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Review

Critical issues underpinning the safe transfer of ill neonates: A review of the literature

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Abstract

Introduction
Critically ill neonates often require urgent transport to a neonatal care facility shortly after birth. The safe transfer of ill neonates is a critical part of their continuum of care.

Methods
A review of the empirical work and literature around the safe transfer of ill neonates was undertaken to explore what factors influence a safe transfer.

Results
What emerged was that a multitude of adverse events influence the clinical deterioration of the neonate, including the physiological condition of the neonate, equipment-related challenges and the unpreparedness of those involved to deal with neonatal clinical emergencies.

Conclusion
This review highlights the necessary equipment required, the nature of clinical emergencies that may arise, and the need to consider utilising specialised neonatal transfer units to effect the safe transfer of the critically ill neonate.

Keywords:
neonates; transfers; specialised teams; equipment

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Introduction

Infant mortality is linked largely to the number of deaths of newly-born infants or those in the first 28 days of life (1). Globally in 2015, 45% of deaths in children less than 5 years of age were neonatal deaths; with the rate projected to increase to 52% by 2030 (2). Although maternal antenatal transfer is optimal, critically ill neonates often require urgent transport to a neonatal care facility shortly after birth. Although the inter-hospital transport of premature infants has become increasingly common, it is known to be linked with increased morbidity and increased mortality from multifactorial causes. Inter-hospital transfers involve transfer of the patient within the same facility for any diagnostic procedure or transfer to another facility that can provide advanced care (3).

Neonates are more vulnerable –in the context of the distance travelled within inter-healthcare transfers – as their condition tends to deteriorate rapidly (4-6). Neonatal transfers are an integral part of neonatal intensive care and form part of the continuum of care that ill neonates may need. This literature review explores some of the factors affecting the transfer of ill neonates by reviewing empirical research related to neonatal transfers. It will highlight the importance of well-prepared advanced life support (ALS) paramedics and specialised teams and the need to restructure the transfer system to ensure that physiological, equipment-related and human issues are addressed.

The literature review

In 2015, the neonatal mortality rate (NMR) in South Africa accounted for 44% of the infant mortality rate and 32% of the less than five years of age mortality rate (1). Rhoda et al (2) referred to the Perinatal Problem Identification Programme 2014–2015, which indicated that the main causes of neonatal death were complications arising from pre-maturity and intrapartum-related events primarily due to intrauterine hypoxia and infections in South Africa. These factors lead to the need for emergency inter-health care transfers, which can be accomplished safely and in a timely manner if the correct resources, organisational structures and transfer processes are in place (7). Critically ill neonates require specialised hospital services and, as neonatal intensive care exists at only a few facilities locally, they are often transferred to higher level healthcare facilities.

ALS paramedics are at the forefront of these transfers and have to strive to maintain an extension of the intensive care unit, despite a resource-poor environment. They play a vital role in the emergency medical care environment and are responsible for intensive care during the neonatal transfer (8). Their scope of practice includes advanced airway management and ventilation, cannulation (intravenous, intraosseous and umbilical), pharmacological administration, emergency cardiovascular care and advanced cardiac arrest management. The development of clinical skills among ALS paramedics is based on a range of factors. For the new ALS paramedic, formal registration with the Health Professions Council of South Africa allows for immediate interaction with critically ill neonates (4).

Researchers have argued that in order to reduce the number of neonatal deaths in low-to-middle income countries, all neonatal mortalities must be scrutinised for systemic causes (9). This suggests the need for closer scrutiny into the issues interfacing with and affecting the transfer process and to make a concerted effort to introduce strategies that deal with these issues. In more developed countries, the inter-healthcare facility transfer of critically ill neonates form a single component, embedded within a larger system of neonatal intensive care (5). Such sophisticated transfer systems are associated with delivering state-of-the-art critical care during the transfer and serves as an extension of the neonatal intensive care units that bring an advanced level of care to the bedside of the referring facility. These systems have improved neonatal outcomes and significantly reduced neonatal mortality rates. Messner (6) described a good neonatal transfer service as including an appropriate management structure, a well configured specialised and dedicated transfer team with relevant knowledge and skills, standardised practice with policies and procedures, and clearly articulated steps for the transfer processes. This is underpinned by good communication and coordination, specialised transfer equipment, a quality improvement program, appropriate documentation and family support. These findings were consistent with reports at a conference in paediatric and neonatal inter-facility transport, which was held in the United States (10).

