THE DEVELOPMENT OF A RETROSPECTIVE NEONATAL CLINICAL AUDIT TOOL FOR TRANSFERS: A MODIFIED DELPHI STUDY

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DECLARATION

I, Maryna Venter, hereby declare that the work contained in this thesis is my original work and that I have not previously submitted it, in its entirety or in part, at any university for a degree. This work has not been reported or published prior to registration for the abovementioned degree.

Signature: Signed by candidate Date: 12/02/2024

CONTENTS

ABBREVIATIONS

EMS	Emergency Medical Services
PRISMA-ScR	Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews
EBSCO	Elton B. Stephens Company
O2	Oxygen
NEC	Necrotising enterocolitis
Temp	Temperature
SpO2	Saturation of peripheral oxygen
HGT	Haemo-glucose test
TOPS	Temperature, Oxygen saturation, skin Perfusion, blood Sugar
mmol/l	millimoles per litre
C	Celsius
mmHg	millimetres Mercury
pH	potential of Hydrogen
CI	Confidence Interval
TRIPS	Transport Risk Index of Physiological Stability
APGAR	Appearance, Pulse, Grimace, Activity, Respiration
ALS	Advanced Life Support
NICU	Neonatal Intensive Care Unit
CTICU	Cardio Thoracic Intensive Care Unit
RN	Registered Nurse
PICU	Paediatric Intensive Care Unit
HREC	Human Research Ethics Committee
ECP	Emergency Care Practitioner
nCPAP	neonatal non-invasive Continuous Positive Airway Pressure
RR	Respiratory Rate
MAP	Mean Arterial Pressure
HR	Heart Rate
FiO2	Fraction of Inspired Oxygen
AE	Adverse Effects
IV	Intravenous
CPAP	Continuous Positive Airway Pressure
BP	Blood Pressure
IHI	Institute for Healthcare Improvement
GTT	Global Trigger Tool
TRIPS II	Transport Risk Index of Physiological Stability II
MINT	Mortality Index for Neonatal Transportation
ETT	Endotracheal Tube
TTM	Transient Tachypnoea of the Newborn
HIE	Neonatal hypoxic-ischaemic encephalopathy

ABSTRACT

Background: Due to limited availability of neonatal and paediatric specialist centres in South Africa, interfacility transfer of high-risk neonates is frequently required in order to access appropriate care, often across vast distances. Due to limited Emergency Medical Services (EMS) capacity, the majority of inter-facility transfers are undertaken by general EMS, as opposed to dedicated neonatal transfer teams. Many high-risk neonates are therefore transported by EMS personnel with very limited neonatal care experience and knowledge, as well as limited equipment capabilities. Interfacility transport of at-risk neonates is directly associated with increased mortality and morbidity, and numerous studies have described higher rates of adverse events and mortality particularly when neonates are transported by non-specialist transfer teams. There is currently no standardised clinical audit tool to assess the risks and clinical quality of care provided during neonatal retrieval. An established clinical audit tool that could be used in further research to establish the safety of neonatal transfers in the South African context would provide clinical value.

Aim: The aim of this study is to develop a retrospective neonatal clinical quality audit tool according to which the safety of neonatal transfers in South Africa can be assessed.

Methods: This study was conducted in two phases using multiple methods. First, a scoping review was conducted to identify normal clinical parameters, aspects of neonatal patient safety, adverse events, and quality of care during transport. Multiple databases were searched using an a priori developed search strategy. Titles and abstracts were screened for relevance, before selecting full-text articles for review and data extraction. Data from articles were collated into an extraction matrix, summarise and reported narratively. The results of the scoping review informed the first-round survey tool of a modified Delphi study – the second phase of this study.

A modified Delphi study was undertaken to obtain a list of consensus-based items that could be collated into a clinical quality audit tool for neonatal transfers in South Africa. Experts in neonatal retrieval, neonatology, paediatrics and intensive care were approached and asked to indicate whether they agreed with each item. They were also requested to provide free-text feedback on items. Consensus was set at 75%. Two rounds of the modified Delphi study were undertaken.

Results: For the scoping review, a total of 866 articles were identified initially. Following application of eligibility criteria, ten articles were finally included in the scoping review. Most articles originated from high-income countries and were observational in nature. However, six categories of adverse events were identified (clinical events, equipment events, medical errors, patient safety risks, quality of care, and other). Specific adverse events and clinical parameters were also extracted and combined to form the first-round survey tool of a modified Delphi study.

In round one 28 respondents consented to form part of the expert panel, and completed the Delphi questionnaire, yielding a response rate of 70%. In round one the expert panel consisted of neonatologists (n=4), paediatric intensivists (n=2), paediatricians (n=2), other medical doctor working in the field of retrieval (n=1) registered nurses (n=3), and advanced life support (ALS) paramedics or emergency care practitioners (ECPs) (n=16). In round two, 19 experts consented and completed the Delphi questionnaire, yielding an attrition rate of 33%. In round two the expert panel consisted of neonatologists (n=1), paediatric intensivists (n=2), other medical doctor working in the field of retrieval (n=1), registered nurses (n=3), and advanced life support (ALS) paramedic or emergency care practitioners (ECPs) (n=12). Following two rounds of consensus, a 41-item

retrospective audit tool was developed and organised into five sections: Airway, respiratory and ventilation, haemodynamic events, medication events, or general and logistic events. Additionally, each item was allocated a severity rating or range requiring additional information gathering to ascertain the severity of the event.

Conclusion: This study enabled the development of a consensus-based retrospective clinical audit tool that can be utilised to assess the quality of care of neonatal transfers performed in South Africa. The clinical audit tool was developed through literature-based evidence, and validated for content through the contributions of a national multidisciplinary panel of experts in the field of neonatal retrieval. The utilisation of the audit tool in the framework of a robust clinical governance system, would enable reporting of adverse events according to standardised parameters. This would contribute to the identification of risk factors and knowledge gaps in neonatal transfer teams, which could assist in the development of improvement projects. In addition, it can be used in before-and-after interventional studies, to assess for the effectiveness of the intervention in the setting of improved patient safety. Through utilisation in future research projects it can assist in the development of standardised guidelines for clinical care standards during neonatal transfer.

Key Terms: Neonatal transfer, adverse events, quality of care, patient safety, systems improvement, standard-setting

CHAPTER 1: INTRODUCTION AND BACKGROUND

Neonates are considered to be one of the most fragile patient populations encountered in the realm of healthcare. The fundamental changes that newborns undergo in order to transition from intra-uterine to extra-uterine life, signifies the biggest physiological adaptation that the human body will endure in its lifetime. Particularly noteworthy changes involve the cardiac, respiratory, metabolic, neurologic and immune systems. The failure of any of these adaptations, can lead to the dysfunction of that particular organ system, which can easily trigger a cascade that could result in the failure of more, if not all, of the other vital organ systems. This transition to extra-uterine life can be affected by various factors during the duration of pregnancy, the birthing process or the post-natal period, such as maternal health and complications, birth trauma and congenital abnormalities. These factors can present with a myriad of unique problems, that is often found to be proportional to the degree of the insult, such as prematurity, congenital cardiac anomaly or persistent pulmonary hypertension to name but a few. Neonatal care is therefore heavily reliant on the early and accurate recognition of minor changes and the ability to appropriately respond to these dysfunctions.(1,2)

In South Africa, 22% of all childhood deaths, and 37% of all infant deaths occur in the neonatal population. South Africa currently has an average neonatal mortality rate of 5-10 times that of Europe and the United States of America (USA).(3) Due to limited availability of neonatal and paediatric specialist centres, interfacility transfer frequently occurs for high-risk neonates, and often across vast distances. Due to limited Emergency Medical Services (EMS) capacity, the majority of interfacility transfers are undertaken by general EMS, as opposed to dedicated neonatal transfer teams. This means that a significant number of high-risk neonates are transported by EMS personnel with very limited neonatal and paediatric care experience and knowledge, as well as limited equipment capabilities.(4–6) Inter-facility transport of at-risk neonates has been shown to be directly associated with increased mortality and morbidity.(7) Various international clinical studies describe higher rates of adverse events and increased morbidity when neonates are transported by non-specialist units.(8,9) Similarly, studies undertaken in South Africa have reported increased rates of adverse events, which directly contributes to the increased neonatal mortality figures.(4,5) Even though the mortality associated with the inter-facility transfer of neonates is just one of the contributing factors of the total neonatal mortality rate, efforts to reduce the incidence of these events could have a notable effect. This is particularly true for the South African context of frequent transfers undertaken by inadequately equipped or trained staff. It is therefore important to focus on the formulation of comprehensive system designs and processes aimed at reducing patient harm and improving the safety and quality of care during neonatal interfacility transfer.(6) There is currently no standardised clinical audit tool to assess the risks and clinical quality of care provided during neonatal interfacility transfer in South Africa. By developing a standardised clinical audit tool that can be applied retrospectively to clinical documentation following neonatal interfacility transfer, one could assess patient safety during transfer, thus guiding future research and quality improvement initiatives. As such, it would provide clinical value and assist in the governance of patient safety practices relating to neonatal interfacility transfer.

This study aimed to develop a retrospective neonatal clinical quality audit tool according to which the safety of neonatal retrieval in South Africa can be assessed. To this end, the objectives were:

1. To perform a scoping review on established clinical audit tools and the nature of adverse events and patient safety risks in the neonatal population. The results of the scoping

review informed the first-round survey tool of a modified Delphi study – the second phase of this study.

2. To, by expert consensus, refine the contents of the developed clinical audit tool.

The dissertation consists of six chapters:

- Chapter 1: Background and introduction (this chapter). This chapter provides a breakdown of the research problem, in order to contextualise the study and highlight the relevance and application.
- Chapter 2: Scoping review. This chapter will outline the methods used in the conduct of the scoping review, including the search strategy and its results. It seeks to explore the existing literature on neonatal retrieval in order to identify and support the clinical parameters used in the audit tool.
- Chapter 3: Methods. This chapter will focus on the methodology and study design utilised throughout the Delphi study. It will also highlight key ethical considerations in the conduct of this project.
- Chapter 4: Results. The results from the Delphi study will be presented in this chapter. The draft retrospective clinical audit tool for neonatal interfacility transfer will also be presented.
- Chapter 5: Discussion. In this chapter the results of the Delphi study will be reviewed and contextualised to existing literature and to the context in which the retrospective clinical audit tool for neonatal interfacility transfer will be applied.
- Chapter 6: Conclusion and recommendations. Chapter six will conclude this project and provide recommendations for implementation and future research in this field.

CHAPTER 2: SCOPING REVIEW

Introduction

A scoping review was undertaken to identify normal clinical parameters, aspects of neonatal patient safety, adverse events, and quality of care during transport, in order to develop a retrospective clinical audit tool for neonatal interfacility transfer. The results of this scoping review informs the first-round survey tool of a modified Delphi study – the second phase of this study. The aim of this scoping review was to identify, summarise and extract data from studies focusing on neonatal interfacility transfer. It sought to identify normal clinical parameters, aspects of neonatal patient safety, adverse events, and quality of care during transport.

The scoping review was conducted, and is reported in accordance with the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR). (10) This scoping review was guided by the methodological framework as outlined by Arksey and O'Malley, consisting of five steps: 1) identifying the research question, 2) identifying relevant studies, 3) screening and selecting eligible studies, 4) extracting and charting data, and 5) summarising and reporting the results. (11) Arksey and O'Malley also recommends consultation with subject-matter experts, which was completed in the subsequent modified Delphi consensus process. (11) This will be discussed in subsequent chapters.

Search strategy, eligibility criteria and article selection

An a priori search strategy was developed. The search string (Appendix A) contained three elements, namely: "infant, neonate or newborn," "interfacility or interhospital transfer," and "adverse events, patient harm or patient safety." Keywords or their synonyms were combined using Boolean operators in various combinations. The search was conducted using the Cochrane, ScienceDirect, Scopus, EBSCO Host, Web of Science and Medline via Pubmed databases.

An initial literature search was conducted in May 2020 in order to inform the first round of the Delphi study. Articles were first independently screened by two reviewers according to title and abstract, before full-text articles were reviewed. Both reviewers were senior emergency care practitioners (South African graduate paramedics) and had experience in both research and critical care retrieval and neonatal interfacility transfer. Articles were limited to human studies that were published in English between 1 January 2005 until May 2020. Articles that did not directly pertain to clinical stability, complications, challenges and adverse events during neonatal inter-hospital or intra-hospital transport were excluded. Vaccine studies and adverse events of vaccinations were excluded since this made up a significant portion of the results, and were deemed irrelevant to the question under study in this scoping review. The reference lists of articles that were included following full-text review were also scrutinised for additional titles, and screened in a similar manner. The thesis databases for all South African medical universities were also searched with the same search strategy as the other databases, as well as the same inclusion and exclusion criteria.

The search was later repeated in April 2023 and this literature review was updated. In this updated round of the literature review, some articles with their focus on in-hospital neonatal adverse event

monitoring were also screened, to ensure that the focus of the literature review accounts for an expansive data set on neonatal adverse event categories and management.

Data extraction and analysis

In accordance with the guidance by Arksey and O'Malley, a data extraction matrix spreadsheet (Microsoft Excel, Microsoft Cor., Redmond, Washington, United States) was created to support data collection from the included articles. (11) The extraction matrix included the reference, study design, and setting or country of where the study was conducted. Studies across various healthcare divisions, have noted differences in patient outcomes in high-income versus low-to-middle income countries (LMIC). This has largely been related to differences on healthcare spending, health system characteristics, socioeconomic, cultural and environmental factors.(12) The increased neonatal mortality in LMIC's are well documented, and particularly linked to healthcare system development and availability.(13) It was therefore deemed of value to give consideration to the setting in which each adverse events study was conducted, due to the impact that the quality of the healthcare system could have on the nature and incidents of adverse events observed. Adverse events or clinical parameters were then divided into six commonly used categories of events, (1,2) namely:

1. Clinical events: Adverse events of physiologic nature related to normal clinical parameters.
2. Equipment events: Adverse events caused by failure of equipment utilised during neonatal transfer.
3. Medication errors: Adverse events related to incorrect medication and fluid administration.
4. Patient safety risks: Adverse events related to compromised patient safety principles, for example lack of availability of required equipment or poorly secured devices.
5. Quality of care: Adverse events related to clinical decisions and treatment interventions.
6. Other: Adverse events related to logistical and operational environment.

