council of South Africa as basic ambulance assistants (BAAs), ambulance emergency assistants (AEAs), paramedics, emergency care technicians (ECTs) or emergency care practitioners (ECPs) (Table 1).

Inter-healthcare transfers are provided through either the planned patient transport (PPT) or emergency response divisions of EMS. PPT service provides an elective patient transport service and inter-healthcare facility transfers operating weekdays from 08h00 - 16h00. Currently there is no specialist neonatal transfer team allocated for neonatal inter-healthcare facility transport and EMS provide this service either by the emergency response or the PPT service depending on clinical need and time of the day the request is made. Neonatal transport equipment is placed in various ambulance bases and in the event of neonatal transfer, the ambulance crew collects the equipment before reporting to the requesting hospital. High-risk neonatal transfers such as intubated neonates are escorted by paramedics. All paramedics receive specific training in neonatal inter-hospital transfer. Currently there is limited research associated with the transfer process within SA, particularly with regards to how it is provided.

Methods

A quantitative, non-experimental design was used to undertake a descriptive analysis of 120 inter-healthcare facility transfers of neonates (from birth to the first 28 days of life) within the eThekwini Health District. Data were collected prospectively from 19 December 2011 to 30 January 2012. Only the public sector ambulance service of the eThekwini Health District was included in the study.

Data were obtained from two questionnaires: the first was completed by communications officers at the communication centre, and the second by the most senior emergency care provider of each transfer team. The service of a professional statistician was used to analyse raw data. The computer software programs used were SPSS Statistics version 20.0 (IBM, USA) and Statgraphics Centurion 15.1 (Statgraphics, USA). The statistical aspect of the research encompassed descriptive statistics, inferential statistics and the χ^2 test. For logistical reasons, the study was limited to one health district, instead of the entire province of KZN. Furthermore, the

study did not include private sector EMS, who also undertake inter-facility neonatal transfers.

Ethical approval was granted by the Institutional Research Ethics Committee (IREC) of the Durban University of Technology (Ethics Clearance No.: IREC 001/11).

Results

All inter-healthcare facility transfers (n=120) were undertaken by road ambulances, with emergency ambulances undertaking 83 (69.0%) transfers, an obstetric ambulance undertaking 35 (29.0%) transfers and the planned patient transport units undertaking 2 (2%) transfers. Ninety-three (77.5%) neonates were referred from hospitals and 27 (22.5%) were referred from primary healthcare clinics.

Sixty-nine (57.5%) cases were primary transfers for specialised or higher level of care while the remaining cases 51 (42.5%) were return transfers (Table 2). A total of 92 (76.7%) of the neonates were preterm, 26 (21.7%) were term and 2 (1.7%) were post term (Table 3). The mean (standard deviation (SD)) time to complete an inter-healthcare facility transfer was 3 h 49 min (1 h 57 min) (range 0 h 55 min - 10 h 34 min) (Table 4). There were delays in dispatch (>3 min) (Fig. 1) due to ambulance non-availability in 70 (47.3%) instances, no paramedic was available for 48 (32.4%) transfers where a paramedic was deemed to be required, no AEA personnel were available to support the neonatal transfer on 7 (4.7%) occasions and on 23 (15.5%) occasions, neonatal transfer equipment was not available. Seventeen (14.2%) requests for the inter-healthcare facility transfer of neonates did not require any specialist equipment. Paramedics were dispatched to 6 (35.3%) transfers, ECTs to 2 (11.8%), AEAs to 3 (17.6%) and BAAs to 6 (35.3%). Delays were common in a number of instances, and the reasons for these delays were numerous. Forty-eight (32.4%) of the transfers were delayed due to no paramedics being available. However, paramedics were only required in 29 (60.4%) of the 48 transfers. The control centre is staffed by either BAAs or AEAs. Improved information gathering by the ambulance control centre from the referring hospital may minimise transfer delay (Table 5).

There were 10 (8.3%) physiologically related adverse events during transfer, including one death. The remaining nine incidents were all potentially life threatening. Thirteen neonates (10.8%) required clinical intervention during transportation and 8 (6.7%) intervention on arrival at the receiving hospital (Table 6). There is a significant relationship between pretransport intervention performed and mean time delay at the referring hospital (p=0.018). Fifteen (12.5%) neonates were inappropriately prepared for transport by the referral hospital, resulting in delays in the transfer. Six (5.0%) neonates were deemed to be too unstable for transfer, with paramedics having been dispatched to 5 (83.3%), and 1 (16.7%) to AEAs.