The transfer of critically ill neonates becomes essential when life-threatening circumstances arise, however they do not come without risk. Critically ill neonates requiring specialist interventions at higher-level care facilities are at an increased risk of mortality if not urgently and safely transferred (11). During the transportation of neonates, the likelihood of an adverse event occurring is at least 75% (12,13). Apart from transportation, the change of environment from a specialised neonatal intensive care unit (NICU), to an ambulance presents additional stress to the neonate, resulting in either minor or life-threatening events.

A qualitative study undertaken by Hosseini et al (14) endeavoured to elicit the perspectives of experts regarding the neonatal transfer system in Iran. Forty-eight experts were involved in four focus group discussions, which emphasised the importance of restructuring the neonatal transfer system by focussing on issues such as the neonatal transport system staff involved in the process, human resource management, conditions and requirements of the neonatal transport system and the information management and communication systems of neonatal transport systems. They concluded that neonatal transport systems in different countries must adapt to the situational dynamics of their country and that each transport system must attend to geographical conditions, access to different important professionals, health system structure and the facilities related to neonatal healthcare. Fenton et al (15) further

lamented that services for neonatal intensive care have evolved in an unplanned fashion, with units of different sizes providing varying amounts of intensive care. They pointed to chronic under-resourcing which has resulted in neonatal intensive care units operating at full capacity most of the time. More recently Sundrani et al (16) wrote that the neonatal transfer system is the most crucial component of regionalised perinatal care. Their study found that immediate and long term outcomes for neonates were related to mode of transport used for the transfer, travelling distance and stabilisation of the infant. They concluded that a specialised transport service could improve the survival of neonates. This conclusion is supported in extant studies, which also found that it is possible to improve the condition of neonates during transfers by using specialised teams who are well trained to prevent in-transit deterioration (17).

In another qualitative study by Janati et al (18), 12 neonatal transport systems in nine developed and developing countries (including the United States, Britain, Canada, Australia, Sweden, Scotland, Hungary, India and China) were studied using a comparative approach. The four criteria used were transport team personnel, transport types and organisation forms, the situation of these countries in neonatal transport and neonatal health indicator of these countries. It was found that the neonatal teams consisted of trained nurses as the major staff on the team and could benefit from the inclusion of medical or paramedic staff. It was further reported that appropriate regionalisation and proper management were crucial factors underpinning the success of the system. They emphasised the need for regionalised neonatal transport system to be developed and resources allocated to meet such needs.

A systematic review of 40 studies undertaken on neonatal transfers in developing countries found that hypothermia was the most critical risk factor for morbidity and mortality (10). The review uncovered that other factors influencing outcomes were linked to hyperthermia, hypoglycaemia, poor perfusion and the duration of the transfer. The review also uncovered that the capacity to provide additional specific care before and during the transfers for neonates with prematurity and respiratory distress, surgical conditions and complicated sepsis further influenced outcomes. It also uncovered that family members often accompanied neonates on most transfers. What emerged as significant, however, was that using transfer teams consisting of specialised team members was linked with improved physiological stability regardless of the distance (19).

Several studies have documented physiological, equipment-related and human issues related to adverse events during transfers. Physiological related adverse events are directly linked to the clinical deterioration of the neonate, with physiological changes being a real possibility during both ground and air transportation (20). The frequency of physiological-related adverse events has been described in both international and local studies (13,20-23).

In a study conducted in Argentina, Goldsmit et al (17) reported physiological changes in 91 (57%) of the 160 newborns that were transferred. In London, Senthilkumar et al (24) and Lim et al (11) also reported adverse events for 43.4% and 36.1% of transfers, respectively. The proportion of adverse events linked to physiological changes in these two studies accounted for 39% and more than 1% of all clinically related adverse events, respectively.

The most common physiological changes that result in the clinical deterioration of neonates include hypothermia, hypotension, hypoglycaemia, cardiac dysrhythmia, respiratory deterioration and decreased levels of consciousness. Goldsmit et al (17) reported that 49 (31%) of the 91 neonates who experienced physiological changes required immediate cardiorespiratory support. Thermal instability was the most common adverse reaction, with 73 (46%) of the neonates deteriorating as a result of hypothermia (17). Hypothermia was also found to be a significant physiological related adverse event in studies by Senthilkumar et al (24) and Henry et al (21), at 19% and 54% respectively. The frequency of hypotension as the most common physiological change was evident in studies by Sabzehei et al (13), Dalal et al (25) and Porwal et al (26) at 18%, 23.4% and 28.8% of all neonatal transfers, respectively.

In developing countries such as India (20,25), Iran (13,27) and Jamaica (21) where the burden of disease and neonatal mortality is particularly high, the chances of physiological related adverse events occurring are higher. Other contributory factors related to an increased include delays in recognising the severity of the illness and delays in delivering the appropriate healthcare, thereby influencing the extent to which the neonate is compromised.