Following data extraction, results were grouped into common themes and are presented narratively and discussed. Specific adverse events and clinical parameters were also extracted and combined to form the first-round survey tool of a modified Delphi study – the second phase of this study (See Chapters 3 and 4).

Results

A total of 866 articles were identified based on the search strings used, of which 24 were found to be duplicates and were removed prior to screening. Two reviewers independently screened the articles for eligibility based on title, which resulted in a reduction to 34 articles by reviewer one, and 24 articles by reviewer two. The reviewers then screened the articles based on abstract, after which the number of articles included for full-text review were reduced to a total of 12 by reviewer 1, and 15 by reviewer 2. Following retrieval and review of the full-texts, ten articles were included in the

analysis of this scoping review. The screening was done as per the eligibility criteria discussed earlier. Figure 1 below shows the screening and review process.

Of these articles, 60% (n=6) originated from high-income countries (United Kingdom, (2,14,15) (n=3) United States (16) (n=1), Canada (17) (n=1), and Spain (18) (n=1)) and 40% (n=4) originated from low- to middle-income countries (South Africa (4) (n=1), Mozambique (19) (n=1), Brazil (20) (n=1), and Argentina (n=1)). Most articles were observational, retrospective or summarise the literature on the topic. Three articles were prospective, but observational in nature. Results are tabulated in Appendix B.

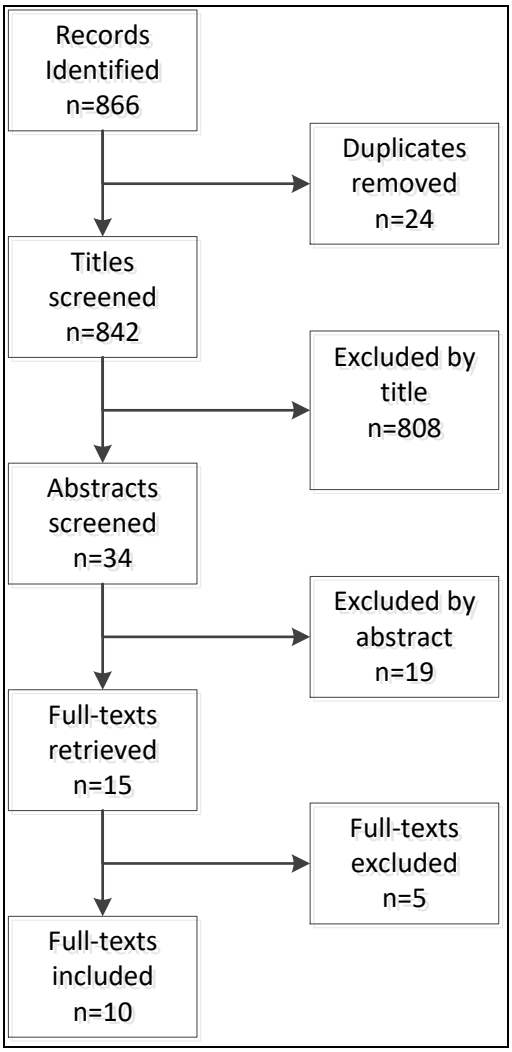

Figure 1: Flow diagram of article screening and review

The included articles were reviewed with the intention of providing an overview of the existing literature on adverse events that occur during neonatal transfer. The intention was to gain clarity on the nature and incidence of these events, as well as the setting that they are influenced by.

One of the most pertinent themes that was identified in multiple studies, is that there is a lack of standardisation of care in neonatal transfers. It is highlighted as a contributing factor to the incidence of adverse events, as a barrier to adverse events reporting and clinical quality monitoring, and as an area that specifically requires development through further research. The importance of

specialised transfer teams were noted on various occasions, with the distinguishing factor not being staff members of a specific qualification, but rather team members who have received neonatal transfer specific specialised training. It was consistently found that neonates face increased risk of adverse events during neonatal retrieval, and that patients of critical clinical presentation are subjected to the highest incidence of adverse events. The type of adverse events that were reported, showed consistency across an array of studies, with variance noted in the incidence of these events in different study settings.

Neonatal interfacility transfer in high-income country settings

The Canadian Paediatric Society published a position statement paper in 2015, detailing the need for improved care during interfacility transfer of neonates. Through a comprehensive review of literature related to the interfacility transport of critically ill neonates, they found that there is a lack of standardisation in clinical competencies, equipment, education and resources, which contribute to creating barriers to optimised patient care. They highlight the most important aspects required for safe and successful transfer to be the skills and competencies of the transport team, the equipment, teams, systems and processes, and provide the following recommendations: Related to specialist teams, they found that the use of non-specialised teams resulted in increased incidence of adverse events, particularly airway adverse events, the need for CPR, hypotensive events and loss of vascular access. Of interest, is that there was no evidence that neonatal transfer staff from a particular professional background (registered nurses, respiratory therapists, physicians and paramedics) improved outcomes, but rather staff that had undergone successful implementation of a neonatal transfer training programme. They do not specify the specific competencies required, but mention that it should be related to the most commonly required clinical interventions, as well as the most frequent adverse events. The minimum recommended equipment required is listed as follows: transport incubator, ventilator with the ability to blend oxygen to 21%, nitric oxide, suction, vital signs monitoring with capability for pulse oximetry, blood pressure monitoring and capnography, defibrillation and point-of-care blood gas analysis.

The transport system should include a centralised dispatch process, with telephonic access to medical advice regarding the need for transfer, appropriate receiving facility identification and arrangement and patient care requirements prior to transfer. Quality assurance is highlighted as an essential component, with specific attention to adverse event reporting, morbidity and mortality reviews and continued professional development. In a study involving 364 neonatal transfers, they reported an adverse event rate of 36%. Out of the reported events, 67% were due to human error and 21% due to equipment failure. The nature of these events were not specified.(17)

An educational article published in the Journal of Respiratory Care in 2013, utilised an extensive review of existing data, validated through an expert panel consensus discussion, to make recommendations on the clinical practices of neonatal transfer. They highlight statistical findings of studies conducted on adverse events in neonatal transfer, of relevance to the current study: The use of specialised teams for neonatal transfer was associated with a reduction in adverse event incidence from 23% down to 9%, and incidence of unplanned events from 61% with non-specialised teams, to 1.5% with specialised teams. They do not provide in-depth analysis of all the events that occurred, but highlighted some of the most commonly occurring events to be that of hypoxia, loss of intravenous access, tachycardia, drug errors, hypothermia and procedure errors. Hypotensive events, airway adverse events, cardiac arrest and ventilator failure were also identified. Life-

threatening events included bradycardia, hypotension and inadequate respiratory support. Ventilator failure secondary to lack of adequate O2 supply was specifically highlighted. Statistical breakdown of the incidence is not provided. The lack of mandatory regulatory oversight of minimum standards of care is highlighted as a developmental need to improve patient safety. (16)

In a narrative review by Ramnarayan, a description of the potential measures that can be utilised to assess quality of care in neonatal retrieval was provided. The author once again raises the fact that there is a lack of agreed key performance indicators or reference platforms that can be utilised to measure the performance of a neonatal transport service. This leads to significant variation in the quality of care provided by different inter-hospital transport teams. In the analysis of the adverse event reporting system utilised by the Children's Acute Transport Service (CATS) in London, it is described that a voluntary reporting system is used, which relies on the medical crew self-reporting adverse events that occur. This is combined with daily case review to identify adverse events utilising a comprehensive in-house designed list of major and minor physiological incidents. This system identifies an overall incidence of adverse events of 21%, with 11.6% of these events being physiologic in nature. The full list of events is not provided, and statistical breakdown is not included, but the most commonly occurring adverse events criteria is listed as follows: 1) Respiratory events: Cyanosis, respiratory arrest, pulmonary aspiration, ventilator malfunction, oxygen depletion, accidental extubation and endotracheal tube occlusion; 2) Haemodynamic events: cardiac arrest, tachycardia, bradycardia, loss of intravenous access; 3) Other events: decreased level of consciousness, hypothermia, hypoglycaemia, lack of monitoring. The increased susceptibility to adverse events of patients with complex clinical presentations is also listed as a consideration.(14)

A limitation of the above studies, is the fact that they are based on review of existing literature and information, and does not present any new research data. It does however provide valuable insights into the practices, challenges and adverse events experienced in the neonatal transport environment, and offer guided recommendations for improved clinical care. Validity is strengthened through the fact that the first study is endorsed by the Fetal and Newborn Committee of the Canadian Paediatric Society, and the consensus discussions conducted with experts in the field in the second study.

In a 2008 study by Lim and Ratnavel, the authors performed a prospective review of adverse events during emergency neonatal transfers in London. The objectives were to categorise and quantify neonatal adverse events that occur during interfacility transfer, and to assign levels of associated risk. In light of findings highlighted in previous studies regarding the decreased incidence of adverse events when neonatal transfers are conducted by specialist teams, it is noteworthy that this study was conducted at the specialised London Neonatal Transfer Service. The study required the neonatal transport team to document any adverse events that occurred during emergency transfers conducted over a six month period. Increasing the robustness of the data, there were also third party reports requested on the included transfers, on events that may have been witnessed by other parties involved in the transfer, as well as independent review of charts.

The reported adverse events were grouped based on an acronym taught during an advanced life support course for retrieval teams, aimed at ensuring that transfers are performed in a structured approach. The ACCEPT acronym includes: A = Assessment, C = Control, C = Communication, E = Evaluation, P = Preparation, Packaging & Pre-departure checklist; T = Transportation. The acronym was applied to the three stages of the transfer process: prior to the arrival of the retrieval team; during patient stabilisation prior to transport and during the course of the transport; and thirdly after arrival of the retrieval team at the receiving facility. The components of the acronym included

the following, depending on which stage of the transfer was assessed:

1. Assessment - correct assessment of presenting problems, both clinical and operational in nature, assessment of new complications and additional requirements, identification of missed problems at the receiving facility.
2. Control - relating to staffing complications, delegation of responsibilities, decision-making regarding mode of transport, equipment and documentation requirements.
3. Communication - issues relating to communication barriers prior to arrival, handover at both referring and receiving, inaccurate information and other essential communication barriers.
4. Evaluation - relating to level of urgency of transfer, priority and appropriateness of transfer.
5. Preparation –problems related to vehicle and equipment preparation, patient stabilisation prior to transfer, patient movement between cot and transport incubator and back to cot at receiving facility.
6. Transportation – problems encountered on route to referring facility, during patient transfer and after leaving the receiving facility.

The risk level of each potential adverse event was scored based on a local risk assessment tool, with severity rating of: 1) Insignificant 2) Minor 3) Moderate 4) Major 5) Catastrophic. This was tabled against the recurrence probability for each event as: 1) rare 2) unlikely 3) possible 4) likely 5) almost certain. The combined allocation gave each adverse event a risk score of Very low; Low; Moderate or High.

The study found that out of 346 transfers, 125 (36.1%) transfers experienced at least one event, whilst the maximum number of events recorded for one single transfer, was 9. Equipment incidents accounted for 43 (21%) of these events, 18 (9%) events were due to ambulance related problems, and another 18 (9%) involved problems with movement into the transport incubator. The remaining 3% of events were not specified. Of the total number of adverse events recorded (204), 139 (67%) of events were perceived to be as a result of avoidable human errors, involving all personnel stages of the transport journey.

For the risk score, 6 (3%) of the events were major events, 23 (11.2%) were moderate and 32 (15.7%) were minor. The remaining 143 (69%) of the events had a risk score of insignificant, whilst none of the events were classified as catastrophic. Of the six major events, 3 resulted in clinical deterioration of the patient. These involved failure to provide early respiratory support, resulting in significant respiratory acidosis; lack of oxygen support during transfer to the incubator, resulting in worsening of pulmonary hypertension; and a third was a delay during the dispatch procedure for an urgent gastroschisis case, resulting in ischemic and infarcted bowel. Moderate problems involved difficulties in ventilating the patients, and temperature management challenges due to incubator difficulties and human errors.(15)

In a 2020 article by Marsinyach Ros et al, a retrospective descriptive study was conducted on neonates transferred during a 6 year period. The sample included every neonate that was transferred by a specialised newborn transport programme in Madrid, and data was collected from the medical charts completed during transfer. The collected data was divided into two periods; the first period denoted the initial 3 years (2009 – 2011) of the transport programme, and the second period between 2012 – 2015. This distinction was made due to the addition of significant resources

to the programme in the initial 2 years, which was followed by problem solving and training. By 2011, all personnel had completed training. A comparative retrospective analysis was done between the two periods, in order to monitor the evolution of the programme. They reported on 24 quality indicators, some of which were reported on in the literature and some of the unit's own design based on experience. The use of the informally identified indicators were necessitated by the fact that there are no universal standard quality indicators available to monitor transfer team performance against. The main aim of the study was to report on and monitor their own unit's performance. A total of 1175 transfers were included in the analysis of period one, whilst 1729 transfers were analysed for period two. Most commonly identified adverse events identified (not listed in specific order) were vehicle failure, in-transport death, accidental extubation, endotracheal tube occlusion, indwelling line dislodgement, equipment failure, oxygen depletion, delayed transfer time, hypotension, desaturation (SpO2 <88%), hypothermia (Temperature <36.5°C) and hypoglycaemia (HGT < 2.6mmol/L). The overall incidence of adverse events during the first period, was noted to be 6.21%, which was found to have decreased to 3.41% at the end of the second period. Unnoticed hypothermia was singles out as as a particularly frequently occurring incident, with a rate of 39.23% in the initial monitoring period. This was shown to have decreased to 29.9% by the end of the second period. These findings could indicate the value that neonatal specific training and experience has in the reduction of the incidence and severity of adverse events during neonatal transfer. The authors however acknowledged the limitation in the retrospective chart review design, as various incidents of missing values and required data points were found. In addition, the division of the data collected into two separate periods, did not allowed to control for clinical presentation of the patients included, which may affect the incidence and type of adverse events. Another limitation is the lack of external validation on the indicators used that were identified internally by the team based on experience. (18)

Neonatal interfacility transfer in low-to middle-income country settings

A study was conducted in Kwazulu-Natal in South Africa in 2011 by Ashokcoomar and Naidoo, in the form of a quantitative prospective descriptive analysis. The focus of the study was inter-facility road ambulance transfers of neonatal patients and a total of 120 transfers were analysed. Two questionnaires were utilised, completed by both the communications centre as well as the senior medical team member who cared for the patient during the transfer. A single health district was included, with focus exclusively on the state sector EMS. The most pertinent shortcomings were identified to be lack of availability of essential equipment, time delays and the incidence of adverse events. Physiological adverse events were found in 8.3% of cases, all of these incidents were deemed potentially life threatening, with one resulting in death. A further 15% of cases involved equipment-related adverse events. Lack of required equipment was identified in 15.5% of cases, with lack of appropriate level of care staff members occurring in 28.8% of cases. The total incidence of events were 67.7%. The adverse environment of retrieval was also highlighted, with focus on adverse weather conditions, noise, vibration, restricted work space and lighting, and unstable equipment.(4). Limitations of this study include the limited sample population from a single district. In addition, analysis or explanation is not provided of the assessment criteria used in the identification of the adverse events, and the nature of these events are not discussed. Another noteworthy consideration for this study is the fact that 57.5% of the transfers were for an upgrade in care, whilst 42.5% were return transfers from specialised care back to a primary care facility.

