NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

DEVELOPING CLINICAL CRITERIA FOR AEROMEDICAL INTER-FACILITY TRANSFERS OF ADULT TRAUMA PATIENTS IN NAMIBIA

By

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Thesis presented in fulfilment of the requirements for the degree of Master of Health Sciences, Faculty of Health and Applied Sciences, Namibia University of Science and Technology, Windhoek, Namibia

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DECLARATION

I, Salome Veldskoen, hereby declare that the work contained in the thesis titled **"Developing Clinical Criteria for Aeromedical Inter-Facility Transfers of Adult Trauma Patients in Namibia"** is my own original work and that I have not previously, in its entirety or in part, submitted it at any university or other higher education institution for the award of a degree.

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DISCLOSURE OF GENERATIVE ARTIFICIAL INTELLIGENCE USE

The researcher used Grammarly to enhance the writing quality during the revision process. Additionally, the researcher utilised Perplexity to search for relevant literature while revising the thesis. After using these tools, the researcher wrote, reviewed, edited and took full responsibility for the finalisation of this thesis.

ABSTRACT

Introduction: Trauma is a major contributor to morbidity and mortality in Namibia. The country's vast distances, centralised specialist care and constrained resources make aeromedical Interfacility Transfers (IFTs) essential for timely access to definitive trauma care. There are, however, no standardised clinical criteria to guide practitioners with decision-making regarding the initiation of aeromedical IFT for adult trauma patients.

This study aimed to develop context-specific clinical criteria for aeromedical IFT of adult trauma patients in Namibia using a systematic, consensus-based approach driven by evidence. The specific objectives were to conduct a comprehensive scoping review of literature on aeromedical IFTs of adult trauma patients to develop a clinical criteria framework to elicit expert opinion, to utilise expert opinion to obtain consensus on the components of the clinical criteria and to construct clinical criteria for aeromedical IFTs in Namibia for distribution to relevant stakeholders to implement.

Methods: A scoping review of literature was conducted to elicit a framework of clinical criteria relevant to aeromedical IFTs of adult trauma patients. This framework was further refined through the stewardship of an appointed steering committee (SC). The SC completed a pilot survey to further refine the framework. The next phase of the study was informed by the framework and involved a structured consensus-building process through a modified Delphi, which entailed anonymous voting on criteria using a Likert Scale, receiving feedback on results from previous rounds and further consideration of subsequent rounds. Expert Panellists (EPs) opinions were elicited throughout the Delphi rounds to establish consensus on essential clinical criteria for the consideration of aeromedical IFTs of adult trauma patients in the Namibian setting. The final phase utilised the consensus-derived criteria to construct a Clinical Decision Support Tool (CDST), suggested for evaluation, validation, and then implementation into the National Referral Policy to support consistent, evidence-based decision making for aeromedical IFTs of adult trauma patients in Namibia.

Results: The scoping review identified eight thematic areas from a broad scope of literature. Regional dominance was noted in the literature, with most studies originating from developed countries, particularly the United States of America, albeit being retrospective studies. The Steering Committee members were from both the public and private sectors, in-hospital and prehospital settings, ensuring a balanced representation whilst ensuring contextual relevance. There were two Delphi rounds conducted: expert participation dropped from 29 in the first round to 14 in the second round. However, consensus on 28 out of 32 clinical criteria statements was achieved. The consensus-based clinical criteria informed the final CDST, thus reflecting locally adapted, evidence-based clinical criteria for aeromedical IFT of adult trauma patients in Namibia.

Conclusions and Recommendations: The study demonstrates the structured, sequential phase approach of integrating evidence synthesis and expert consensus as effective in standardised clinical criteria development for aeromedical IFTs of adult trauma patients in a setting with limited resources. The CDST offers a practical context-specific decision tool aimed at improving decision-making consistency, optimising aeromedical resources and timely access to the advanced Namibian trauma care system. It is recommended that the CDST be evaluated for suitability and, thereafter, considered for adoption into the National Referral Policy and emergency frameworks in both the public and private sectors, under the tutelage of the Ministry of Health and Social Services. Prospective studies are, however, needed to confirm the validity of the CDST in real-world practice, evaluating its efficiency and direct impact on patient outcomes. Continuous refinement of the CDST is essential in the evolving Namibian trauma care system.

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DEFINITION OF TERMS

Advanced Life Support Paramedic: A prehospital emergency care practitioner who uses more sophisticated clinical skills to manage a patient (Jansson et al., 2021).

Aeromedical: The practice of aviation medicine relating to flight physiology, age, illness of the patient and environmental factors (Loyd et al., 2024).

Clinical criteria: Clinical criteria include common and relevant signs and symptoms of a disease, which either individually or in combination constitute a clear or indicative clinical picture of the disease (Russell, 2020).

Clinical decision support tools: Includes a variety of tools and interventions, computerised as well as non-computerised, intended to improve healthcare delivery by enhancing medical decisions with targeted clinical knowledge, patient information, and other health information (Sutton et al., 2020).

Definitive care: Refer to the advanced medical treatment a patient receives from specialists at hospitals and larger facilities, which results in the resolution of the condition (Kornelsen et al., 2016).

Delphi method: A group-based process to elicit the opinions of experts, considering anonymity, iterative data collection, feedback and statistical analysis (Barrett & Heale, 2020).

Interfacility transfer: The movement of patients from one health facility to another. For higher care or step-down care, speciality care or definitive care (Firstenberg et al., 2017).

Level I trauma centre: A tertiary care hospital that provides comprehensive care from initial injury through rehabilitation. The requirements for this kind of facility include teaching and research on trauma management (Southern & Celik, 2025).

Level II trauma centre: Provides initial treatment for all trauma cases, with the ability to stabilise and transfer patients requiring more specialised care. Requirements for such facilities include 24-hour access to general surgeons (Southern & Celik, 2025).

Level III trauma centre: Provides prompt assessment, management, surgery, and stabilisation for patients with traumatic injuries. Key components include 24-hour access to emergency physicians (Southern & Celik, 2025).