In South Africa, Mgcini (23) conducted a cross-sectional, descriptive study of 104 transfers by both private and public ambulances in Gauteng from October to December 2007. He found that many neonates arrived in a poor clinical condition following transfer to a referral hospital, resulting in a relatively high mortality rate (7%), occurring within 48 hours after transfer, with significant predictors of mortality bradycardia, hypoxia, hypotension and hypothermia.

Physiological-related adverse events are also linked to both equipment and human-related adverse events (7,28). In a mobile intensive care unit, the role of specialised optimally functioning equipment is crucial to the outcome of the neonate, especially when dealing with the critically ill patient (5). Noise levels, limitations in space and low levels of light increase the need for optimally functioning equipment for patient monitoring and care during transport (29). Equipment-related adverse events occurring during inter-healthcare facility transportations have been identified by Carreras-Gonzalez et al (7) as being a result of equipment malfunction or technical errors. Gilpin and Hancock (30) emphasised that neonatal deterioration from

equipment failures should not occur and should be related to progression of the neonatal illness rather than the physical transfer. McEvoy et al (31) agreed and suggested that critical care neonates should be supported during the transfer with reliable equipment to monitor the neonate, thus minimising adverse events.

Whyte and Jefferies (5) are of the opinion that critical incidents associated with equipment failure are also associated with the changeover of oxygen supplies and equipment when moving the neonate either around the hospital, between trollies or neonatal beds, or in and out of ambulances. The resultant adverse event will either be hypoxia or hyperoxaemia. This has also been noted by Wiegersma et al (32), where 12.5% of all adverse events found in their study were related to technical failure, of which leakage of compressed air was the most common at 4.1%. Out of 1197 intra-hospital transfers, 58 (4.8%) of the transports noted a lack of oxygen or compressed air supply, the highest of all equipment or technical related errors (33). A study by Fried et al (34) documented that the most commonly occurring equipment related adverse events were due to monitor failure, infusion pump failure and unspecified ventilator failure. Loss of intravascular access occurred in 12% and 3.1% of all neonates transported in the studies by Goldsmit et al (17) and Viera et al (33), respectively. Accidental extubation occurred in 0.6% and 2% of the studies by Viera et al (33) and Senthilkumar et al (24), respectively.

Other studies have found problems with ambulance vehicles. Wiegersma et al (32) reported ambulance breakdown and mechanical problems (ranging from starting of the ambulance and dysfunctional lights and loading bridges) make up 4.2% of these problems. The findings of Kumar et al (35) study are noteworthy, as developing countries suffer financial constraints regarding the use of air ambulances even if they are available, making road transportation the only feasible alternative. Hence the increased risk of vehicle breakdown. In other developing countries such as India, Sampathkumar et al (36) stated that in resource-poor settings, most of the available ambulances are not sufficiently equipped to handle critically ill neonates.

Although studies in South Africa are scarce, Ashokcoomar and Naidoo (22) found equipment-related adverse events in 18 (15%) of 120 transfers, with some transfers experiencing more than one event. These were related to problems with the oxygen supply (1.7%), ventilator failure (7.5%), incubator failure (7.5%), loss of arterial cannulation (0.8%) and ambulance breakdown (2.55%). The lack of equipment was also a significant finding in this study, where equipment for 37 (30.8%) of the 120 transfers was unavailable. This equipment included incubators for 21 (17.5%) of the transfers, monitoring equipment for 13 (10.8%) transfers, ventilators for 10 (8.3%) transfers, ventilator circuits for three (2.5%) transfers, infusion pumps for three (2.5%) transfers, syringe drivers for four (3.3%) transfers, portable oxygen for two (1.7%) transfers and an administration set for one (0.8%) transfer.

Conclusion

The literature reviewed reflects that the neonatal transfer process is a complex one, with the potential for ill neonates being exposed to a greater risk of adverse events during the transfer process. The studies reviewed documented that poor cardiorespiratory support and equipment failures were most common and influenced mortality. Moreover, the empirical work done further revealed that logistical problems underpinning the transfer system related to both problems with ambulances and equipment being unavailable or malfunctioning particularly incubator failure jeopardised a safe transfer process. This suggests the need for good clinical governance to ensure that the transfer vehicles and appropriate staff and equipment are in place for transfers, and the need for specialised teams who are rigorously trained in preventing the clinical deterioration of neonates.

Competing interests

The author of this article declares no competing interests. The author has completed the ICMJE conflict of interest statement.

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