Another retrospective observational study was conducted in Mozambique, with the aim of assessing the association between mortality and TOPS in transferred neonates. TOPS is an illness severity score, assessing for Temperature, Oxygen saturation, skin Perfusion and blood Sugar (glucose). It is used on admission of transferred neonates, to assess for clinical stability. The sample included neonates transferred via ambulance into Beira Central Hospital, the second largest hospital in Mozambique. They admit approximately 2200 neonates per year, of which 56% are transferred in either from other healthcare facilities or from home. A total patient population of 198 neonates were included in the study. Information was collected on neonates who presented on admission with one of the following parameters: temperature <36.3°C, SpO2 <90%, capillary refill time >3s and blood glucose levels <2.2mmol. Hypothermia was recorded in 75.8% of cases, hypoxia in 32,3%, delayed capillary refill time in 11% and hypoglycaemia in 7.9% of cases. Numerical data were summarized as median and interquartile range (IQR), and the categorical data as absolute frequency and percentage. Comparisons between groups were performed using Mann–Whitney test (numerical data) and Chi Square test or Fisher's test (categorical data). The association between TOPS and mortality was investigated with a logistic regression model, adjusting for imbalances at NICU admission. These are not specified. The study concluded that TOPS is of value in the identification of neonates at increased risk of mortality. (19)

In a 2011 study by Vieira et all, they developed a predictive tool for complications during intra-hospital neonatal transport. The study was based in Brazil, and investigated the various patient and clinical indicators that will put the patient at risk of experiencing at least one adverse event during transport. Data was collected prospectively over a period spanning from 1997 to 2008, and analysed retrospectively using multiple logistic regression analysis. Only patients transferred for diagnostic or therapeutic procedures by a team dedicated to and trained in neonatal intensive care were included. Each patient could be enrolled repeatedly, if they were transferred on multiple occasions. This could potentially be a limitation of the study, if patients with complex pathologies and increased risk of events, presented multiple times. The clinical adverse events were identified and classified according to the following parameters: Hypothermia – axillary temperature below 36°C; hyperthermia – axillary temperature greater than 37.5°C; bradycardia when heart rate below 80 beats per minute; tachycardia when heart rate above 180 beats per minute, hypoxia when oxygen saturations were below 88%; hyperoxia when saturations were above 95%; desaturation defined as persistent 5% reduction in baseline reading of the oxygen saturation level; hypotension when mean arterial blood pressure is less than gestational age +5, or less than 55mmHg in term neonates. Apnoea episodes were defined as a respiratory pause of more than 20 seconds whilst hypoglycaemia was recorded when blood glucose fell below 2.2mmol/l. Hypercapnoea was considered at arterial carbon dioxide levels above 45mmHg, and hypocapnoea in the event of arterial carbon dioxide levels below 35mmHg.

A total of 1197 intra-hospital transfers were included, with a mean (95% CI) transport time of 101 ± 61 minutes (97-104). Patients included in the study presented with an array of different diagnoses and states of clinical stability, and 19% of patients were mechanically ventilated.

Clinical adverse events related to the vital parameters listed above, were recorded in 327 (27.3%) of cases, with the most commonly recorded events being hypothermia in 182 (15.2%) cases, hyperoxia in 65 (54.4%), desaturation in 51 (4.3%) and apnoea in 12 (1%) of reported cases. Tachycardia was considered significant if it occurred in the setting of haemodynamic instability. Neonates

transferred for surgical intervention were found to have a four-time increased risk of clinical complications compared to those transferred for diagnostic investigation.

Clinical complications experienced in the duration of the transfer included loss of intravenous access in 37 (3.1%) of cases, obstruction of endotracheal tube occurred in 1 (0.1%) case, accidental extubation in 7 (0.6%) cases and dislodged catheter in 3 (0.1%) cases. Depletion of oxygen source occurred in 10 (0.8%) cases and equipment failure was recorded in 58 (4.8%) cases. This comprised monitor, infusion pump, incubator, and ventilator failure. Transfer duration in excess of 120 minutes was found to present with a 62% higher incidence of clinical complications. Another limitation of the study is the fact that only transfers that took place between the hours of 8am and 5pm on weekdays were included, as this was the only time that specialised staff were available to perform the transfers. This could have resulted in exclusion of potentially complex, urgent cases transferred in less optimum conditions, assumed to be at increased risk of adverse incidents. The study was also not able to quantify the sequelae of the adverse events in the clinical course of each patient. Even though patients from a single centre was enrolled, the sample size was large, and provide for valuable data with regards to adverse events and patient safety risks during neonatal transfer.(20)

In a 2012 study by Goldsmit et al, they assessed factors that could predict clinical deterioration. A prospective observational design was used, and a total of 160 neonates that were transferred into a specialist facility were included. Patients were evaluated with a pre-transport score on the Transport Risk Index of Physiological Stability (TRIPS), and were re-evaluated on completion of the transport with a repeat TRIPS score. The transfer was conducted by a neonatologist in 85% of the cases. This is a limitation with regard to external validity, as the results are largely representative of a single population. It could however add value in understanding the impact that specialist teams may have on the incidence of adverse events.

The study identified clinical deterioration in 91 (57%) of the patients, hypothermia occurred in 46% of patients and 32 (20%) of the neonates had deranged blood glucose levels. Tissue infiltration occurred in 12% of the neonates who had intravenous access. Twenty-eight of the neonates that had suffered clinical deterioration during transfer, died in hospital, while 12 of those deaths occurred within less than 7 days of admission. Some comments addressed what clinical deterioration implied, but few definitive parameters were identified. Normal temperate ranges were considered to be 36.5°C – 37.5 °C; tachypnoea was defined as a respiratory rate above 60 and hypoxia at saturation levels below 85%. Hypoglycaemia was defined as a glucose result of <2.6mmol/L. The study was based on the TRIPS score before and after the transfer as well as 7-day mortality and intervention needed at the receiving facility.

Neonatal inter facility transfer needs to be performed by specifically trained medical personnel, who are well versed in the specialised equipment utilised and procedures. There is a definite need for developed systems and guidelines, as well as an audit process for governance purposes. Utilising teams consisting of nurses and doctors specifically trained for the neonatal retrieval environment needs to be prioritised, since it has been proven to optimise the clinical outcome of the patient.

This study once again indicated that some form of clinical assessment risk score before and after the transport can also act as a quality indicator in itself. The most commonly occurring adverse clinical events that were noted during the study were included in the gathered data for this review, even though this was not a full list of their perceived events. What was interesting to note in the study is that clinical deterioration during transport was not due to any of the pre-disposing clinical factors of the patient (such as birth weight, age, APGAR score etc), implying that the event of transportation itself may have been the cause of the deterioration, be it from the adverse out-of-hospital environment, ambulance equipment malfunction, human error or the natural progression of illness in the patient. The study also found that deterioration during transport had a significant effect on mortality and the need for resuscitation at the receiving facility.

Limitations of the study was that the sample population was small and different physicians measured the TRIPS score at different times, which may be affected by inter-rater reliability.(21)

Summary and derivation of the first-round survey tool

Through the articles reviewed, it is apparent that the inter-facility transfer environment poses an increased risk for the occurrence of adverse events. The most commonly identified adverse events related to clinical parameters and incidents, affecting patient stability. Various studies however, also found adverse events related to equipment failure or incidents, clinical errors by healthcare providers, and a range of non-grouped incidents. The latter type were only included in the draft tool design if it was identified in at least 30% of the articles, or had a statistically significant incidence in the study in which it was reported.

In a comparison between the studies conducted in high-income countries and those conducted in low-to middle-income countries, some notable differences were identified. Studies conducted in high-income countries tend to involve large sample sizes of between 1000 and 2904 enrolled patients, and specialised neonatal retrieval teams were used in at least one arm of majority of studies. Comparisons were made between adverse events incidence in specialised teams and non-specialised teams. Much smaller sample sizes were presented in low-to-middle income country studies, ranging from 120 to 198 patients. Specialised teams were only available in one of these studies, and was not of neonatal retrieval speciality but simply of neonatal care, and no comparison of adverse event incidence was made between specialised and non-specialised transport.

Notably different adverse event incidence rates were reported between the high-income environments (9% with specialised teams, up to 36.1% with non-specialised teams) and low-to middle-income environments (57% - 75.8%). The significance of this variation would need to be explored in light of factors such as patient diagnosis and clinical presentation, clinical care provided prior to transfer, transport distance and interventional scope of the transport teams. This level of data is not recorded in the published articles.

Despite the variation in the reported incidence rates, the type of adverse events that were reported in the studies showed notable consistency despite the varied settings.

As evident in the review above, the type of adverse events that most commonly occur in the field of neonatal transfer are well defined and corroborated through various studies conducted in numerous

different countries. The clinical variables used to define exactly when an incident would be termed an adverse event, however, presented with a degree of variation.

Some sources that consistently agreed on the nature of adverse events that occur, did not clearly or consistently define clinical cut-offs or physiologic parameters. . This was identified as a limitation of this review, and an additional literature review was done to investigate the nature of adverse event monitoring utilised in in-hospital studies. Even though in-hospital studies were not included in the scoping review, the clinical cut-offs mentioned in the hospital-based studies were reviewed and compared to the values used in the interfacility transfer studies. This was done to ensure accuracy of the parameters used in the draft audit tool. The same subtle variations were noted in the clinical parameters used in in-hospital adverse event monitoring.

Based on the variations identified with regards to clinical parameters, and considering those against the different settings that the studies were conducted in, as well as the factors controlled for in some of the studies, it is plausible that these variations are influenced by contextual circumstances. The impact of underlying disease pathology on what is accepted as normal or abnormal clinical parameters, needs to be acknowledged. This could lead to altered absolute cut-off for values used in identifying adverse events, relative to patient diagnosis and pathology**.** Nevertheless, the initial first-round survey tool is presented in Appendix B.

Conclusion

The purpose of the scoping review was to identify the most commonly occurring, or most serious adverse events that may occur in the neonatal population during inter-facility transfer. The review identified that adverse events occur commonly, especially when neonates are transferred by non-dedicated teams who do not have additional training or an expanded equipment armamentarium. It was found that adverse events occur within six domains: clinical events, equipment events, medical errors, patient safety risks, quality of care, and other. There is notable consistency among the studies regarding the types of clinical adverse events that occur, and the most frequently occurring incidents could clearly be identified for use in the development of a draft audit tool. There was, however heterogeneity in clinical cut-offs or physiologic parameters to denote an adverse event in some of the categories. This speaks to the interdependence of clinical adverse events and the underlying pathology, clinical stability, and treatment plan of each individual neonate.

CHAPTER 3: METHODOLOGY

Problem Statement

Neonatal interfacility transfer occurs commonly in South Africa due to limited neonatal intensive care resources, and where they exist, these resources are often concentrated to urban centres.(4,5) Neonates are particularly vulnerable during interfacility transfer due to their dependent physiology, particular pathology, or due to transport stress. This may lead to physiologic instability and clinical adverse events during interfacility transfer. Furthermore, due to the complex and unpredictable nature of out-of-hospital care (including interfacility transfer) other adverse events may also occur such as dislodgement of indwelling catheters or tubes, and equipment failures. The rate of adverse events is much higher in contexts where neonatal interfacility transfers are undertaken by non-dedicated crew without the requisite training or equipment. (17) This is the case in South Africa.

Most systems rely on retrospective clinical audit to determine the quality of clinical care provided during interfacility transfer and to detect any adverse events that might have occurred. Currently, there are no standardised guidelines governing the quality of care delivered during neonatal interfacility transfer in South Africa, nor is there a set of mutually agreed upon criteria that might denote an adverse event. This hinders the detection of adverse events, allows for variation across different systems and services and influences the types of research and development studies that can be undertaken. There is a pressing need to develop a set of consensus-based items that can be compiled into a retrospective neonatal clinical quality audit tool according to which the safety of neonatal transfer in South Africa can be assessed.

Aims and Objectives

This study aimed to develop a retrospective neonatal clinical quality audit tool. To this end, the objectives were:

1. To perform a scoping literature review on established clinical audit tools and the nature of adverse events and patient safety risks in the neonatal population. The results of which were used to develop the first-round survey tool of a modified Delphi study.
2. To, by consensus, refine the contents of the developed clinical audit tool derived in objective 1

Methods

This study was conducted in two phases using multiple methods. In the first phase, a scoping literature review was conducted to inform the data collection instrument for the second phase. The methodology for the first phase of this study (scoping literature review) has already been described (see chapter 2). In the second phase of the study, a modified Delphi survey was conducted among experts in the field of neonatal care or neonatal retrieval. Delphi studies are considered to play a pivotal role in the development of clinical practice guidelines in settings where limited research is available, or clinical research is difficult to conduct. It makes use of collective knowledge, experience and intelligence, through a process of consensus among experts.(22) As such, the Delphi approach is

suitable to answer the research question of this study. The methodological approach of the modified Delphi study will be described in this chapter.