Level IV trauma centre: Delivers Advanced Trauma Life Support (ATLS) before transferring patients to a higher level of care. Requirements for these centres include an emergency department capable of implementing ATLS protocols (Southern & Celik, 2025).

Trauma V trauma centre: Provides initial evaluation, stabilisation, and transfer coordination for patients needing advanced care. Essential components include transfer agreements to ensure timely access to higher-level trauma care (Southern & Celik, 2025).

Mechanism of injury: The manner in which a patient sustained physical injury. It also describes how, with what force and to which part(s) of the body the force was applied (Dumovich. & Singh, 2022).

Prehospital emergency care: A medical subspecialty that concentrates on the emergency medical care of patients before they reach the hospital or during a hospital transfer (Access & Medicine, 2023).

Return of spontaneous circulation: It is the return of a sustained perfusing heart rhythm post-cardiac arrest (Lian et al., 2022).

Trauma systems: Organised and coordinated efforts in a geographical area to deliver trauma health services (Mwandri & Metcalfe, 2025).

ABBREVIATIONS/ACRONYMS

AEMS:	Aeromedical EMS
AIS:	Abbreviated Injury Scale
ALS:	Advanced Life Support
ANZCA:	Australian and New Zealand College of Anaesthetists
ATLS:	Advanced Trauma Life Support
BLS:	Basic Life Support
CCATT	Critical Care Air Transport for Aeromedical Transport Teams
CCN:	Critical Care Nurse
CDST:	Clinical Decision Support Tool
CHBC:	Community Health-Based Care
CPR:	Cardiopulmonary Resuscitation
CINAHL:	Cumulative Index to Nursing and Allied Health Literature
DMV:	Domestic Violence
DVT:	Deep Vein Thrombosis
EC:	Emergency Care
ECPs:	Emergency Care Practitioners
ED:	Emergency Department
EMC:	Emergency Medical Care
EMS:	Emergency Medical Services
EP:	Expert Panel
EPs:	Expert Panellists
GAP:	Glasgow Coma Scale, Age, Pressure
GBD:	Global Burden of Disease
GCS:	Glasgow Coma Scale
ICP:	Intracranial Pressure
ICU:	Intensive Care Unit
IHO:	Intermediate Hospital Onandjokwe
IHR:	Intermediate Hospital Rundu
IFTs:	Inter-facility transfers
IHSH:	Intermediate Hospital Oshakati
IITT:	WHO Integrated Triage Tool
ILS:	Intermediate Life Support

IKH:	Intermediate Hospital Katutura
ISS:	Injury Severity Score
JBI:	Joanna Briggs Institution
HDC:	Higher Degrees Committee
HEMS:	Helicopter Emergency Medical Services
HPCNA:	Health Professions Council of Namibia
KDH:	Khorixas District Hospital
LMICs	Low and Middle-Income Countries
MOI:	Mechanism of Injury
MO:	Medical Officer
MoHSS:	Ministry of Health and Social Services
MSF:	Médecins Sans Frontières
MVA:	Motor Vehicle Accident
NAMPOL:	Namibian Police Force
NHS:	National Health Service
NSA:	Namibian Statistics Agency
NUST:	Namibia University of Science and Technology
PCC:	Population, Concept and Context
PEC:	Prehospital Emergency Care
PHC:	Primary Health Care
RCTs:	Randomised Control Trials
ROSC:	Return of Spontaneous Circulation
RR:	Respiratory Rate
RTA:	Road Traffic Accidents
RTS	Revised Trauma Score
SATS:	South African Triage Scale
SBP:	Systolic Blood Pressure
SC:	Steering Committee
SDG:	Sustainable Development Goal
SOE:	State Owned Enterprise
TBIs:	Traumatic Brain Injuries
TS:	Trauma Score
UK:	United Kingdom

UMIC:	Upper Middle-Income Country
UN:	United Nations
UNFPA:	United Nations Population Fund
USA:	United States of America
WHO:	World Health Organisation

CHAPTER 1: INTRODUCTION

1.1 Background

Trauma-related injuries or mortality present a great challenge to the global health community, and even more so in Low and Middle-Income Countries (LMICs) (World Health Organisation [WHO], 2021). The aetiology of trauma varies, with Road Traffic Accidents (RTAs), interpersonal violence, suicide and falls being part of the leading causes of trauma (WHO, 2024).

Africa has the highest rate of RTA deaths per 100,000 population (26.6 per 100,000), followed by the Eastern Mediterranean with 18 per 100,000 (Lagarde, 2007). Additionally, the top ten countries with the highest RTA rates are in Africa (World Health Rankings, 2022). Interpersonal violence varies widely across the region and is based on geographical location and socio-economic factors. In a retrospective study from a level 1 trauma centre in a Middle Eastern country, the leading cause of trauma was interpersonal violence, with 76.7% by either penetrating or blunt force trauma, with many patients requiring intubation (Mollazehi et al., 2020). A systematic analysis for the Global Burden of Disease (GBD) on global, regional and national burden of suicide from 1990-2021, found 746,000 deaths by suicide in 2021. Regionally, Eastern Europe recorded the highest number of deaths by suicide (19.2 deaths per 100,000), followed by Southern sub-Saharan Africa (16.1 deaths per 100,000) and Central sub-Saharan Africa (14.4 deaths per 100,000). The average ages of deaths by suicide amongst males and females were 47 years and 46.9 years, respectively, in 2021 (Weaver et al., 2025). This reflects a markedly disproportionate trauma burden in Africa relative to other regions globally (Adeloye et al., 2016). The trauma burden of disease is further compounded by a lack of infrastructure, limited access to emergency services, and insufficient local clinical guidelines to address patient needs, particularly in LMICs (Muhango et al., 2025).

Namibia is an LMIC and one of the most sparsely populated countries in Africa and the world (World Bank, 2025). The 2017 report on death and mortality from the Namibian Statistics Agency (NSA) reported that trauma-related injuries were the major cause of non-communicable deaths in the country. Road traffic accidents were responsible for 76.4% (n=575) of trauma-related deaths in 2016 and 73% (n=473) in 2017. Assault with a sharp object was second with 9.1%, drowning submersion with undetermined intent was in third place with 6.8% and discharge from unspecified firearms with 5.1% in fourth place. These trends were common in adult patients between 25 and 39 years of age. In 2019, the World Health Organisation (WHO) estimated the RTA death rate per 100,000 population in Namibia to be 34.81, higher than the overall estimated RTA death rate for Africa (26.6 deaths per 100,000) (WHO, 2022).