In 18 (15.0%) transfers there were adverse events associated with equipment failure and issues with equipment being unavailable (Table 7). Correlation between paramedic transfers undertaken and equipment-related adverse events shows that 18 (15.0%) transfers experienced adverse events, of which 11 (61.1%) occurred during paramedic transfer. Correlation between physiologically related adverse events and equipment-related adverse events shows that 5

Table 1. Prehospital emergency care categories of registration with HPCSA

Qualification*	Description
BAA	An entry-level, 4-week qualification leading to a basic life support scope of practice
AEA	A mid-level 4-month qualification leading to an intermediate life support scope of practice of a limited number of invasive techniques
Paramedic	This is either a 1-year or a 3-year qualification leading to an ALS scope of practice of an array of invasive techniques
ECT	A 2-year mid-level qualification leading to a limited number of skills within the ALS scope of practice
ECP	A 4-year professional Bachelor degree within the ALS scope of practice with an additional scope of practice which includes thrombolysis and rapid sequence intubation

*All qualifications are registered with the HPCSA.

Table 2. Referring and receiving facilities, primary and return transfers and dayshift and nightshift transfers

	n (%)
Referring facilities	
Prince Mshiyeni Memorial Hospital	9 (7.5)
R K Khan Hospital	14 (11.7)
St Mary's Hospital	2 (1.7)
King Edward VIII Hospital	13 (10.8)
Mahatma Gandhi Memorial Hospital	7 (5.8)
Addington Hospital	2 (1.7)
Inkosi Albert Luthuli Central Hospital	29 (24.2)
Clairwood Hospital	2 (1.7)
St Augustine's Hospital	1 (0.8)
Isipingo Medical Towers Hospital	4 (3.3)
Wentworth Hospital	1 (0.8)
City Health Hospital	9 (7.5)
Primary Health Clinic	27 (22.5)
Total	120 (100)
Receiving facilities	
Prince Mshiyeni Memorial Hospital	11 (9.2)
R K Khan Hospital	15 (12.5)
St Mary's Hospital	07 (5.8)
King Edward VIII Hospital	22 (18.3)
Mahatma Gandhi Memorial Hospital	23 (19.2)
Addington Hospital	4 (3.3)
Inkosi Albert Luthuli Central Hospital	29 (24.2)
Clairwood Hospital	3 (2.5)
St Augustine's Hospital	1 (0.8)
Isipingo Medical Towers Hospital	1 (0.8)
Osindisweni Hospital	3 (2.5)
Cancelled	1 (0.8)
Total	120 (100)
Primary and return transfers	
Primary transfers	69 (57.5)
Return transfers	51 (42.5)
Total	120 (100)
Dayshift and nightshift transfers	
Dayshift	97 (80.8)
Nightshift	23 (19.2)
Total	120 (100)

(50.0%) of the 10 (8.3%) physiologically related adverse events that occurred during transfers were a direct result of equipment-related adverse events. Although a small number was involved (5 (50.0%)), the χ^2 test showed a statistically significant *p*-value of 0.007.

Discussion

There were 120 neonatal transfers in 43 days (average 2.79 per day). This is a high incidence compared with Ireland[5] or Slovenia,[6] where between 0.482 and 0.487 inter-facility transfers take place per day, respectively. The higher incidence of transfers in the eThekwini Health District can be attributed to a lack of specialised neonatal facilities and trained staff.

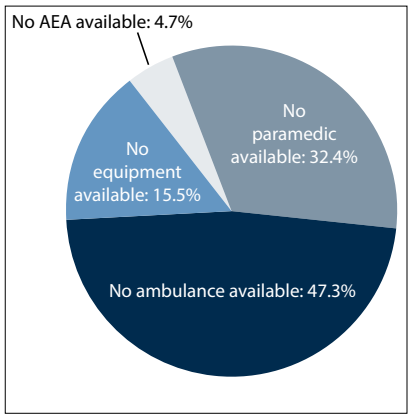

Fig. 1. Reasons for delay in dispatch.