Setting

In South Africa, neonatal interfacility transfer is undertaken by non-physician, advanced life support providers. ALS providers may either be qualified through vocational training programmes (one-year certification) or by attending a higher education institute (normally 3-4 years). (23) Different ALS providers have a variety of scopes of practice and education in neonatal care. (24) These providers may either work for the resource-poor public emergency medical services, or the more resourced private sector. These different sectors and providers, lead to a variation in crew composition, clinical capabilities and potentially quality of care provided during interfacility transfer. There are very few dedicated neonatal retrieval and transport services, especially in the public sector. (25)

Locally, and to the researcher's knowledge, there currently exists no educational offering to equip these providers to safely transfer neonates. Although, there have been calls to standardise training, (24) and expand scopes of practice. (26) More recently, there has been an attempt to develop a curriculum to support neonatal interfacility transfer education. (27)

There is a paucity of literature on the population of neonates being transferred in South Africa, however, a recent study originating from the private sector, described the patients being transported. (23). The most common diagnoses were respiratory distress syndrome, congenital heart defects and prematurity. There was a requirement for mechanical ventilation in almost half of the patients. (23)

This study sought to involve neonatal or critical care retrieval experts from across South Africa, working in both the public as well as the private sector. Due to the fact that there is no registered neonatal or critical retrieval specialty in the EMS environment in South Africa, in-hospital staff with neonatal specialty were also included in order to strengthen the quality of data collected.

Sample and sampling

In line with previously described Delphi methods, we sought to include a minimum of 20 participating experts in the field of neonatal care or neonatal retrieval. (28) However, attempts were made to contact and invite at least 40 experts. This was done in order to compensate for the impact that attrition might have on the validity of the results. The expert panel was selected based on the below inclusion criteria, and was established by means of purposeful and snowball sampling. The panel of experts were selected based on the following eligibility criteria:

a) Inclusion criteria
    i. Doctors specialised in, or currently working in the fields of neonatology, neonatal ICU (NICU), paediatric intensive care, paediatric cardiothoracic ICU (CTICU) or neonatal retrieval.

ii. Registered nurses (RN's) working in neonatal ICU, paediatric ICU (PICU) or paediatric cardiothoracic ICU.
iii. Advanced Life Support paramedics or Emergency Care Practitioners working in the field of critical care retrieval.

b) Exclusion criteria
i. Paediatric specialists or nurses working in PICU's that do not admit neonatal patients.
ii. Medical professionals not working in neonatal care or retrieval.
iii. Identified individuals not responding to an electronic invite to the study after three invitations.

All the experts that were selected to form part of the expert panel for completion of the Delphi study, were included due to their involvement in various steps of the neonatal retrieval process. Nursing staff and doctors that work in Neonatal Intensive Care Units or Paediatric ICU's that frequently admit neonates, were offered the opportunity to take part in the study. Their exposure and involvement in the acute phase of neonatal patients who have been transferred into their units, make them well versed in the most common clinical or logistical adverse events that may have occurred during the retrieval process. Advanced Life Support Paramedics or Emergency Care Practitioners that frequently conduct neonatal interfacility transfers were also included in the study, due to the direct patient care that they are exposed to during the 3 clinical phases of the retrieval process; 1) patient handover and stabilisation at the referring facility 2) patient monitoring and clinical care during the transfer period 3) patient handover at receiving facility.

Delphi Survey

During the scoping review that was conducted in Study 1 and discussed in chapter two, adverse events that were documented to occur during neonatal transfers were identified. Educational articles and position papers were included to define clinical cut-offs or physiologic parameters used in the determination of an adverse event. The events were grouped together during the scoping review according to the following commonly used criteria, (1,2,16,17) and then regrouped per body system or similar for ease of understanding during the first round of the Delphi survey.

A total of 35 adverse events were identified according to the above criteria, and the clinical events were then divided according to the physiological system affected. This was done in order to assist with logical flow of the survey tool. Clinical categories identified were airway complications, ventilation complications, haemodynamic complications, intravenous complications, medication errors and general complications. Equipment, patient safety and logistical factors were included under the general complications category. See Appendix C for the survey design used in Round 1 of the Delphi. Participants also had the opportunity to provide justification.

Following the first round of the Delphi survey, a second survey was developed for participants to denote the severity of each identified adverse events that reached consensus in the subsequent round. Severity categories were based on established classification criteria (29) and were defined as:

1. Negligible: A negligible event is asymptomatic and requires no active intervention.

2. Marginal: A marginal event is an incident that requires minimal intervention and has no prospect of long-term sequelae.
3. Serious: A serious adverse event is defined as a clinically significant or impactful incident but that is not immediately life threatening.
4. Critical: A critical adverse event results in a life-threatening consequence requiring urgent intervention and could cause permanent disability or impairment.
5. Catastrophic: A catastrophic adverse event results in death.

Procedure

Once the inclusion criteria for the expert panel had been finalised, the possible experts were enrolled through various means. For the EMS staff, contact was made with senior responsible staff at the different private and government organisations active in the Critical Care Retrieval environment. With permission, contact details for eligible staff members were requested, and e-mail communication was sent to the possible participants. This contained a brief description of the study, and an invitation to partake as part of the expert panel. Each invitee was supplied with an electronic link to the Delphi study on the Google Forms (Google Inc., California, US) platform. The link opened up to the information and consent sheet, and if the participant agreed and consented to take part in the study, it allowed them to proceed to the Delphi's first round questionnaire.

The nurses enrolled in the study, were approached via the unit managers of relevant neonatal or paediatric intensive care unit, or cardiothoracic intensive care unit (if neonates are nursed in these dedicated units following corrective surgery for congenital heart defects). The invitation was sent to the Unit Manager if they agreed, who in turn forwarded it their staff members who met the inclusion criteria for the study.

Doctors were approached through direct contact with specialists involved in the process of Critical Care Retrieval at the leading specialist receiving centres in both Johannesburg and Cape Town. This decision was based on the fact that these are the only major metropoles in South Africa with varied neonatal specialist care centres, and often receive neonates from specialised critical care retrieval services and other ALS providers. These doctors were also requested to extend the invite to participate in the study to their peers and colleagues.

Data were collected using a self-administered questionnaire (Appendix B) utilising the Google Forms (Google Inc., California, US) platform. Data collection took place over 9 months (March 2023 to December 2023).

E-mail addresses of participants who completed the survey was collected by Google Forms and were delinked from their specific answers to the items presented. This information was used to send follow-up e-mails to remaining potential participants on 3 occasions, two weeks apart, requesting their participation in the study. All respondents from the first round were automatically included in the following round.

Participants were required to indicate their agreement with the items presented (Appendix B) and denote whether they consider this to be an adverse event or not. Participants also had the opportunity to provide a justification for their answer. A consensus threshold of 75% was set and any items that did not reach consensus were set to be repeated in a subsequent round.

In the final round of the Delphi study, participants were required to categorise each consensus-based adverse event in terms of severity. These were: catastrophic, critical, serious, marginal or negligible, as defined above. Again, a consensus threshold of 75% was set.

Data management and analysis

Data management

The data were recorded using Google Forms (Google Inc., California, US) and later extracted into Microsoft Excel (Microsoft Corporation, Washington, US) for data cleaning. There were no missing data points and as such no entries were removed.

Data analysis

The data analysis techniques for the scoping review were already discussed in the previous chapter (see chapter 2).

The demographic information of participants were analysed descriptively and presented as proportions and numbers. After each round, data were analysed descriptively and consensus was calculated based on the proportion of participants that agreed with each item (round 1) or allocated each item to a specific severity level (round 2). After each round, the attrition rate was also calculated based on the proportion of the expert panel from the previous round that responded to a subsequent round.

Open ended, free-text data were analysed using simple content analysis and general categories were developed to report the sentiment of the responses by the expert panel.

Lastly, during final analysis of the severity rating the five-point severity scale (catastrophic to negligible) was reduced to a simpler, more user-friendly three-point severity scale (critical – serious – marginal).

Ethical Considerations

Study one (the scoping review) did not require ethical approval given that no propriety or confidential data were collected and only published, accessible secondary data were collected. No human participants were involved in the study.

Study Two was a low-risk study that involved non-clinical data, in the form of expert opinions. Participation was completely voluntary and participants could withdraw from the study at any time by either closing their browser or not responding to subsequent rounds. There were no risks to participants (other than time inconvenience) and participants did not derive any direct benefit from the study. Participants were not reimbursed for their time or participation in the study.

A participant information sheet (Appendix C) was electronically distributed to all participants, detailing the purpose and nature of the study. They were provided with an individualised electronic link to the Delphi Survey via e-mail. The landing page of the link provided similar information, as

well as a statement of consent, with a tick box indicating consent to participate in the study. The tick box was a mandatory field in order to proceed to the rest of the Delphi Survey. Demographic data of the study participants were the only personal information gathered in data collection, and respondents' anonymity was maintained because their email address was delinked from their answers.

The project commenced after ethical approval was obtained from the Human Research Ethics Committee (HREC) of the University of Cape Town (HREC ref 694/2018).

CHAPTER 4: RESULTS

The results of the scoping review were presented and discussed in Chapter 2. These results formed the basis of the development of a draft adverse event audit tool, which detailed the most commonly occurring adverse events in neonatal retrieval. A panel of experts were then requested to take part in a modified Delphi study, in order to derive a consensus-based item list of relevant adverse events for the proposed retrospective neonatal clinical quality audit tool. In this chapter, the results of the Delphi study will be presented.

Demographics and response rates

A total of 40 experts were invited to participate in round one of the Delphi study. In round one 28 respondents consented to form part of the expert panel, and completed Delphi questionnaire, yielding a response rate of 70%. In round one the expert panel consisted of neonatologists (n=4), paediatric intensivists (n=2), paediatricians (n=2), other medical doctor working in the field of retrieval (n=1) registered nurses (n=3), and advanced life support (ALS) paramedic or emergency care practitioners (ECPs) (n=16).

In round two, 18 experts consented and completed the Delphi questionnaire, yielding an attrition rate of 36%. In round two the expert panel consisted of neonatologists (n=3), paediatric intensivists (n=2), other medical doctor working in the field of retrieval (n=1), registered nurses (n=3), and advanced life support (ALS) paramedic or emergency care practitioners (ECPs) (n=12). In both Delphi rounds the majority of participants (50% in both rounds) had five years or more experience in their fields. The majority of the sample represented the private sector, 61% and 56% in rounds one and two, respectively. The demographic information of the expert panel composition in rounds one and two are summarised in Table 1.

Table 1 Demographics of the expert panel

	ROUND 1	ROUND 2
Highest Qualification	n=28	n=18
ALS or ECP	16 (57%)	12 (67%)
Medical Doctor	9 (32%)	4 (22%)
Registered Nurse	3 (11%)	3 (17%)
Field of Expertise		
Neonatology	7 (25%)	3 (17%)
Paediatric Intensive Care	2 (7%)	2 (11%)
Paediatrics	2 (7%)	0 (0%)
Retrieval	17 (61%)	13 (72%)
Experience in specialised field		
< 2 years	3 (11%)	2 (11%)
2-5 years	11 (39%)	7 (39%)
5-10 years	11 (39%)	5 (28%)
> 10 years	3 (11%)	4 (22%)
Health Sector		
Both	3 (11%)	4 (22%)
Private	17 (61%)	10 (56%)
Public	8 (29%)	4 (22%)

Round 1 – Derivation of the items for the retrospective neonatal clinical quality audit tool

It was anticipated that at least two rounds of the Delphi would be required to achieve consensus on which of the adverse events items should be included in the audit tool, however consensus of >75% was achieved after just one round. Airway related events had 4 proposed adverse events, and consensus ranged from 89.3% to 100% while ventilation or respiratory related adverse events had 7 proposed clinical events, and consensus ranged from 85.7% to 100%; and haemodynamic clinical parameters included 8 adverse event criteria, and consensus ranged from 89.3% to 100%. Medication errors included 4 adverse event types, and consensus of 100% was achieved on all 4 listed events. Finally, the last category grouped general adverse events together, consisting of 12 individual events. First round consensus for all 12 events ranged from 85.7% to 100%. The consensus rates for each of the different items are shown in table 2.

Table 2 Consensus on adverse event items

	n	%
Airway Adverse Events		
Unneccessary intubations (e.g. neonate on nCPAP is intubated for transfer, without clinical indication)	25	89%
Endotracheal tube obstruction (e.g. kinking or from secretions)	28	100%
Dislodged endotracheal tube (e.g. accidental extubation)	28	100%
Displaced endotracheal tube (e.g. too deep, too shallow or oesophageal)	27	96%
Respiratory Adverse Events		
Sustained hypoxia (SpO2 <90% in term neonates, excluding cyanotic congenital heart disease)	27	96%
Hyperoxia (SpO2 >94% in premature neonates, or >90% in congenital heart defects)	27	96%
Apnoea or bradypnoea	26	93%
Sustained tachypnoea (RR >60 breaths per minute)	24	86%
Pneumothorax	28	100%
Respiratory distress without adequate respiratory support	27	96%
Uncorrected respiratory acidosis or alkalosis, due to inappropriate ventilation	27	96%
Haemodynamic Adverse Events		
Sustained hypotension (MAP <40 or gestational age)	28	100%
Sustained bradycardia (HR <100 beats per minute)	25	89%
Sustained tacycardia (HR >160 beats per minute)	26	93%
Cardiac arrest requiring resuscitation	28	100%
Infiltrated or blocked intravenous lines	27	96%
Lack of patent intravenous access when indicated	28	100%
Incorrect type of fluid administered	27	96%
Incorrect fluid administration rates or volumes	27	96%
Medication Adverse Events		
Dosaging errors (infusion rates or bolus administration)	28	100%
Incorrect medication administered	28	100%
Required medication not administered (e.g Prostin or inotropes)	28	100%
Lack of sedation and/or analgesia, when indicated	28	100%
General Adverse Events		
Hypothermia (Temp <36°C, excluding targeted temperature management for hypoxic ischaemic encephalopathy)	28	100%
Hyperthermia (Temp > 37.4°C)	28	100%
Hypoglycaemia (blood glucose level < 2.6mmol/L)	28	100%
Equipment failure (ventilator, incubator, monitor etc.)	28	100%
Inexperienced / non-specialised staff / teams	26	93%

Incorrect information from receiving hospital (e.g. non-disclosure of complications; only providing information on one diagnosis but neglecting to disclose other abnormalities etc.)	27	96%
Inadequate handover information regarding initial treatment at referring facility (transferring crew unable to supply treatment details)	28	100%
Inadequate oxygen supply	26	93%
Omission of life saving interventions (e.g needle thoracentesis)	28	100%
Inability to blend oxygen to achieve lower FiO2	27	96%
Provision of non-humidified oxygen	24	86%
Inadequate / incorrect equipment	28	100%

The results from the first round of the Delphi study, meant that the proposed adverse event audit tool could be accepted in its original format for inclusion in the next round of the Delphi study. The draft audit tool was divided into six sections, each section with a set of individual adverse events associated with that particular section.