A 2016 report from the United Nations Population Fund (UNFPA) supports the emphasis on interpersonal trauma deeply entrenched in the Namibian society, with results from the Namibia Demographic Health Survey (2013) finding that 35% of women aged between 20 and 24 experienced some form of physical violence from an intimate partner. The same UNFPA report shared that between 2012 and 2016, the Namibian Police indicated that the highest causes of trauma were assault with grievous bodily harm secondary to interpersonal violence (22,174 reported cases), common assault (18,054 reported cases), rape (2839 reported cases), attempted murder (1138 reported cases) and murder (734 reported cases).

Alcohol-related trauma injuries in Namibia have also been a growing concern. A descriptive retrospective study investigating the prevalence and profile of injuries in the Khorixas District Hospital (KDH) in Namibia by Oyefeso et al. (2011) indicated that 36% of the 331 injury cases seen at the hospital between January 2001 and December 2004 were alcohol-related trauma. Low-Middle-Income Countries are faced with additional infrastructural and health policy-related challenges, limiting their effective response and management of trauma-related injuries (Whitaker et al., 2019). To mitigate the growing trauma burden of disease, effective trauma systems need to be in place, particularly in LMICs. Trunkey (2000) describes trauma systems as organised and coordinated efforts in a geographical area to deliver trauma health services. Key components of a trauma system include Emergency Care (EC) activation, acute medical care and rehabilitation (Stewart et al., 2019).

Prehospital Emergency Care (PEC), provided by Emergency Medical Services (EMS), serves as a bridge between the scene of an emergency and facility-based emergency care. Additionally, EMS has an expanded function of transporting patients between healthcare facilities via ground or air for definitive care. Aeromedical Inter-Facility Transfers (IFTs) is a unique and dynamic mode of delivery of health care through the transportation of a sick or injured person by a helicopter (rotor wing) or aeroplane (fixed wing) from a remote area or an area without the necessary medical facilities or skills to a more suitable area (Loyd et al., 2022; Posselt et al., 2018).

Aeromedical evacuation finds its roots in the military, where the army used helicopters to evacuate the injured from the battlefield (Araiza et al., 2018). The concept of utilising air ambulances to deliver trauma health care to soldiers in combat stems from a known quote by Dr Dominique Larrey, a surgeon of Napoleon during his 1812 invasion of Mentz, Germany. Dr Larrey stated, *"Previous to my departure from the capital, I organised six divisions of flying ambulances, each one consisting of eight surgeons. The surgeons major exercised their divisions daily, according to my instructions, in the performance of operations, and the application of bandages. The greatest degree of emulation, and the strictest discipline, were prevalent among all the surgeons"* (Trunkey, 2000). Dr Larrey's statement of 'flying ambulances" referred to horse-drawn wagons designed to swiftly transport injured soldiers from the battlefield. Modern-day aeromedical evacuation systems embody Dr Larrey's principles of rapid response and specialised surgical care in response to trauma (Trunkey, 2000).

A successful and efficient aeromedical IFT depends on a multisectoral team of highly skilled professionals spanning from in-hospital staff, i.e., medical doctors and nurses, to prehospital medical personnel, i.e., paramedics, and the supporting aviation crew, i.e., pilots, air traffic controllers and immigration control (Masterson et al., 2020). The emergent nature of aeromedical IFTs requires medical practitioners to make quick clinical decisions that are time and place-sensitive surrounding a patient's clinical presentation, thus affecting the quality of care (Prabowo & Reksoprodjo, 2019).

The health system of Namibia is divided into two sectors: the private sector, catering for 18% of the population through private healthcare offered by medical aid schemes or cash payments. The private health sector in Namibia offers access to specialised care, access to private health facilities and in some instances the benefit of shorter waiting times. The remaining 82% of the Namibian population depends on the public health sector. The Ministry of Health and Social Services (MoHSS) governs the public health sector and is responsible for policy making, maintenance of public health facilities and the overall service delivery to the patients in the public health sector for their medical care (Christians, 2020). The private and public health sector highlights socioeconomic differences in Namibia, as the private health sector provides specialised private care to a smaller part of the population, the public sector caters for a larger population and is often plagued with overcrowded health facilities, staff shortages, leading to an imbalance of health practitioner and patient ratios (Christians, 2020).

The Namibian National Referral Policy Guideline, aimed at the public (government) healthcare system, outlines the core of patient referrals, which is for one healthcare facility to assume clinical responsibility for the patient's care. Community Health-Based Care (CHBC) establishments in the Namibian setting act as connection points between the public and the healthcare establishments by recognising the patient's need for referral and thus expediting this process from the public's stance (Ministry of Health and Social Services [MoHSS], 2015).

The Namibian referral system exists between three (3) main domains of healthcare delivery, i.e., primary, secondary, and tertiary levels (Petersen & Gaylard, 2019). Depending on the patient's clinical presentation, MoHSS, in the national referral policy for public facilities, has five (5) criteria for escalating referrals. Level 1 comprises clinics (first-line health institutions) serving to prevent, promote, rehabilitate, and perform basic curative services. Health Centres are the second level, performing similar functions as clinics with the addition of supervisory responsibilities of the CBHC entities and the added senior staff complement of Medical Officers (MO) to perform simple invasive procedures. The third level is district hospitals, staffed by MOs, nurses, and

PEC personnel referred to as Emergency Care Practitioners (ECPs). District hospitals also attend to general surgical procedures and manage patients with acute and chronic conditions, e.g., breast biopsies, asthma management, etc. With only four (4) intermediate hospitals in Namibia at present, the 4th level of referral is predominantly situated in the central and northern parts of Namibia, i.e., Intermediate Hospital Katutura (IHK) in Khomas region (Windhoek), Intermediate Hospital Oshakati (IHSH) in Oshana region (Oshakati), Intermediate Hospital Rundu (IHR) in Kavango East region (Rundu) and Intermediate Hospital Onandjokwe (IHO) in Oshikoto region (Oniipa) (Figure 1.1).