Table 3. Demographic variables of neonates transferred

Variable	*n* (%)	Variable	*n* (%)
Neonatal age		Diagnosis	
From birth to 4 hours	11 (9.2)	Preterm	90 (75.0)
Between 4 hours and 1 day	21 (17.5)	Respiratory distress syndrome	49 (40.8)
Between 1 day and 7 days	35 (29.2)	Meconium aspiration syndrome	13 (10.8)
Between 7 days and 28 days	53 (44.2)	Hyaline membrane disease	24 (20.0)
Total	120 (100)	Low birth weight	25 (20.8)
Neonatal weight (g)		Neonatal sepsis	6 (5.0)
<1 000	6 (5.0)	Supportive care	2 (1.7)
1 000 - 1 499	42 (35.0)	Apnoea	2 (1.7)
1 500 - 1 999	29 (24.2)	Infection or suspected infections	14 (11.7)
2 000 - 3 999	38 (31.7)	Patent ductus arteriosus	4 (3.3)
>4 000	5 (4.2)	Retinopathy of prematurity	1 (0.8)
Total	120 (100)	Tricuspid atresia	1 (0.8)
Neonatal sex		Pyloric stenosis	1 (0.8)
Male	83 (69.2)	Perforated trachea	1 (0.8)
Female	37 (30.8)	Birth abnormalities	3 (2.5)
Total	120 (100)	Tumour to eye	5 (4.2)
Gestational age		Congenital heart disease	2 (1.7)
Preterm	92 (76.7)	Congenital pneumonia	12 (10.0)
Term	26 (21.7)	Exposed intestines	2 (1.7)
Post-term	2 (1.7)	Abdominal obstruction	5 (5.2)
Total	120 (100)	Perforated bowel	1 (0.8)
		Hydrocephalus	2 (1.7)
		Diaphragmatic hernia	3 (2.5)

Table 4. Timeframes for the inter-healthcare transfers

	Time difference	Min. (h:min)	Max. (h:min)	Mean (SD) (h:min)	95% (CI) (h:min)
From request (T1) to dispatch (T2)	T2 - T1	00:04	07:50	01:20 (01:36)	01:04 - 01:39
From dispatch to becoming mobile to the referring hospital (T3)	T3 - T2	00:00	04:00	00:27 (00:44)	00:20 - 00:36
From time of becoming mobile to the referring hospital to time at the referring hospital (T4)	T4 - T3	00:00	03:42	00:21 (00:24)	00:17 - 00:26
From time at the referring hospital to time of becoming mobile to the receiving hospital (T5)	T5 - T4	00:00	02:17	00:43 (00:26)	00:39 - 00:49
From time of becoming mobile to receiving hospital to the time at receiving hospital (T6)	T6 - T5	00:00	01:30	00:27 (00:16)	00:24 - 00:30
From time at receiving hospital to time of completion at receiving hospital (T7)	T7 - T6	00:01	01:50	00:28 (00:14)	00:25 - 00:31
Total time taken to complete transfer	T7 - T1	00:55	10:34	03:49 (01:57)	03:29 - 04:12

Table 5. Qualification and experience of telephone operator

Qualification of telephone operator	*n* (%)	Time (years)	Communication experience, *n* (%)	Operational experience, *n* (%)
BAA	71 (59.2)	None	-	33 (27.5)
AEA	49 (40.8)	<1	36 (30.0)	2 (1.7)
Paramedic	-	1 - 3	3 (2.5)	5 (4.2)
ECT	-	3 - 5	3 (2.5)	2 (1.7)
ECP	-	>5	78 (65.0)	78 (65.0)
Total	120 (100)	Total	120 (100)	120 (100)

Table 6. Skill intervention performed

Intervention pretransport	*n* (%)	Intervention during transport	*n* (%)	Intervention post transport	*n* (%)
Oxygenation via BVM	13 (10.8)	Oxygenation via BVM	9 (7.5)	Oxygenation via BVM	6 (5.0)
Suctioning	2 (1.7)	Suctioning	4 (3.3)	Suctioning	1 (0.8)
Admin. of pharm. agents	6 (5.0)	Admin. of pharm. agents	3 (2.5)	Admin. of pharm. agents	2 (1.7)
Intubation	2 (1.7)	Admin.of fluids	3 (2.5)		
Adjusting depth of tracheal tube	2 (1.7)	Intravenous cannulation	1 (0.8)		
Restrapping tracheal tube	3 (2.5)	Cardiopulmonary resuscitation	1 (0.8)		
NGT insertion	1 (0.8)				
Admin. of fluids	1 (0.8)				

BVM = bag valve mask; NGT - nasogastric tube.