Participants were given an opportunity for open ended comment and suggestions on each section, the content of which were considered for addition to the audit tool. Insightful recommendations were made, most of which pertained to motivation behind the answers selected. The comments that offered expansion of or comment on the listed adverse events, were utilised to guide the development of the severity rating, and in particular the final audit tool criteria. This will be expanded on further in the discussion.

Round 2 – Severity rating of adverse events in the retrospective neonatal clinical quality audit tool

The next phase of the Delphi study involved the adverse events identified in the previous phases of the study, to be allocated a severity rating. Each adverse event was presented to the expert panel, and they were asked to rate each individual event according to the level of severity that each event is associated with. The same format audit tool was utilised as in the first round of the study, and adverse events remained under the heading of Airway, Respiratory, Haemodynamic, Medication Errors and General Adverse events.

As can be seen in Table 3, not all of the items achieved consensus on their severity rating in this round. Consensus rates were as follows: in the airway adverse events, consensus was achieved in 3 out of the 4 events, in the respiratory related adverse events, 50% of the events achieved consensus, whilst the haemodynamic adverse events achieved consensus in only 3 of the events. Medication adverse events achieved consensus in 3 out of 4 events, and in general adverse events, 4 of the events achieved consensus.

Various open-ended comments were noted by the expert panel regarding the adverse events that did not achieve consensus. These responses were systematically examined, and they were categorised according to the adverse events that they related to, or concepts raised. A recurring response was identified, relating to the fact that classifying certain adverse events were dependent on more clinical information being made available. Panellists agreed that those particular items are difficult to class according to a specific clinical cut-off or severity, whilst not set in a particular clinical circumstance. A number of clinical adverse events were identified to be dependent on the pathology

and clinical circumstance that they occur in, whether or not they would fall within a marginal, serious or critical severity category. The emphasis that the expert panel placed on the need for individualised patient clinical information in order to be able to rate the severity of the adverse events, suggested that additional Delphi rounds would not yield higher consensus and the Delphi study was closed. It was felt that the possibility for consensus in these items had been exhausted. This arises from the fact that evaluating the severity of these particular events is possible only in the context of individual clinical scenarios or with additional clinical or circumstantial information. This finding shifted the focus of the study from the development of an adverse event audit tool, to the consideration for the value of an adverse event trigger tool, which may prompt further information gathering and the application of clinical reasoning in order to denote an adverse event and to provide it with a severity rating.

Table 3 Severity rating of AE items

	Critical		Serious		Marginal	
	n	%	n	%	n	%
Airway Adverse Events						
Unnecessary intubations (e.g. neonate on nCPAP is intubated purely for transfer, without clinical indication)	10	53%	9	47%	0	0%
Endotracheal tube obstruction (e.g. mucous plugs or kinking)	17	89%	1	5%	1	5%
Accidental extubation	16	84%	2	11%	1	5%
Displaced endotracheal tube (e.g. too deep, too shallow or oesophageal)	17	89%	2	11%	0	0%
Respiratory Adverse Events						
Sustained hypoxia (SpO2 <90% in term neonates, excluding cyanotic congenital heart disease)	13	68%	4	26%	1	5%
Hyperoxia in premature neonates (SpO2 >94%)	6	32%	11	58%	2	11%
Hyperoxia / high concentration O2 administration in a cyanotic cardiac lesion where SpO2 is >85%	12	63%	5	26%	1	5%
Apnoea or bradypnoea	17	89%	2	11%	0	0%
Sustained tachypnoea (RR >60 breaths per minute)	7	37%	10	53%	2	11%
Pneumothorax	17	89%	2	11%	0	0%
Respiratory distress without adequate respiratory support (not initiating nCPAP or mechanical ventilation when required)	15	79%	4	21%	0	0%
Uncorrected respiratory acidosis or alkalosis, due to inappropriate ventilation	14	74%	4	21%	1	5%
Haemodynamic Adverse Events						
Sustained hypotension (MAP <40 or gestational age)	13	68%	6	32%	0	0%
Sustained bradycardia (HR <100 beats per minute)	16	84%	3	16%	0	0%
Sustained tachycardia (HR >160 beats per minute)	5	26%	14	74%	0	0%
Cardiac arrest requiring resuscitation	19	100%	0	0%	0	0%
Infiltrated or blocked intravenous lines	7	37%	8	42%	4	21%
Lack of patent intravenous access when indicated	8	42%	9	47%	2	11%
Incorrect type of fluid administered	7	37%	7	37%	3	16%
Incorrect fluid administration rates or volumes	14	74%	5	26%	0	0%
Medication Adverse Events						
Dosaging errors (infusion rates or bolus administration)	15	79%	4	21%	0	0%
Incorrect medication administered	17	89%	2	11%	0	0%
Required medication not administered (e.g Prostin or inotropes)	18	95%	1	5%	0	0%

Lack of sedation and/or analgesia, when indicated	10	53%	7	37%	2	11%
General Adverse Events						
Hypothermia (Temp <36°C, excluding targeted temperature management for hypoxic ischaemic encephalopathy)	12	63%	6	32%	1	5%
Hyperthermia (Temp > 37.4°C)	10	53%	7	37%	2	11%
Hypoglycaemia (blood glucose level < 2.6mmol/L)	15	79%	4	21%	0	0%
Omission of life saving interventions (e.g needle thoracentesis)	19	100%	0	0%	0	0%
Equipment failure (ventilator, incubator, monitor etc.)	14	74%	4	21%	1	5%
Inexperienced / non-specialised staff / teams	14	74%	5	26%	0	0%
Incorrect information from referring hospital (e.g. non-disclosure of complications; only providing information on one diagnosis but neglecting to disclose other abnormalities etc.)	10	53%	6	32%	3	16%
Inadequate handover information regarding initial treatment at referring facility (transferring crew unable to supply treatment details e.g antibiotic therapy, dates of indwelling lines)	8	42%	6	32%	4	21%
Provision of non-humidified oxygen	7	37%	6	28%	5	26%
Inability to blend oxygen to achieve lower FiO2	8	42%	7	28%	4	21%
Inadequate / incorrect equipment (e.g adult SpO2 probes used on neonate / incorrect size BP cuffs etc.)	8	42%	8	42%	3	16%
Inadequate oxygen supply	17	89%	2	11%	0	0%

Categories identified from open expert narrated comments

Underlying causes for some of the clinical presentations listed as possible adverse events, should be considered before classifying it as an adverse event incident. Specific events identified as particularly susceptible to this, were cases of sustained tachycardia, bradycardia, tachypnoea and hyperoxia. Expert comments include "*depends on the underlying cause; it depends, what is the diagnosis; this depends on the patient and certain conditions; depends on the pathology and the patient; you need to look at your patient, where is it coming from, what is the trend, how is the patient affected*".

The same constrain was identified for quality of care and medical errors categories, such as incorrect fluid type or volume administered; incorrect medication administered and loss or lack of patent IV access. The severity of these incidents were all thought to be dependent on the fluid or medication type involved in the incident, the volume administered or the clinical indication for the administration.

The duration and value of the particular events were also identified as a variable that would need to be known in order to determine ultimate severity of the adverse event. With regards to hypoxia (oxygen saturation below 90%), comments made such as "*How long is sustained? Depends on what is wrong with the baby and whether sats is in the high 80's or low 80's. Depends on how old - if just born within first hour of life etc?"* Multiple comments were made where panellists allocated an adverse event for example to the "critical" category, but stated that their severity allocation could possibly change to "serious", depending on the particular clinical circumstance.

Even though the majority of the panellists were in agreement with the cut-off variables used for normal clinical parameters, there were some comments made around the consideration of alternative values for blood glucose levels, hypoxia, tachycardia, bradycardia and temperature ranges. The suggested changes were not significant – for example hypoxia was suggested to change from 90% to 88%, but this is in keeping with a finding noted in the scoping review, where heterogeneity existed between the clinical parameter cut-off values defined and utilised in some of the studies.

Various comments were received pertaining to the lack of availability of appropriate equipment utilised in the retrieval environment. These included some first-person reports, such as "*We are currently unable to transfer babies on CPAP resulting in unnecessary intubations*" and "*The sats probes available to us in transport do not always work well on neonates*", indicating that the expert works in the retrieval field, and not the in-hospital neonatal field. More generalised comments also highlighted that lack of equipment or capabilities not being available: "*It is difficult to monitor BP in transport without appropriate cuffs for neonates*". Specific items mentioned were: poorly fitting saturation probes, temperature and respiratory monitoring capabilities, neopuff resuscitation device, infusion pumps, point of care arterial blood gas analysis, lack of nCPAP capability, transport ventilators with advanced modes and functions. This raises concerns around impact that the lack of required equipment would have on the incidence of adverse events, and the increased patient safety risk that it presents.

Lack of handover of thorough patient treatment history and interventions was highlighted as a factor that could potentially lead to additional adverse events, with examples given such as "o*verdoses of medication could be administered to the patient if last dose time and amount is not available to the receiving team*".

Another recurring notion among different categories of the adverse events tool, was the lack of appropriately trained staff working in the overarching retrieval environment. Experts were of the opinion the inappropriately trained or skilled staff increases the risk of certain adverse events in particular, such as neonatal intubation, ventilation strategies and lack of confidence to perform advanced life-saving interventions. One expert remark interlinked several of the principles touched on in the previous categories identified: "*Poor training with high degrees of stress and lack of appropriate equipment often leads to severe adverse events such a prolonged hypoxia leading to brain damage/ death*". Some of the concerns and challenges identified through these comments, are of particular interest in the context of specialised retrieval units and will be explored further in the discussion.

Even though the focus of the Delphi was centred around the inclusion of specific adverse event incidents and their allocation to severity categories, some coincidental insights were obtained with regards to adverse events reporting culture. In clarification provided by some of the experts for their reasoning behind an adverse event inclusion or rating, some comments were noted relating to the fact that a particular incidents might be more difficult to categorise as they are rather related to a particular setting and "*not reflective of the practitioner*" or "*not the person's fault*". This speaks to some of the barriers to adverse events reporting that may exist due to a historical blame culture. Adverse events reporting is often associated with blame, and reporters fear punitive recourse. The fact that an adverse event was caused do to system failures, does not exclude it from qualifying as an adverse events. In fact, the identification and reporting of such events, add immense value in identifying, and possibly correcting, the shortcomings of such systems. (30)

The results obtained from the Delphi study, validated the adverse events included in the draft audit tool with first-round consensus. Further validation of adverse event severity rating was obtained for some of the adverse events categories, whilst a range was identified for the remaining items, subject to further examination of the particular event in the clinical context of each particular patient. This is to account for the variation that exists within disease pathology, diagnosis and patient variables. Specific challenges encountered in the setting of Adverse Events in the South African neonatal transfer environment, were also identified through the narrative results.

A retrospective neonatal clinical quality audit tool

Following two rounds of Delphi, the derived retrospective neonatal clinical quality audit tool and their corresponding severities are shown in table 4, below.