Figure 1.1: Map of Intermediate Hospitals across Namibia
(Worldometer - https://www.worldometers.info/maps/namibia-road-map/)

The intermediate hospitals function as training hospitals. They conduct operational research and attend to complicated gynaecological, paediatric and surgical or trauma cases, to name a few. The national referral hospital (Level 5) in Namibia, i.e. Windhoek Central Hospital, located in Khomas Region (Windhoek), is the apex of the country's government-managed health facilities and can handle all referral cases not manageable by the other intermediate hospitals. The national referral hospital is highly specialised, with nursing staff, doctors, and ECPs. It also contains the best state diagnostic and therapeutic facilities and oversees the annual review of the referral system (MoHSS, 2015).

The Namibian National Referral Policy Guideline indicates that emergency referrals are to be made from one clinician to another clinician. It also does not require that the patient be booked for an ambulance or patient bus, as the referring clinician decides the method of transport. In the guidelines, the reference to transport only indicates the use of patient buses, with nurses accompanying patients who are clinically stable enough to sit. The second transport mode referenced is ambulance staffed by ECPs and nurses. There is, however, no reference made in the referral guideline about the utilisation of aeromedical transportation for patients requiring IFT from one facility to another in Namibia (MoHSS, 2015).

Aeromedical IFTs are costly and time-sensitive and thus require great accuracy during clinical decisions (Gerecht, 2014). A survey done between 2013 and 2014 to ascertain the operational functionality of EMS in Africa concluded that only a minority of African countries (9%) have appropriate EMS coverage and that most of the systems were either government-operated or fee-for-service operated (Mould-Millman et al., 2017).

Aeromedical IFTs of adult trauma patients in the Namibian setting are performed by a selected number of emergency services that provide aeromedical IFT care. Because of the high costs associated with aeromedical services, most of the emergency services utilise aeromedical IFT service providers from the same resource pool. There are very strict criteria in place to be accredited as an aeromedical IFT service provider, which has also limited the number of service providers.

1.2 Problem statement

Namibia does not have any standard clinical criteria in the Namibian National Referral Policy Guideline to guide practitioners to request aeromedical IFTs. According to Pule et al. (2022), there is a paucity of international clinical criteria for aeromedical IFTs of adult trauma patients, and those available are not specific to the African setting. This can therefore lead to disparity in the activation of aeromedical IFTs for private and state patients. In addition, there is currently no nationalised emergency call centre number, which affects those patients in the remote and rural areas who predominantly depend on the government's provision of ambulance transport.

Aeromedical IFTs serve as a link to definitive care, particularly for trauma patients who often require urgent treatment such as surgical intervention, radiological examination, etc. and thus having specific criteria to guide clinical decision-making in terms of the request for aeromedical IFTs may improve patient outcomes (Walrath & Herbal, 2016). Laatz (2018) advocate that a lack of appropriate clinical criteria for aeromedical transfers of patients can lead to large subjective elements and practitioner biases toward patients. Misallocating this resource can greatly disadvantage the health system. Developing clinical criteria requires input from medical practitioners with the necessary exposure and experience to utilise their decision-making knowledge effectively (Mould-Millman et al., 2015). The development of clinical criteria should be in line with local, regional, and international health and aeromedical protocols, but relevant to the Namibian setting.

Context-specific clinical criteria are important as the challenges faced in the Namibian setting can affect the policies and procedures which will govern the development of aeromedical IFTs of adult trauma patients. Context-specific clinical criteria will also ensure that the patients get rapid evacuation over long distances, overcoming the often-difficult Namibian terrain, especially for patients in remote areas, drastically reducing transfer times. Currently, aeromedical IFTs in Namibia are only facilitated via fixed-wing aircraft. Most of the aviation companies licensed to conduct aeromedical transfers have configured fixed-wing aircraft. In the Namibian context, with vast distances between facilities in different regions and the speed often required to transfer patients from one facility to the next, fixed-wing aircraft are deemed more suitable; thus, the clinical criteria considerations are primarily looking at fixed-wing aircraft.

1.3 Research questions

The research was underpinned by the research questions below, which sought to explore current evidence and establish consensus clinical criteria for aeromedical IFTs in Namibia.

1. What is known from the existing literature about clinical criteria for the aeromedical IFTs of adult trauma patients?
2. How can clinical criteria for the aeromedical IFTs of adult trauma patients in Namibia be established?
3. What clinical criteria will best facilitate the utilisation of aeromedical IFTs of adult trauma patients in Namibia?

1.4 Aim and objectives

1.4.1 Research aim

The aim of this study was to utilise the perceptions of an expert panel critically and systematically to develop standard clinical criteria for aeromedical IFTs of adult (≥18 years) trauma patients in Namibia.

1.4.2 Research objectives

To achieve this aim, the specific study objectives were:

1. To conduct a comprehensive scoping review of literature on aeromedical IFTs of adult trauma patients to inform the development of a clinical criteria framework to elicit expert opinion.
2. To utilise expert opinion to obtain consensus on the components of the clinical criteria for aeromedical IFTs of trauma patients in Namibia.
3. To construct clinical criteria for aeromedical IFTs in Namibia for distribution to relevant stakeholders to implement.

1.5 Research significance

Currently, there are no laws in Namibia regulating aeromedical IFTs. The only commonality between government-coordinated aeromedical IFTs and the private sector is the financing of the IFTs and the available service providers. Most private patients who have medical aid plans are insured for aeromedical IFTs. The government does not offer this as an option to patients but rather requests “mercy flights” or emergency aeromedical IFTs through the Motor Vehicle Accident (MVA) Fund of Namibia, which is a State-Owned Enterprise (SOE) or requests special clearance through the office of the Executive Director of Health in the MoHSS (Silverman, 2015). This leads to great disparity in patient management and utilisation of a limited resource in patients with traumatic injuries, particularly secondary to RTAs. Privately owned aviation companies and prehospital service providers thus charge for aeromedical IFTs at liberty. Hence, the importance of developing standardised clinical criteria for aeromedical IFTs of adult trauma patients in Namibia. Standardised clinical criteria for aeromedical IFTs in Namibia will aid in the maturation of a more developed trauma system.