Table 7. Equipment required before proceeding with the transfer

Availability of equipment	*n* (%)	Unavailable equipment	*n* (%)	Reasons for unavailability	*n* (%)
Yes	66 (55.0)	Oxygen	2 (1.7)	Equipment not available at base	23 (20.0)
No	37 (30.8)	Ventilator	10 (8.3)	Equipment defective	3 (2.5)
N/A	17 (14.2)	Incubator	21 (17.5)	Not purchased	2 (1.7)
Total	120 (100)	Syringe driver	4 (3.3)	Other	9 (7.5)
		Infusion pump	3 (2.5)		
		Cardiac monitor	1 (0.8)		
		SpO_2 monitor	2 (1.7)		
		$EtCO_2$ monitor	6 (5.0)		
		NIBP monitor	3 (2.5)		
		Temperature monitor	1 (0.8)		
		Ventilator circuits	3 (2.5)		
		Administration sets	1 (0.8)		

Battery operated equipment

Fully charged	*n* (%)	Reasons for not being fully charged	*n* (%)
Yes	70 (58.3)	Batteries not charged	6 (5.0)
No	16 (13.3)	Batteries not maintaining charge	6 (5.0)
N/A	34 (28.3)	Batteries not charged long enough	4 (3.3)
Total	120 (100)		

Ventilator circuit

Sealed pack	*n* (%)	Reasons for not being in a sealed pack	*n* (%)
Yes	20 (16.8)	Circuit not autoclaved	1 (0.8)
No	2 (1.7)	Circuit not disinfected	1 (0.8)
N/A	98 (81.7)		
Total	120 (100)		

Equipment clean for transfer	*n* (%)	Reasons for equipment not being clean	*n* (%)
Yes	95 (79.2)	Incubator was used and not cleaned	4 (3.3)
No	6 (5.0)	Back-to-back transfers (incubator wiped down only)	2 (1.7)
N/A	19 (15.8)		
Total	120 (100)		

N/A = not applicable; SpO_2 = estimate of arterial oxygen saturation; $EtCO_2$ = end-tidal carbon dioxide; NIBP = non-invasive blood pressure.

Caring for a critically ill neonate during a transfer is very different to caring for a neonate in a neonatal intensive care unit. This is because EMS personnel have to deal with adverse weather conditions, noise, mechanical vibration, unstable equipment, restricted lighting, limited work space and limited support services. However, with appropriate equipment and appropriate utilisation of staff with specialist training,

inter-facility neonatal transfers can be safely undertaken.[7] There is rarely a need for haste when undertaking a neonatal intensive care transfer. The speed of the actual transfer is no substitute for the time invested in resuscitating and stabilising the neonate before transfer. Taking intensive care to the neonate and pretransport stabilisation may be more beneficial than rapid delivery to a healthcare facility.[8]

EMS in the eThekwini Health District has no specialised or dedicated transport team for neonatal inter-health care facility transfer. Studies highlighted equipment and physiologically related adverse events and time delays in the transportation of neonates when these transfers are carried out by non-specialised neonatal transportation teams.[5,6,10] This study demonstrated similar results. The introduction of dedicated or skilled regional teams with dedicated ambulances may help minimise intra-transfer deterioration. Inexperienced and junior staff in the communication centre also contributed towards delays, as evidenced by the dispatch of inappropriate neonatal transfer equipment and the inadequate dispatch of emergency care personnel. All physiologically related adverse events were life-threatening, with conditions such as respiratory and cardiac deterioration, desaturation, development of hypothermia and cardiorespiratory arrest. One death occurred during neonatal transfer. The cause of the neonatal death was multi-faceted: reasons included inappropriate pretransport preparation, lack of pretransfer stabilisation and a lack of available Advanced Life Support (ALS) personnel, which resulted in clinical supervision being delegated to a less-qualified ambulance clinician. It is feasible that the appropriate allocation of a paramedic to this transfer may have prevented the adverse outcome.

Conclusion

This study identified numerous shortfalls in inter-healthcare facility transfer of neonates, with the greatest shortcomings being time delays, equipment problems and adverse events. Clear protocols and programmes are to be developed in resource-constrained environments to address the problems identified in the study. Specialised and dedicated transport teams with a thorough understanding of the transfer process, that utilise sophisticated transportation equipment and well-structured processes are required for the safe and expedient inter-healthcare transfer of neonates. To achieve a high standard of neonatal care and monitoring (both on the ground and in the air), it is essential that there is effective communication and co-ordination between all role players, as well as meticulous stabilisation and training programmes. This must be underpinned by good team work by all role players. Only then can the transport service achieve clinical excellence.

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