Table 4 Consensus on adverse event items

	Severity Rating
Airway Adverse Events	
Unneccessary intubations (e.g. neonate on nCPAP is intubated for transfer, without clinical indication)	Serious to Critical
Endotracheal tube obstruction (e.g. kinking or from secretions)	Critical
Dislodged endotracheal tube (e.g. accidental extubation)	Critical
Displaced endotracheal tube (e.g. too deep, too shallow or oesophageal)	Critical
Respiratory Adverse Events	
Sustained hypoxia (SpO2 <90% in term neonates, excluding cyanotic congenital heart disease)	Serious to Critical
Hyperoxia (SpO2 >94% in premature neonates, or >90% in congenital heart defects)	Serious to Critical
Apnoea or bradypnoea	Critical
Sustained tachypnoea (RR >60 breaths per minute)	Serious to Critical
Pneumothorax	Critical
Respiratory distress without adequate respiratory support	Critical
Uncorrected respiratory acidosis or alkalosis, due to inappropriate ventilation	Serious to Critical
Haemodynamic Adverse Events	
Sustained hypotension (MAP <40 or gestational age)	Serious to Critical
Sustained bradycardia (HR <100 beats per minute)	Critical
Sustained tacycardia (HR >160 beats per minute)	Serious
Cardiac arrest requiring resuscitation	Critical
Infiltrated or blocked intravenous lines	Serious to Critical
Lack of patent intravenous access when indicated	Serious to Critical
Incorrect type of fluid administered	Serious to Critical
Incorrect fluid administration rates or volumes	Serious to Critical
Medication Adverse Events	
Dosaging errors (infusion rates or bolus administration)	Critical
Incorrect medication administered	Critical
Required medication not administered (e.g Prostin or inotropes)	Critical
Lack of sedation and/or analgesia, when indicated	Serious to Critical
General Adverse Events	
Hypothermia (Temp <36℃ , excluding targeted temperature management for hypoxic ischaemic encephalopathy)	Serious to Critical
Hyperthermia (Temp > 37.4℃)	Serious to Critical
Hypoglycaemia (blood glucose level < 2.6mmol/L)	Critical
Equipment failure (ventilator, incubator, monitor etc.)	Serious to Critical
Inexperienced / non-specialised staff / teams	Serious to Critical
Incorrect information from receiving hospital (e.g. non-disclosure of complications; inadequate recording of interventions, misdiagnosis)	Serious to Critical
Inadequate handover information regarding initial treatment at referring facility (transferring crew unable to supply treatment details)	Serious to Critical
Inadequate oxygen supply	Critical
Omission of life saving interventions (e.g needle thoracentesis)	Serious to Critical
Inability to blend oxygen to achieve lower FiO2	Serious to Critical
Provision of non-humidified oxygen	Serious to Critical
Inadequate / incorrect equipment (BP cuff, SpO2 probe, ICU ventilator etc)	Serious to Critical

CHAPTER 5: DISCUSSION

There is a diverse range of levels of qualification and education in the South African EMS environment, but a lack of universally accepted patient care guidelines. As such vast differences are found in the nature, equipment and human resources, and quality of care associated with the interfacility transport of neonates between different sectors and different provinces. This highlights a need for the development of standardised clinical care practices in the neonatal interfacility transfer sphere, in order to ensure a robust patient safety framework. The core focus of patient safety practices, is to prevent or reduce patient harm or injury and to improve quality of care. Being able to accurately identify and report on the adverse events that most frequently occur in a particular patient population, enables healthcare services to re-orientate their systems design and implement processes aimed at reducing the occurrence of adverse events The aim of this study was therefore to develop a retrospective neonatal clinical quality audit tool that can be employed as part of a clinical governance system. It could be utilised to assess the incidence and severity of neonatal adverse events that occur during neonatal interfacility transfer in South Africa. Following two rounds of consensus, a 41-item retrospective audit tool was developed and organised into five sections. Additionally, each item was allocated a severity rating (or range), to indicate whether the adverse event would have a marginal, serious or critical impact on patient morbidity or mortality.

The audit tool was distributed to an expert panel for validation through a modified Delphi study. The expectation was that at least two rounds would be required in order to reach consensus on the adverse events that the expert panel agreed should be included in the tool. First round consensus was however achieved on each adverse event, with consensus scores ranging from 85.7% to100%. This could imply that the scoping review that was done in the first study was thorough, and successfully identified the adverse events most commonly associated with neonatal transfer. The rapid consensus rate could also be indicative of the homogeneity of the expert panel, with valuable experience in this particular field. This is unlikely, though, considering that experts from a variety of clinical and professional backgrounds and health sectors were sampled. It was therefore reasonable that the audit tool could be accepted in its original format for inclusion in the next round of the study, which examined the clinical severity of each of the adverse events.

The primary design of the survey was in the format of pre-determined categories, experts were able to give comment on each category selection. Clarification of their allocation or their nuanced views on each event category guided the results obtained. Even though consensus was achieved on all the adverse events identified, there was suggestion for consideration of slightly altered values for the normal ranges of some clinical parameters. This is in keeping with findings from the scoping review, that variation exists in the cut-off values used to identify abnormal vital signs. Variation in these values may also be as a result of the underlying pathology (e.g. cyanotic congenital heart defects affecting the cut-off for oxygen saturation and hypoxia triggering) or of the gestational age of the neonate at birth. This highlights the complexity of denoting events as adverse in neonatal interfacility transfer and corroborates the views of the expert panel that some events cannot be allocated to a severity rating without interrogating individual clinical scenarios or without additional clinical or circumstantial information. Some of these ideas will be expanded upon in the remainder of this chapter.

Adverse events and categories included in the audit tool

In order to gather the data points required to formulate the audit tool a scoping literature review was conducted, which consistently highlighted the fact that neonatal patients are at increased risk for the occurrence of adverse events. The neonatal period represents a time of dramatic and rapid physiologic changes in the setting of immature body systems that are learning to adapt to extra-uterine life. This makes neonates particularly fragile and susceptible to the deleterious effects of adverse events, especially during transport. Their capacity to tolerate and compensate for adverse conditions are restricted, and minor physiologic events can have significant consequences. (2,17,31) This reaffirms the need for patient safety practices specific to the neonatal care environment, with a focus on monitoring and reduction of adverse events during neonatal interfacility transfer. It was evident that in order to ensure a safe patient care environment, consideration needs to be given to events that result in direct harm to the patient, such as hypoxic events or medication errors, but of equal importance are factors that could increase the patient's risk to harm. These factors include items such as team composition, quality of information gathering between facilities and the availability of appropriate equipment. The adverse events included in the draft audit tool therefore include events of both a clinical and logistical nature.

The types of adverse events that were found to occur most frequently during neonatal transfer, were well defined and corroborated through various studies that were conducted across different countries. The nature of the adverse events that most frequently occur during neonatal transfer was corroborated through multiple studies there were conducted across varied settings. There was however, considerable heterogeneity in the discreet clinical cut-off values or physiologic parameters used to define a clinical adverse event, and a degree of variation existed in these clinical parameters. This was thus mitigated against through review of additional literature focused on normal neonatal physiology as well as in-hospital NICU studies with documented clinical variables. This was necessary despite these sources falling outside the remit of the scoping review, again highlighting an important gap in the literature that focuses on neonatal interfacility transfer. Even though clarity was obtained on a number of the variables, there remains a lack of standardised agreed parameters for absolute identification of a clinical adverse events in the neonatal population. Neonatal care is inherently complex, requiring a nuanced understanding of the interconnected factors that contribute to adverse events, and makes determination of certain overarching absolute cut-off values challenging.

The adverse events that were identified in the scoping review, were grouped according to the adverse event category that each event was associated with, and clinical adverse events were divided further according to the physiological system that they could affect. Each of these will now be discussed in terms of the literature, highlighting the potential impact that they may have on neonatal morbidity and mortality.

Adverse events that are related to advanced airway management, include incidents such as accidental extubation or obstructed endotracheal tubes. These events are often marked by rapid subsequent clinical deterioration as a consequence. Non-elective extubation is recorded as resulting in hypoxaemia, bradycardia and cardiac arrest. The emergent reintubation that is necessitated as a corrective measure, is often performed under suboptimal circumstances and has been associated with secondary events such as laryngeal trauma, increased intracranial pressure and worsened hypoxia. (32) Such consequences may further be exacerbated in contexts like South Africa where prehospital providers do not have specific training, exposure or regular currency in the endotracheal intubation of neonatal patients.

Adverse events associated with respiratory and ventilation status have similar deleterious physiological effects to those in the airway management category, due to the resultant hypoxia that ensues. In the setting of omitted care, whether it be due to possible medical error or due to logistical problems such as lack of availability of required equipment, the harmful physiological consequence may be more subtle and not immediately evident. There is robust evidence available detailing the clinical benefit of neonatal non-invasive continuous positive airway pressure ventilation (nCPAP), and its value in preventing invasive ventilation in the neonatal population, thereby mitigating the associated risk factors and consequence of invasive ventilation. (33) From a whole-systems perspective, initiating nCPAP and avoiding endotracheal intubation completely, may also minimise the number of ventilator days, and hospital and NICU length of stay. As such, this approach may drive down costs and decrease access block in a context like South Africa with limited fiscal space and few NICU beds and resources. While it might seem immaterial, the lack of availability of nCPAP in neonatal interfacility transfer, therefore increases the patient's risk for harm, either through intubation that may have been otherwise avoided; or persistent respiratory distress for an extended period of time. In order to understand the extent of this, and lack of other neonatal equipment (e.g. appropriately sized monitoring attachments), it is recommended that a national audit be completed to map the equipment resources available to services that undertake neonatal interfacility transfer. Following which, it is further recommended that a similar Delphi process be undertaken to reach consensus on minimum equipment requirements and standards for all services who undertake neonatal interfacility transfer.

To the same extent, medical errors such as inadequate sedation and analgesia has been associated with an increased incidence of adverse events such as accidental extubation, prolonged periods of tachycardia, or ventilator dyssynchrony resulting in desaturation and hypoxic events. (32) For this reason, some items that were included in the list of identified adverse events, which may not seem like an obvious adverse event, but needs to form part of the reporting structure due to its propensity for exposing the patient to increased risk of serious events occurring. The adverse events included in the draft audit tool therefore included events of clinical as well as logistical nature, in order to provide overview of direct adverse events, as well as factors and components that may lead to the occurrence of adverse events. Reporting on, and understanding the logistic events and complexities that occur during neonatal interfacility transfer is an important consideration not only because it may increase the risk of, or result in, actual patient harm but it may also inform training and equipment requirements, or standard operating procedures.

Adverse event severity rating

For some of the adverse events that were included in the audit tool, consensus could not be achieved on the severity category allocation. This was not due to lack of agreement between the experts, but rather due to the fact that they were of the opinion that the severity of the event can only be determined once more clinical information is available. An event that may seem minor in nature, could become a critical event if it was sustained for a prolonged duration. To the same extent, an adverse event that may pose very little harm to a clinically stable patient, could have catastrophic effects in a critically ill patient with increased susceptibility or limited physiologic reserve. (34,35)

An imperative aspect that warrants recognition in the identification and severity rating of adverse events, is the potential impact of underlying disease pathology on defining the boundaries of normal or abnormal clinical findings, and the subsequent impact that a particular event might have. This

extends to the duration that the abnormal parameter is maintained for, as well as to the degree of the derangement. This can be demonstrated through the examination of a number of the adverse event types that are often encountered.

For example, in the consideration of an event of hypoxia if the patient's oxygen saturation drops to 87% and this is sustained for a period of one minute, the deleterious effects would be notably different compared to an oxygen saturation of 60% that is sustained for a period of 4 minutes. (35–37) Similarly, in the instance of hyperoxia, the deleterious effects on various physiological systems are well documented, remarkably so in the premature neonatal population. The susceptibility to the hyperoxic effects are associated with variables such as gestational age, type of oxygen support, duration of exposure and clinical stability.(38) A premature neonate that presents with an oxygen saturation of 100% without any supplemental oxygen, would however not be at risk of the harmful effects and should not be identified as an adverse event, even though the accepted clinical parameter guidelines would place the patient in the adverse event category. (35,38) Certain hyper-metabolic states such as sepsis is often accompanied by derangements in clinical parameters such as tachycardia and tachypnoea. These changes form part of the natural physiological compensation in order to meet the increased metabolic demand and maintain a homeostatic environment.(39) A patient that presents with a sustained tachypnoea, could thus be compensating for an underlying metabolic acidosis and the tachypnoea would not necessarily be associated with a clinical adverse event in the absence of possible harm to the patient. In evaluation of events such as loss of intravenous access during transfer, the clinical significance of the event is highly subjective to the therapeutic need for the fluid or medication administered. If a patient is dependent on vasoactive medication for haemodynamic support, the loss of patent access could result in rapid clinical demise, indicating a possible catastrophic adverse event. However, if the intravenous access was for the purposes of intermittent medication administration such as a daily antibiotic dose, it would indicate a minor adverse event.

To this extent, understanding the contextual nuances of clinical variability on the assessment and severity rating of adverse events is crucial. The allocation of a severity rating for particularly categories of physiological derangements and medical errors should allow for further examination of the particular details of the event, through guided assessment points. These should make provision for specific variables such as disease pathology; patient diagnosis, underlying clinical condition and stability; duration and depth of clinical derangement, and the patient's treatment plan.

These findings guided the notion that the clinical audit tool that was originally developed, would be best suited in an expanded format as a clinical trigger tool.

System considerations

Another finding from the scoping review that was reiterated by the expert panel, is the possible deleterious effects that the lack of specialised teams have during the neonatal transfer process. In inexperienced or untrained, non-dedicated neonatal interfacility transfer teams, higher incidents of adverse events are reported, and the events may be of more catastrophic nature due to lack of recognition, improper or delayed response or lack of clinical proficiency required in the management of these events.(17,20) This particular adverse event category presents a complex problem in the South African context of limited healthcare resources. Hospitals and clinics in the more remote or rural regions of South Africa, are often under-resourced and staffed by clinicians of basic levels of qualification. Specialist care is only accessible through transfer to specialist centres. When sick

neonates present at these health centres, there is often a lack of capability to stabilise their initial condition prior to the transfer. Due to the limited EMS resources previously described, the team that is tasked with the transfer is also not capable of the required level of intervention that the patient might need. This results in neonates being exposed to adverse clinical conditions for prolonged periods of time, impacting negatively on the morbidity and mortality burden of this patient population. (4–6)

This closely relates to another area of particular concern identified through the results, that there is an inability to provide appropriate care and monitoring during neonatal transfer due to a lack of availability of required equipment. This is not due to a global lack of appropriate equipment devices for neonatal retrieval, as equipment items such as ICU transport ventilators with nCPAP capability, oxygen humidification devices, neonatal vital signs monitors with appropriately sized blood pressure cuffs and saturation probes, and fluid and medication infusion devices are all available on the market. This is linked to the resource constraints of our healthcare environment, but particularly due to the lack of standardised recommendations of quality of care during neonatal retrieval. There is no official guidance on and monitoring of, the minimum standards required in order to safely conduct neonatal transfers.

The impact of adverse events related to system design, limitations and errors cannot be overlooked due to the fact that our setting faces some unique constraints compared to that of higher income countries. Their impact may also have a more profound effect on our healthcare system due to increasing costs and NICU hospital bed blocking, but also the prolonged impact of morbidity on families that cannot afford care of a child with an impairment, leading to loss of income.

The lack of specialised resources in the neonatal transfer environment in South Africa, cannot easily be resolved, as these resources simply are not readily available. Steps can however be taken in order to lessen the negative impact of these constraints. Capacitating the resources that are currently available with better knowledge, is sure to result in improved patient care quality. The need for specific education focused on neonatal care and neonatal transfers are of crucial importance. In order to achieve this, the knowledge gap that exists in the specific environments needs to be identified, in order for a targeted solution to be developed.