Trauma centres are important because they determine the level of care available for patients with various injuries and provide life-saving treatment. Namibia lacks level I trauma centres; thus, developing IFT criteria is a step towards developing standardisation of care, timely response and the appropriate allocation of resources. Private healthcare establishments, including medical aid companies, can use the data from this study to develop aeromedical IFT-specific benefits for their clientele. Moreover, this study may increase the quality and equality of care provided to patients by implementing Sustainable Development Goal (SDG) 10, which aims to reduce inequalities, including access to healthcare.

1.6 Thesis layout

This thesis follows a traditional structure, beginning with Chapter One, which provides background information on aeromedical IFTs, the Namibian setting and current clinical criteria utilised for patient referrals.

It highlights the research problem, i.e., Namibia in its current patient referral system lacks clinical criteria to guide health practitioners when referring a patient via aeromedical IFTs.

Chapter Two discusses a broad review of relevant literature focusing on clinical criteria for aeromedical IFT of adult trauma patients in Namibia.

Chapter Three outlines the study's methodology, a quantitative descriptive research design that describes how the research was conducted, particularly to answer the research questions.

Chapter Four presents the study results and reflects the multi-phase design, which generated quantitative data comprising both ordinal and nominal variables.

In Chapter Five, the study findings are interpreted and discussed in relation to the research questions, while being anchored in the context of existing literature. Furthermore, several implications of the study are explored to demonstrate the contribution to filling the identified knowledge gap, particularly within the Namibian context. It also articulates the study's contributions to the body of knowledge.

Finally, Chapter Six summarises the main findings of this study on the development of the clinical criteria for aeromedical IFTs of adult trauma patients in Namibia. Lastly, this chapter outlines future research and identifies noteworthy trends in the field. Hereafter, the references for this study are detailed, and the appropriate appendices are attached. This layout ensures a coherent flow throughout the thesis and serves as a roadmap for readers.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The literature review aims to analyse the existing literature on clinical criteria for aeromedical IFTs of adult trauma patients. This allows for a comprehensive understanding of the body of knowledge. The review aims to contextualise the study within the body of knowledge and to identify the best methodological approach to refine key aspects. The research questions guided the scope of the literature review. An exhaustive coverage of the literature was conducted, which allowed for a comprehensive knowledge base of the literature.

The electronic databases UpToDate, PubMed Central (PMC), MEDLINE, CINAHL, Cochrane Library and EMBASE, though not exclusively, were searched. Google Scholar and other health sciences databases for grey/unpublished literature (reports, conference papers, dissertations, bibliography and any other unpublished work), such as the Sigma Repository, OpenDOAR and ProQuest, were also searched for the appropriate literature.

A set of predetermined search rules was established, screening for articles which included “aeromedical transfer”,” clinical criteria” and “adult trauma patients.” Articles which did not contain any of the search terms or had terms focusing particularly on “paediatrics or infants” were excluded. This was established based on the study population, which focused on “adults”.

A total of 45 articles were identified and used for this literature review on 2 March 2023. The identified articles were assessed for quality, reviewing sources, dates of publication, and study populations. Further analysis was carried out to extract and synthesise the appropriate data, capturing key study details such as the study aim, objectives, methodology and findings. An updated search was conducted on 30 November 2025 with some modifications to the search rules. The updated search was customised to only include articles published between March 2023 and November 2025. This was due to a two-year delay in the completion of this study. An additional 10 articles were identified in the 2025 updated search, bringing the total number of included studies up to 55 articles (Figure 2.1).

Numerous sources of this literature review indicate the benefits of aeromedical IFTs, particularly the time-saving benefit, but also the benefits of expert care provided to adult trauma patients during aeromedical IFTs. However, much of the literature is based on retrospective studies with no randomised control trials specific to clinical criteria for aeromedical IFTs of adult trauma patients. The literature was synthesised under the following themes: burden of trauma in adults, benefits of aeromedical IFTs, importance of clinical criteria and recommended clinical criteria for aeromedical IFTs of adult trauma patients. This literature review finally aimed to identify gaps in the literature for future research.