Patient safety culture and adverse event reporting

In the healthcare industry, particularly in the context of clinical patient care, adverse events monitoring is often fragmented, not well defined and dependent on each individual facility, network or provider's commitment to the process of reporting and monitoring. There is an apparent lack of standardised and systematic methods by which safety can be evaluated. (31,40,41) Some of the key challenges related to adverse events reporting and monitoring stem from the reliance on voluntary reporting by the staff involved in the patient care. Some research suggest that as little as only 8 – 20% of adverse events are voluntarily reported, and that as much as 90% of the events that are reported, did not cause any harm to the patient. (42,43)

In addition to the willingness of staff to report adverse events, the recognition of individual events are often dependent on practitioner knowledge and interpretation of what defines an adverse event and when an event is reportable. The results obtained from the expert panel regarding the variation that exists in the identification of adverse events, echoes this notion that underreporting may be

associated with lack of clarity in the absence of well-defined, objective assessment methods. This makes accurate adverse events monitoring particularly difficult, and leads to inefficient quality improvement projects and once again highlights the need for standardisation guidelines for clinical quality of care.

In an effort to improve identification of adverse events, clinical audit and trigger tools have been recommended in different settings within the healthcare environment. One such example, is the Institute for Healthcare Improvement (IHI) Global Trigger Tool (GTT) for Measuring Adverse Events, developed to identify adverse events in adult patients. The GTT was one of the first trigger tools to be developed specifically for the monitoring of adverse events. It is designed to be used in retrospective review of patient records, using a determined set of triggers aimed at identifying possible events of patient harm.(42) Specific to the field of neonatal transfer, there are various scoring methods utilised in different settings, aimed at the identification of transport related risk and identification of illness severity. The Transport Risk Index of Physiologic Stability II (TRIPS II) as well as the Mortality Index for Neonatal Transportation (MINT) are both used to assess the severity of the neonate's condition and predict mortality. (44) Even though the use of these scoring tools can assist in heightened awareness of the risk of adverse events for each particular patient that it is used on, it does not make specific provision for the identification of adverse events.

The value in the use of an adverse event trigger tool, is that it sensitises the reviewer to the possibility of an adverse event by identifying a categorical finding according to pre-determined criteria. It then provides subsequent screening parameters according to which the finding is explored, in light of the clinical context of the patient. (45) This assists with the decision-making process and reduces the susceptibility to individual reviewer interpretation, as it defines and clarifies the criteria of inclusion. In the absence of a trigger tool (such as what is being proposed in this study) there will be a requirement to undertake an in-depth review of every individual patient record to identify the contextual clinical variables, in order to determine whether an adverse event could have occurred. Thus, with the application of this consensus-derived, retrospective trigger tool, retrospective review can be undertaken efficiently, minimising costs and resource consumption – i.e. only those cases where a trigger is flagged according to the items developed in this work, should require in-depth review and clinical reasoning. This would require further development of the adverse events severity rating scale, due to the fact that the current proposed scale does not allow for the guided consideration of clinical and pathological variables, and does not consider the extent of the vital sign derangements.

Another barrier that is encountered in the process of adverse events reporting, is the notion that adverse events are caused by practitioner error or negligence. In addition to this, these events have historically been associated with a culture of blame and have often been handled in a punitive manner. Whilst negligence and human error certainly are causative factors in patient harm, adverse events need to be approached from a systems perspective instead of an individual practitioner perspective. When a systems approach is utilised, it examines and considers all the aspects involved in the patient care process that could contribute to the occurrence of adverse events within that particular system. (30,46) This was echoed in the results obtained from the Delphi study, where the impact of limitations within the neonatal transfer sphere was identified as a contributing factor in

the adverse events that are encountered. The particular perception was noted that an adverse event must in essence be related to human error. This speaks to some of the barriers to adverse events reporting that may exist due to a historical blame culture. Adverse events reporting is often associated with blame, and reporters fear punitive recourse. The fact that an adverse event was caused due to system failures, does not exclude it from qualifying as an adverse events. In fact, the identification and reporting of such events, add immense value in identifying, and possibly correcting, the shortcomings of such systems. (30)

Recommendations for implementation:

It has been clearly demonstrated that there is a need for improved safety practices in the environment of neonatal transfers in South Africa. Various factors contribute to the incidence of neonatal adverse events relative to our environment, most notably: 1) Lack of standardised guidelines that can be utilised to guide safe clinical practice; 2) Lack of minimum required standards of care that can be utilised to monitor system compliance; 3) Limited availability of specialised resources.

The impact of these limitations can be mitigated on small scale through improvement projects that can be employed at a local team level. Of vital importance is a clinical governance system that allows for the frequent monitoring of the quality of care. The current clinical audit tool could be of value in this process, as it would enable neonatal transfer units to objectively assess the adverse events rates that occur most frequently in their environment. This would assist in the identification of problem areas in need of intervention, which could guide staff education, improvement projects and the development of in-house standard patient safety guidelines.

Easily accessible adverse events reporting systems are a necessity in order to improve patient safety, but of vital importance is that the staff are provided with thorough training on the identification of adverse events. The utilisation of a structured trigger and audit tool, could provide value in guiding operational staff on which type of events to report. This would assist in the mitigation of individual practitioner bias in the adverse events reporting process. The assessment and monitoring of these events should be through a non-punitive systems-based approach, and should involve feedback to the team and tangible systems improvements where required.

The effectiveness of quality improvement projects and systems improvements can be monitored with post-interventional reassessment utilising the audit tool.

LIMITATIONS

While the first round of the Delphi survey was informed by a scoping review of the literature, the scoping review approach is not without limitation. Firstly, to improve relevance, the scoping review was only limited to literature that related to adverse events during interfacility transfer of neonates. It is acknowledged that such a narrow inclusion criteria promotes the transferability of the work to the topic under study it could have resulted in some important adverse events that occur during a neonate's course of stay in-hospital, to be excluded for consideration by the expert panel. However, this was mitigated against because facility-based and out-of-hospital clinical experts were included in the Delphi participant panel. No grey literature was included in the scoping review and this might have also provided additional items for consideration. Lastly, very few articles were actually

retrieved during the scoping review, despite a robust search strategy, highlighted the dearth of literature in this field.

The Delphi approach also has several limitations. Firstly, it represents the lowest level of evidence (expert opinion) and as such may also be sensitive to subjectivity and bias. Similarly, scope of the results is limited by the background and expertise of the panel which is recruited. Yet, a heterogenous sample was drawn and attrition between rounds one and two was marginal – retaining a representative spread of experts. Another limitation of the Delphi study is that it was ended after only two rounds and some items on the severity rating did not reach consensus. This was a deliberate decision following feedback from the Delphi expert panel which indicated that there was no more prospect of attaining consensus because items would require additional clinical information or context for a severity rating to be allocated.

The tool that has been proposed has only been validated for content and it would need to be piloted to determine accuracy, relevance and feasibility in terms of ease of use and efficiency. Furthermore, it is only useful in the setting of retrospective care review and the identification of events that have already occurred, versus predicting or preventing adverse events.

CHAPTER 6: CONCLUSION

In light of the fact that there are no standardised guidelines informing neonatal transfers in South Africa, this study aimed to develop a retrospective neonatal clinical audit tool according to which the safety of neonatal transfer in South Africa can be assessed.

A scoping literature review was conducted on literature identified through a priori developed search strategy. A total of 866 articles were initially identified, and after application of eligibility criteria, 10 articles were included in the final review. These studies were based on adverse events in neonatal transfer and were reviewed in order to identify adverse events, neonatal patient safety, normal clinical parameters and quality of care during transport. This informed the data collection for the development of the draft clinical audit tool.

The second phase of the study involved the validation of the content included in the audit tool through a modified Delphi study conduct amongst experts in the field of neonatal care or neonatal retrieval. The Delphi expert panel included nurses and doctors working in neonatal or paediatric intensive care units that regularly admit neonates. Doctors, advanced life support paramedics (ALS) and Emergency Care Practitioners (ECPs) working in the neonatal retrieval field were also included. Through purposeful and snowball sampling, 28 panellists completed the first Delphi round. Events relating to clinical, logistical and equipment aspects were included in the tool, and were divided into 5 categories of adverse events. First-round consensus was achieved for all the items. Consensus rates for airway adverse events ranged from 89.3%-100%, respiratory adverse events ranged from 85.7%-100%, haemodynamic adverse events from 89.3% to 100%, medication errors achieved 100% consensus, and general adverse events ranged from 85.7%-100%.

In the second phase of the Delphi study, each adverse event was allocated to a severity rating. In the airway adverse events, consensus was achieved in 3 out of the 4 events. For respiratory related adverse events, 50% of the events achieved first round consensus, whist the haemodynamic adverse events achieved consensus in 3 of the events. Medication adverse events achieved consensus in 3 out of 4 events, and in general adverse events, 4 of the events achieved first round consensus. Based on comment from the expert panel, the remaining items were identified to be of value as trigger tool items, which require application to a background of disease pathology and clinical setting, before a severity rating can be allocated. Eighteen experts completed the second round, indicating a 36% attrition rate. Panellist were requested to provide expert opinion in open comments section in both phases of the Delphi study, which were analysed and incorporated into the final audit tool design.

Through literature-based evidence, and validated for content through the contributions of a national multidisciplinary panel of experts in the field of neonatal retrieval, this study enabled the development of a consensus-based retrospective clinical audit tool. The utilisation of the audit tool in the framework of a robust clinical governance system, would enable reporting of adverse events according to standardised parameters. This would contribute to the identification of risk factors and knowledge gaps in neonatal transfer teams, which could assist in the development of improvement projects. In addition, it can be used in before-and-after interventional studies, to assess for the effectiveness of the intervention in the setting of improved patient safety. Through utilisation in

future research projects it can assist in the development of standardised guidelines for clinical care standards during neonatal transfer.

RECOMMENDATIONS FOR FUTURE RESEARCH

The current audit tool should be validated to determine accuracy, relevance and feasibility through intra- and inter-rater reliability. This could be achieved through retrospective chart review of clinical records completed during neonatal transfers. The reviewed records should be representative of all the South African health spheres, and the reviewers should include a sample similar to what was used in this study.

The current audit tool should be expanded into a trigger tool for the identification of adverse events, providing for the inclusion of clinical patient specific variables, disease pathology and extent of vital signs derangements, to aid in the identification and severity grading of adverse events. This could be done through a consensus-day interviews with a panel of neonatal specialists that are experienced particularly in the fields of neonatal intensive care, neonatal surgery, neonatal cardiology, neonatal pulmonology and neonatal critical care retrieval.

Development of standardised guidelines for quality of care in neonatal transfers in South Africa. Most importantly, clinical treatment guidelines aimed for use by EMS staff who conduct neonatal transfers in the South African environment. Secondly, guidelines for the minimum requirements for equipment, education and resources should be developed.

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APPENDIX A: SEARCH STRATEGY

Cochrane			
Search terms	Search date	**Results**	**Selected**
Infant AND transfer AND risk	05/04/2020	36	1
Infant AND transfer AND safety	05/04/2020	12	0
Infant AND transfer AND equipment	05/04/2020	2	0
Infant AND transfer AND monitoring	05/04/2020	5	0
Infant AND transport AND risk	05/04/2020	19	1
Infant AND transport AND safety	05/04/2020	7	0
Infant AND transport AND equipment	05/04/2020	2	0
Infant AND transport AND monitoring	05/04/2020	5	0
Infant AND retrieval AND risk	05/04/2020	15	0
Infant AND retrieval AND safety	05/04/2020	122	0
Infant AND retrieval AND equipment	05/04/2020	11	0
Infant AND retrieval AND monitoring	05/04/2020	60	1
Infant AND interhospital AND risk	05/04/2020	0	
Infant AND interhospital AND safety	05/04/2020	0	
Infant AND interhospital AND equipment	05/04/2020	0	
Infant AND interhospital AND monitoring	05/04/2020	0	
Newborn AND transfer AND risk	05/04/2020	27	1
Newborn AND transfer AND safety	05/04/2020	8	0
Newborn AND transfer AND equipment	05/04/2020	1	0
Newborn AND transfer AND monitoring	05/04/2020	4	0
Newborn AND transport AND risk	05/04/2020	15	1
Newborn AND transport AND safety	05/04/2020	4	0
Newborn AND transport AND equipment	05/04/2020	3	1
Newborn AND transport AND monitoring	05/04/2020	3	0
Newborn AND retrieval AND risk	05/04/2020	125	1
Newborn AND retrieval AND safety	05/04/2020	98	0
Newborn AND retrieval AND equipment	05/04/2020	8	0
Newborn AND retrieval AND monitoring	05/04/2020	50	1
Newborn AND interhospital AND risk	05/04/2020	0	
Newborn AND interhospital AND safety	05/04/2020	0	
Newborn AND interhospital AND equipment	05/04/2020	0	
Newborn AND interhospital AND monitoring	05/04/2020	0	
Neonate AND transfer AND risk	05/04/2020	29	2

Neonate AND transfer AND safety	05/04/2020	9	0
Neonate AND transfer AND equipment	05/04/2020	1	0
Neonate AND transfer AND monitoring	05/04/2020	4	0
Neonate AND transport AND risk	05/04/2020	16	1
Neonate AND transport AND safety	05/04/2020	7	0
Neonate AND transport AND equipment	05/04/2020	2	0
Neonate AND transport AND monitoring	05/04/2020	5	0
Neonate AND retrieval AND risk	05/04/2020	124	1
Neonate AND retrieval AND safety	05/04/2020	9	0
Neonate AND retrieval AND equipment	05/04/2020	64	1
Neonate AND retrieval AND monitoring	05/04/2020	59	0
Neonate AND interhospital AND risk	05/04/2020	0	
Neonate AND interhospital AND safety	05/04/2020	0	
Neonate AND interhospital AND equipment	05/04/2020	0	
Neonate AND interhospital AND monitoring	05/04/2020	0	
Infant AND harm	05/04/2020	163	0
Infant AND adverse/event	05/04/2020	6	0
Infant AND clinical error	05/04/2020	30	3
Infant AND medical error	05/04/2020	16	0
Infant AND iatrogenic disease	05/04/2020	14	0
Infant AND iatrogenic injury	05/04/2020	1	0
Newborn AND harm	05/04/2020	1	0
Newborn AND adverse/event	05/04/2020	62	2
Newborn AND clinical error	05/04/2020	23	3
Newborn AND medical error	05/04/2020	11	2
Newborn AND iatrogenic disease	05/04/2020	2	0
Newborn AND iatrogenic injury	05/04/2020	1	0
Neonate AND harm	05/04/2020	152	2
Neonate AND adverse/event	05/04/2020	3	0
Neonate AND clinical error	05/04/2020	22	2
Neonate AND medical error	05/04/2020	11	1
Neonate AND iatrogenic disease	05/04/2020	3	1
Neonate AND iatrogenic injury	05/04/2020	1	0
Total after duplicate removals			3
Science direct			
Search term	**Search date**	**Result**	**Selected**