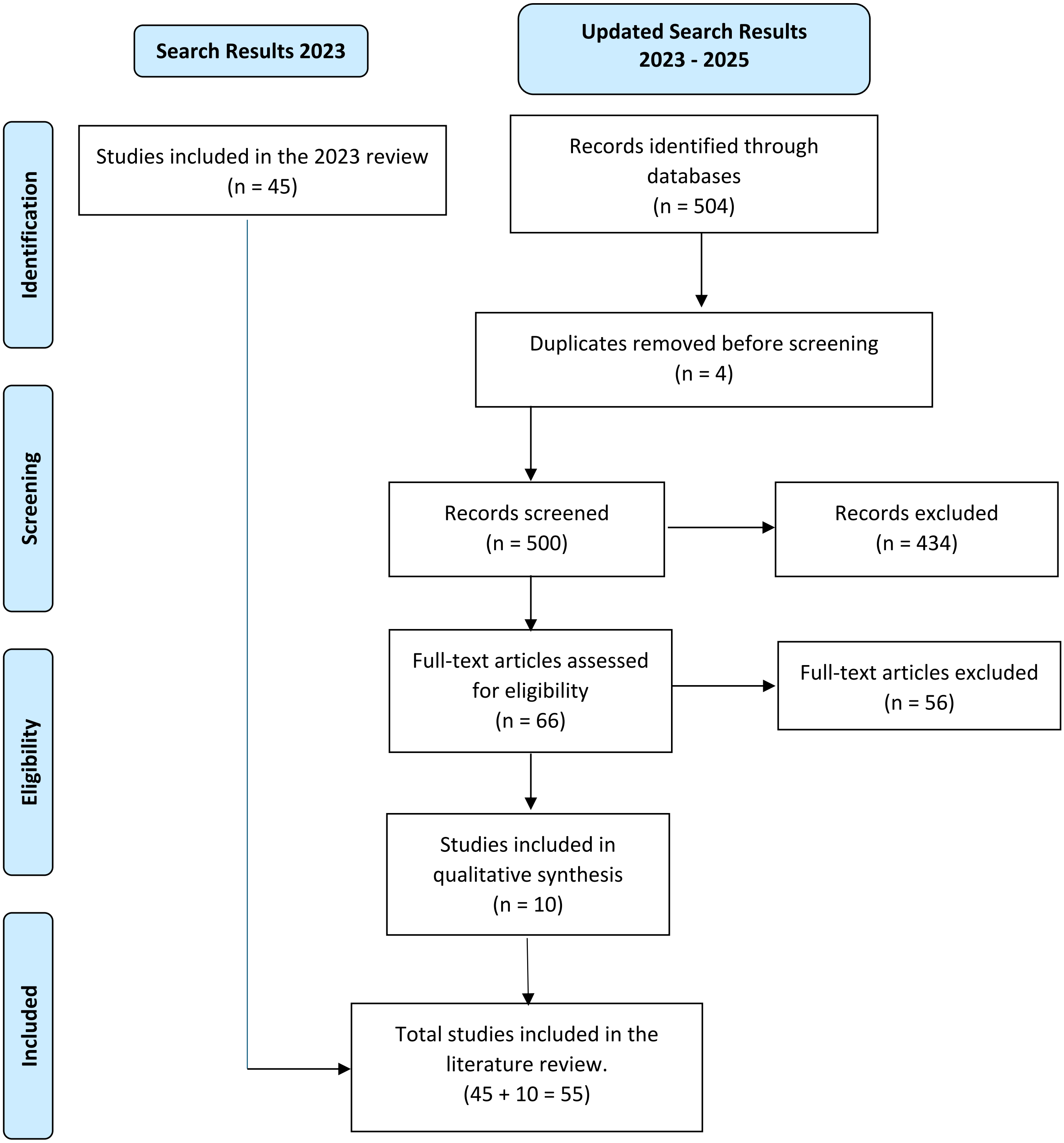


Figure 2.1 PRISMA Flow Diagram of Updated Literature Review

2.2 Burden of trauma in adults

Physical trauma can be defined as an injury inflicted on the body tissue by an extrinsic factor. It is the sixth leading cause of death worldwide and is proving to be a formidable global burden of disease (Kostiuk & Burns, 2022). Fatovich et al. (2011) in a retrospective study in Perth, Australia, found that the leading cause of trauma-related incidents was RTAs. The study also found that the age group of patients mainly treated for trauma-related injuries were adult patients with an average age of 34 years, and that trauma patients treated in very remote areas were 87% more likely to die from their trauma-related injuries. Like the Namibian setting, specialised medical facilities were in more densely populated regions, and therefore, extended transport times negatively affected the outcomes of trauma patients, as time-sensitive invasive clinical procedures such as craniotomies, which are used as an emergency treatment for patients with cerebral oedema due to a cerebral injury, were delayed (Koome et al., 2020). In the study, a comparison was drawn between the patients' outcomes and every 1000 km travelled, flown, and driven. The results indicated that patient mortality increased with excessive distance travelled; thus, aeromedical IFTs were recommended in contrast to ground ambulances for trauma patients requiring emergent medical interventions. There were limitations to the study as there was not sufficient investigation done to determine what complications patients developed who were transported by aeromedical IFTs in comparison to those transported by ground ambulances, as trauma patients' physiology can be affected by altitude (Fatovich et al., 2011).

A retrospective study performed by DuBois et al. (2021), in Wisconsin, United States of America (USA), found that 25% of the patients seen in the Emergency Department (ED) were adult patients who sustained trauma-related injuries due to RTAs, falls and industrial-related accidents. This study identified that most of the RTAs took place in rural areas or areas with level IV trauma centres (trauma centres providing only Advanced Trauma Life Support (ATLS), with physicians assessing the patient before transferring the patient to a facility with higher care). A level V trauma centre can provide initial patient assessment and treatment but is always prepared to send severe trauma patients to facilities that could provide a higher level of care and cannot engage in quality assurance and health information outreach programmes c

In a systematic review, outcomes of adult trauma patients treated in rural versus urban centres were compared. Rural trauma centres are at greater mortality risks for patients compared to urban level I/II centres because of extended out-of-hospital stays, despite clinical instability, under triage, restricted access to specialists, and lower volumes; however, with efficient transfer procedures, adjusted survival can match urban outcomes. The data focused on geriatrics or older adult patients >65 years residing in rural areas or underdeveloped regions in Canada, Australia, the USA and Norway, where facilities are limited and trauma-related injuries increased. Key findings from Khodarahmi et al., (2025) indicated minimal differences in inpatient mortality rates, suggesting effective care in both settings. The results show that urban centres had longer lengths of stay (1-3 days) and higher ICU admission rates (3%-15%) compared to rural centres, likely due to more complex trauma cases. The review highlights the need for resource allocation and support for rural trauma care, including aeromedical transfer considerations, while recognising the critical role of urban centres in managing severe injuries.

A retrospective cohort study done on the Irish HEMS missions between 2013 and 2023 like Khodarahmi et al. (2025), also focused on geriatric patients >65 years of age. Ireland is a developed country with an ageing population, according to the latest results from the Irish Longitudinal Study on Ageing (Scarelett et al., 2025). With a primary focus on the special population of geriatrics or older adult patients >65 years, with a median age of 74. Geriatrics have diverse clinical histories with considerations given to frailty, polypharmacy, which can complicate prehospital assessments and triage scores. The study emphasised the frequency of aeromedical IFTs as 32.2% from rural settings. Road traffic collisions were identified to contribute to the leading cause of trauma, with approximately 24% of the transported patients being referred to specialised centres. Results further highlighted the challenges related to complex clinical profiles of older adults, including frailty and polypharmacy, which complicate prehospital assessment and triage. The overall findings of the study echo the pivotal role of aeromedical IFT in facilitating timely access to emergency and specialised care for emphasising the need for geriatric and older population triage protocols and strategic service planning to meet the evolving demographic needs.

Fedor et al. (2018) conducted a study on major trauma incidents occurring outside trauma centres in the prehospital setting and evaluated these cases as they presented through the ED. Their research highlighted retrieval considerations for major trauma incidents, noting that major trauma patients often require aeromedical IFTs to a level I trauma centre. Level I centres are tertiary hospitals, with all-round care for trauma patients from injury through to rehabilitation. Patients may also require Level II trauma centres, which can initiate treatment and are accessible 24/7 for more effective injury management. Fedor et al. (2018) further identified aeromedical IFTs as a vital access point into the trauma care system and thus an integral part of holistic trauma patient management. The study also showed that it is easier to activate air ambulances from Level I and Level II trauma centres, as their infrastructure is designed in such a manner that they have helipads or well-maintained airstrips at the hospitals.

Tsuchiya et al. (2016) in a Japanese nationwide retrospective cohort study compared adult trauma patients with an Injury Severity Score (ISS) of more than 16 (major trauma) transported by ground ambulances versus aeromedical IFTs for mortality. The ISS is a tool used to calculate the severity of multiple injuries to the human body (ratings 1-75) by squaring three scores obtained from the Abbreviated Injury Scale (AIS), an anatomically based injury severity scoring system that rates injury to each part of the human body on a 1-6 scale (Li & Ma, 2021). An ISS of 1-8 (minor), 9-15 (moderate), 16-24 (severe) and 25 and above are very severe (Dehouche, 2022). Of the 21,286 eligible cases, 4128 patients were transported using aeromedical care. The injury profile of the patients was as follows: severe chest injuries, pelvic fractures, and injury to extremities, with 32.6% of the patients presenting with head injuries, 31.3% with abdominal trauma and 22.2% with facial trauma. The study identified trauma in adults as a major factor, but it also indicated that the nature of injuries that the patients presented with, in contrast to the surrounding medical facilities, required aeromedical IFTs, again highlighting the complementary relationship between trauma care and aeromedical IFTs (Tsuchiya et al., 2016).

Ambunda and Lourens (2022), in a retrospective descriptive observational study, identified Traumatic Brain Injuries (TBIs) as a leading cause of morbidity in patients involved in RTAs in Namibia. The patients who met the inclusion criteria for this study were synonymous with the current study. That is, patients older than 18 years of age are being described as adults, and patients who have sustained a form of trauma, specifically severe TBIs. The study found that the financial costs of a patient in the Khomas and Otjozondjupa regions of Namibia with a severe TBI were USD 25,007.89 and USD 20,231.95, respectively, as per the data collected from the MVA Fund of Namibia between 2014 and 2018. The injury severity of the working population in Namibia, coupled with the high cost of treatment for patients with trauma-related injuries, has placed a great socio-economic burden on the healthcare sector of Namibia.

According to Kisting (2012), the MVA Fund of Namibia announced that all RTA-related patients would be moved from private healthcare facilities to receive their primary care from state facilities, except in special cases where the patient required surgical interventions not available at the state hospital. This was given the steep rise of trauma-related incidents caused by RTAs with 401 crashes, 881 injuries and 81 fatalities in the 2011/2012 term, costing the SOE N$21 million to the private healthcare system.

Alcohol abuse has also added to the trauma burden in Namibia. He et al. (2019), found that 64.8% of Namibians consume alcohol and that the mean age of those who consume the highest amount of alcohol is 31 years. This introduces various socio-economic dilemmas in the communities, such as domestic violence, assault, and inappropriate conduct in a public space. De Klerk (2007), in a report on the Convention on the Rights of a Child, highlighted that the characteristics of perpetrators of women and child abuse were synonymous with increased alcohol consumption and reduced levels of education. Long distances, wild animals on the roads, and increased use of alcohol all contribute to RTAs and have thus made the fight against trauma-related injuries in Namibia more challenging (Ashipala & Langendorf, 2022).

In a recent newspaper article, it was indicated that most of the specialised health facilities, like surgeons from different faculties of medicine and health-related infrastructure, are still very centrally located in the Khomas region, particularly Windhoek, the capital city of Namibia ("Windhoek health centres bursting at seams", 2018). This leads to a high rate of patient referrals from the regional health facilities to the intermediate state hospitals or the private hospitals with specialist care in the populated Khomas region. This also increases the number of ground ambulance IFTs, including critical care IFTs, which are more suited for aeromedical transport given the vast geography of Namibia. Most of the state-owned ground ambulances facilitating IFTs are staffed with a driver and a nurse or a driver and a Basic Life Support (BLS) practitioner or an Intermediate Life Support (ILS) practitioner. The staff can experience challenges en route if the patient becomes unstable and the interventions required are out of their scope of practice (Puyeipawa Nakashole, 2025). This not only increases patient morbidity but also patient mortality, in contrast to the aeromedical IFTs, which reduce travel times but are also staffed with higher-qualified practitioners, such as ALS or physicians (Visser, 2011).

Aeromedical IFTs provide advantages to adult trauma patients, including access to remote/rural scenes where ground delays surpass the golden hour, advanced en-route critical care by specialised crews, and quicker transport to trauma centres (cutting total prehospital time by 15%–50%). Despite the possible advantages for the patient, aeromedical interventions carry substantial risks. A retrospective study by Anghele et al. (2025) analysed the data between 2015 and 2019 that were conducted by the S.M.U.R.D. Galati, which is a Romanian air ambulance. Unlike the Romanian air ambulance, the Namibian air ambulance relies on smaller, ad-hoc operations like Desert Air or private charters with limited fixed-wing/rotary coverage, focused on IFTs from remote areas due to vast terrain, lacking dedicated HEMS bases or routine scene response. Similar to this study, the study on developing clinical criteria for aeromedical IFTs of adult trauma patients in Namibia also seeks to reduce trauma in polytraumatised geriatrics or older adult patients >65. The study by Anghele et al. (2025) characterised the clinical and demographic profile of polytraumatised patients transported by air. It provided descriptive data that can improve the organisation of aeromedical transport services, particularly in regions with limited access to trauma centres. Predominance of RTAs and multiregional injuries are precursors for revising prehospital triage criteria for air transport. Therefore, efficient scene management increases the potential benefits of air transport in reducing mortality rates in trauma patients. Furthermore, there is a need to develop the creation of uniform national air transfer procedures and better aeromedical team training initiatives (Anghele et al., 2025).