Neonate or infant) and (transfer or transport or interhospital) and (adverse event)	06/04/2020	45	7
(Neonate or infant) and (“risk management” or “equipment safety” or patient safety”	06/04/2020	25	4
(Neonate or infant) and (“patient harm” or “adverse event” or “clinical error” or “medical error” or “iatrogenic disease” or “iatrogenic injury”)	06/04/2020	1343	24
(Neonate or infant or newborm) and (transfer or transport or interhospital) and (monitor or “physiologic monitoring) and not vaccine	06/04/2020	273	8
(Neonate or infant or newborn) and (transfer or transport or interhospital) and complications	06/04/2020	37	2
Total after duplicate removal			43
Scopus			
Search terms	**Search date**	**Results**	**Selected**
(Infant or newborrn or neonate or bab) and (“patient transfer” or “patient transport” or interhospital) and (“risk management” or “safety management”)	05/04/2020	32	11
(Interhospital transfer) and neonate and risk	07/04/2020	152	27
(Neonate or newborn or infant) and (“clinical error” or “medical error” or adverse)	10/04/2020	720	27
Total after duplicate removals			65
Ebscohost			
Search terms	**Date searched**	**Results**	**Selected**
(Neonate or infant or newborn or baby) and (transfer or transport or interhospital) and “adverse event”	11/04/2020	76	7
(Neonate or infant or newborn or baby) and monitoring and (transport or transfer)	11/04/2020	122	3
Total after duplicate removals			8
Web of science			
Search term	**Date searched**	**Results**	**Selected**
(Neonate or infant or newborn or baby) and (transport or transfer) and adverse	10/04/2020	109	4
(Neonate or infant or newborn or baby) and (transport or transfer) and monitoring	11/04/2020	200	3
Total after duplicate removal			7
Pubmed			
Search term	**Date searched**	**Results**	**Selected**
(Neonate or infant or newborn or baby) and (transport or transfer) and adverse	13/04/2020	74	5
(((neonate[Title/Abstract] OR newborn[Title/Abstract] OR infant[Title/Abstract] OR baby[Title/Abstract]) AND (transfer[Title/Abstract] OR transport[Title/Abstract]	15/04/2020	986	156

OR interhospital[Title/Abstract])) AND (risk[Title/Abstract] OR safety[Title/Abstract]) AND ((fft[Filter]) AND (humans[Filter]) AND (english[Filter]) AND (2005:2023[pdat]))) NOT (vaccine)			
("neonatal transfer" OR "neonatal transport") AND (adverse[Title/Abstract])	15/04/2020	37	1
Total after duplicate removal			132

APPENDIX B: ADVERSE EVENTS AND CATERGORIES IDENTIFIED FROM SCOPING REVIEW

Reference		Location	Study Design	Clinical Event	Equipment Event	Medical Error	Pateint Safety Risk	Quality of Care	Other
Sharma, Ford, Calvert. 2011	Adaptation for life: A review of neonatal physiology	United Kingdom	Educational Article						Normal clinical variables
Ashokcoomar. 2012	An analysis of inter-healthcare facility transfer on neonates within eThekwini	South Africa	Prospective Descriptive Analysis	Hypoxia, hypothermia, acidosis, bradycardia, hypotension, respiration rate changes, hypoglycaemia.	Equipment failure. Tube blockage and dislodgement, IV access loss, loss of O2 supply	Drug errors	Lack of appropriate equipment	Inadeqaute ventilatory and circulation support	Poor communication, lack of appropriate handover
Whyte, Jefferies. 2015	The interfacility transport of critically ill newborns	Canada	Position Statement	Hypthermia, vibration effect			Lack of appropriate equipment	Appropriate team selection	Information gathering and handover
Cavallin et al. 2022	Prognostic role of TOPS in ambulance transferred neonates	Mozambique	Retrospective observational	Hypothermia, hypoxia, hypotension, hypoglycaemia					
Blakeman and Branson. 2013	Inter-and Intra-hospital transport of	USA	Educational Article	Hypothermia, hypoxia, hypotension,	Ventilator Failure (O2 supply failure)	Medication errors.	Airway adverse events	Inadequate ventilatory support	Cardiac Arrest

	the critically ill			bradycardia, tachycardia					
Ramnarayan. 2009	Measuring the performance of an inter-hospital transfer service	United Kingdom	Narrative Review	Hypoxia, resp arrest, aspiration, bradycardia, tachycardia, cardiac arrest; hypothermia, hypoglycaemia	Ventilator Failure; O2 supply failure, lack of monitoring		Tube occlusion, accidental extubation	Loss of intravenous access	
Lim, Rantnavel. 2008.	A prospective review of adverse events during interhospital transfer	United Kingdom	Prospective Review	Acidosis	Ventilator & incubator failure	Removal of O2 support		Delayed intubation	Insufficient handover information
Ros et al. 2020	Evaluation of specific quality metrics to assess performance of a psecialised newborn transport programme	Spain	Retrospective descriptive analysis	Hypothermia, hypotension, hypoxia, hypoglycaemia	Equipment failure, O2 depletion		Tube occlusion, accidental extubation, loss of indwelling lines		Delayed transfer, vehicle breakdown

Vieira et al. 2011	Factors associated with clinical complications during intra-hospital transports in a neonatal unit in Brazil	Brazil	multiple logistic regression analysis	Hypothermia, hyperthermia, bradycardia, tachycardia, hyperoxia, apnoea, hypotension, hypoxia, hypoglycaemia, extubation, tube obstruction, loss of IV access, pH derangement with hypo or hypercapnoea	Equipment failure, O2 depletion			Lack of specialised teams	

APPENDIX C: FIRST-ROUND SURVEY TOOL

	Clinical Parameter / Incident	Include	Exclude
1	**Airway complications:**		
1.1	Unneccessary intubations e.g. neonate on nCPAP is intubated purely for transfer, without clinical indication		
1.2	ETT obstruction (kinking, secretions)		
1.3	Dislodged ETT (accidental extubation)		
1.4	Dislplaced ETT (too deep / too shallow/oesophageal)		
2	**Ventilation complications:**		
2.1	Sustained hypoxia (SpO2 <90%) (excluding cyanotic CHD)		
2.2	Hyperoxia (SpO2 >94% in prem neonates / > 90% in CHD)		
2.3	Bradypnoea / Apnoea		
2.4	Sustained tachypnoea (RR >60)		
2.5	Pneumothorax		
2.6	Respiratory distress without adequate resp support e.g. sternal recessions, where high-flow / CPAP would be indicated		
2.7	Respiratory alkalosis / acidosis due to inappropriate ventilation		
3	**Haemodynamic complications:**		
3.1	Sustained hypotension (MAP < 40 or gestational age)		
3.2	Sustained bradycardia (HR < 100)		
3.3	Sustained tacycardia (HR > 160)		
3.4	Cardiac arrest requiring resuscitation		
4	**Intravenous complications:**		
4.1	Infiltrated / blocked IV lines		
4.2	Lack of IV access when IV therapy is indicated		
4.3	Incorrect type of fluid administered		
4.4	Incorrect fluid administration Rates		
5	**Medication errors:**		
5.1	Dosaging errors (infusion rates or bolus administration)		
5.2	Incorrect medication administered		
5.3	Required medication not administered (e.g Prostin or inotropes)		
5.4	Lack of required sedation and/or analgesia		
6	**General complications:**		
6.1	Hypothermia (T < 36 Celcius) (excluding TTM for HIE)		
6.2	Hyperthermia (T > 37.4 Celcius)		
6.3	Hypoglycaemia (Hgt < 2.6)		
6.4	Equipment failure (ventilator, incubator, monitor etc.)		
6.5	Inexperienced / non-specialised staff / teams		
6.6	Incorrect information from receiving hospital		
6.7	Inadequate handover information r.e initial Rx at referring facility		
6.8	Inadequate O2 supply		
6.9	Omission of life saving interventions (e.g needle thorecenthesis)		
6.10	Inability to blend O2 to achieve lower FiO2		
6.11	Non-humidified O2		
6.12	Inadequate / incorrect equipment		

APPENDIX D: PARTICIPANT INFORMATION SHEET

<Date>

Dear <participant name>

PARTICIPATION IN DEVELOPMENT OF A RETROSPECTIVE NEONATAL CLINICAL AUDIT TOOL THROUGH A MODIFIED DELPHI STUDY.

We are aiming to develop a clinical quality audit tool focused on neonatal patient safety aspects, adverse events and quality of care during inter-facility transport. The aim of this tool would be to have a standardised audit tool according to which patient transport records can be assessed and audited for adverse events, patient safety risks and quality of clinical care. In order to achieve this, I need to determine the most common adverse events, patient safety risks and minimum standards of care that neonatal experts encounter, or consider to be of importance, in the neonatal population during, or immediately after, an interfacility transfer.

I would herewith like to invite you to form part of the expert panel who will participate in the Delphi survey that will be conducted in order to develop this audit tool. You have been selected based on your specific expertise in this field and your participation would be greatly appreciated.

If you consent to partake in the study, it will require of you to follow a link, which will be e-mailed to you, which will take you to the study, and request of you to complete a statement of consent for participation in the study. You will then be required to answer a short survey on neonatal adverse events and patient safety aspects. During the completion of the survey, you will be required to draw on your previous experience, expertise and available data in order to formulate your specialist opinion. You will also be able to suggest additional items to add to the audit tool. The process will be repeated for a minimum of three rounds, in order to design an appropriate clinical audit tool, as well as achieve consensus on the overall contents of the tool. You will then be asked, in a final round, to apply the tool to a small sample of simulated patient transfer records, in order to assess the reliability of the tool in identifying adverse events, patient safety risks and quality of care.

As per Delphi method stipulations, several rounds of comments and opinions may be required via e-mail, with links to SurveyMonkey®, in order to achieve consensus.

Any communication with you will be strictly by the researcher only, and all personal information will be kept confidential. Anonymity will be maintained throughout the study. If you consent to partake in the study, it is requested that you do not divulge your opinions to other participants in the study, if they may be identified through interactions outside of the study.

There are no risks to participation in this study and you will not receive any specific benefits or compensation for your participation. However, the development of the audit tool might benefit your practice and future patients.

You are free to withdraw consent and participation from the study at any point.

This proposal has been reviewed and approved by the Human Research Ethics Committee of the University of Cape Town. The UCT's Faculty of Health Sciences Human Research Ethics Committee can be contacted on 021 406 6338 in case you have any ethical concerns or questions about your rights or welfare as a participant on this research study.

Kind regards,

E-mail: VNTMAR030@myuct.ac.za

Cell: +2782 859 1870

APPENDIX E: ETHICAL APPROVALS

UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee

Room E53-46 Old Main Building
Groote Schuur Hospital
Observatory 7925
Telephone [021] 406 6621
Email: shuretta.thomas@uct.ac.za
Website: www.health.uct.ac.za/fhs/research/humanethics/forms

29 October 2018

HREC REF: 694/2018

Dr W Stassen
Emergency Medicine
F51, OMB

Dear Dr Stassen

PROJECT TITLE: DEVELOPMENT OF A RESTROSPECTIVE NEONATAL CLINICAL AUDIT TOOL THROUGH A MODIFIED DELPHI STUDY (MSc Candidate - Miss M. Venter)

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

Approval is granted for one year until the 30 October 2019.

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.
(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

Please quote the HREC REF in all your correspondence.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please note that for all studies approved by the HREC, the principal investigator **must** obtain appropriate institutional approval, where necessary, before the research may occur.

The HREC acknowledge that the student, Ms Maryna Venter will also be involved in this study.

Yours sincerely

Signed by candidate

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE
Federal Wide Assurance Number: FWA00001637.
Institutional Review Board (IRB) number: IRB00001938
This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical

UNIVERSITY OF CAPE TOWN

FACULTY OF HEALTH SCIENCES
Human Research Ethics Committee

FHS016: Annual Progress Report / Renewal

HREC office use only (FWA00001637; IRB00001938) This serves as notification of annual approval, including any documentation described below.			
☑ Approved	Annual progress report	Approved until/next renewal date	30/04/2024
☐ Not approved	See attached comments		
Signature Chairperson of the HREC/ Designee	Signed by candidate	Date Signed	24/4/2023

HUMAN RESEARCH ETHICS COMMITTEE
24 APR 2023
HEALTH SCIENCES FACULTY
UNIVERSITY OF CAPE TOWN

Note: Please email this form and supporting documents (if applicable) in a combined pdf-file to hrec-enquiries@uct.ac.za.
Please clarify your plan for research-related activities during COVID-19 lockdown.
Please use the latest form found on our website:
http://www.health.uct.ac.za/fhs/research/humanethics/forms

Comments to PI from the HREC

Principal Investigator to complete the following:

1. Protocol information

Date (when submitting this form)	20/04/2023		
HREC REF Number	694/2018	Current Ethics Approval was granted until	30/04/2023
Protocol title	Development of a retrospective neonatal clinical audit tool through a modified Delphi study		
Protocol number (if applicable)	n/a		
Are there any sub-studies linked to this study?		☐ Yes	✓ No
If yes, could you please provide the HREC Reference number for all sub-studies? **Note:** A separate FHS016 must be submitted for each sub-study.			
Principal Investigator	Dr Willem Stassen		
Department / Office Internal Mail Address	Div EM, F51, OMB		

(Note: Please complete the Closure form (FHS010) if the study is completed within the approval period)