2.3 Benefits of aeromedical IFTs

Utter et al. (2008), conducted a retrospective multi-institutional case series study in the USA, which assessed the transfer of patients between rural and regional trauma centres. The patient population was 1,099, with most of the patients presenting with blunt trauma injuries. On average, the patients in the study presented with an ISS of 11.6; thus, the degree of patient injuries was of such a nature that they required higher care. Ground ambulances transferred 36% (n=396) of patients, and aeromedical IFTs 13% (n=143) of patients. The patients were transferred from the referring hospital to 114 receiving hospitals. The study highlighted (1) rural dependency on regional health facilities for specialist care, (2) frequency of IFTs and (3) aeromedical IFTs as a necessary resource to bridge the gap between rural and regional health facilities.

In a retrospective cohort study, the association of the mode of transport with the neurological outcomes of traumatic spinal cord injury (tSCI) patients was examined. tSCI patients are at a higher risk of neurological-related injuries. The case can be more fatal in geriatrics or older adult patients >65 years. Key findings from Sterner and Brooks (2024) indicated that helicopter transport was associated with significantly improved American Spinal Injury Association Impairment Scale (AIS) grade improvements, particularly for patients with severe injuries (AIS grades A and B). Additionally, patients who decompressed within 0 to 12 hours showed better outcomes when transported by helicopter. The study highlights the importance of transport mode in influencing clinical outcomes for tSCI patients (Sterner & Brooks, 2024).

Hawilo & Taneja (2020), discussed why aeromedical IFTs were frequently used and preferred as the mode of transport for IFTs in Canada. Factors that contributed to the high use in the study were patient acuity (i.e., Intensive Care Unit (ICU) patients), adverse weather events, available staff, and comparative costs. Widener et al. (2017), in a study on the airport infrastructure and northern remote communities of Canada, established that due to extreme weather conditions and long and possibly dangerous roads, the best mode of transport in such conditions was aeromedical transport. According to statistics from the study, 80% of Canadian IFTs were aeromedical. The geographical layout of Canada is comparable to Namibia in terms of the geographical distances of ground IFTs; distances are generally very vast, and roads are not accessible in remote areas or of poor condition in rural areas. Thus, the use of aeromedical transport will be best for communities on the outskirts. Take the example of a settlement, Rietoog in the Hardap region, the settlement only has an operational clinic, which is 194 km from Windhoek by road, with very treacherous road conditions. In 2017, the settlement did not have access to ground ambulance services (“Ambulance needed in Rietoog”, 2017). As per the recommendation of the literature, aeromedical IFTs would be a great benefit to this community and many other rural settlements in Namibia, as they can overcome the distance but also access hard-to-reach areas and, with the appropriate staff complement, cater to the needs of the community.

The study analysed the specialist staffing benefits of aeromedical IFTs. An aeromedical IFT team in Canada is generally staffed with a physician or paramedic along with a Critical Care Nurse, in contrast to ground ambulances, which are often staffed with lower-qualified or non-specialised personnel. In parallel to the Canadian study, the study by Aranda (2021) reviewed the benefits of aeromedical IFTs in the United Kingdom (UK) as part of the National Health Service. The study found that NHS aeromedical IFTs were completed by highly trained personnel comprising physician-led teams. This already provides the patient with a surgical advantage compared to the patients transported with a ground ambulance, and patients in remote or austere locations can get access to advanced emergency care.

Garner et al. (2013) hypothesised that adding a physician to aeromedical IFTs would reduce mortality and increase procedural and clinical capabilities. The study made a retrospective comparison between physician-led and paramedic-led aeromedical IFTs over 2 years. The inclusion criteria of the patients were (1) blunt trauma and (2) ISS >10. Paramedics treated 140 patients, and 67 patients were treated by physicians. Both groups performed endotracheal intubations, thoracic decompressions, and volume resuscitation strategies as per patient requirements. The physician-led group had a lower rate of mortality, concluding that aeromedical IFTs staffed with specialist care are beneficial to patients. This study highlighted a key benefit of aeromedical IFTs, which can be particularly useful in the Namibian setting, in that it may bring skilled healthcare personnel to remote communities. Consider the extraordinarily successful international humanitarian organisation "Doctors without Borders". Their focus is to bring high-quality, skilled medical personnel to the world's most challenging areas, including those in remote areas. This process is facilitated by the Médecins Sans Frontières (MSF) Air Operations Movement, which is the aeromedical unit.

Steenhoff et al. (2021) reviewed the Air Medical Resource Management of the Holmes Medical Centre in Melbourne, Florida, USA. The study found that a key factor for trauma patients was time, time from injury sustained to definitive care, such as the operating table or access to a trauma surge. This highlights how the reduced transfer times over longer distances provided by aeromedical IFTs of adult trauma patients allow patients speedy access to definitive care. The Italian study by Paoli et al. (2020) compared the response and call times of a helicopter and a ground ambulance for 65 primary calls, 49 IFTs and 1 ICU transfer. The study found a mean total length of the calls of 1 hour 26 minutes and a strong positive relationship ($r = 0.92$) between flying time and route length (distance travelled) for the helicopter, emphasising the time-saving benefit of aeromedical IFTs. The study further recommended that aeromedical transport be used for distances greater than 45 km or longer than 2 hours.

This retrospective cohort study using data from the Pennsylvania trauma outcomes study (2000 to 2017) of adult trauma patients identifies a specific time threshold of prehospital time reduction for air medical transport (AMT) associated with improved survival. Adult trauma patients transported by EMS under longer prehospital stays have increased mortality risks that are correlated with response, scene, and transport intervals, especially in severe cases. The study provided guidelines on the time required to save an adult trauma patient. The findings from Boland (2025) establish that a minimum AMT timesaving of 13 to 17 minutes for patients meeting National Field Triage Guidelines (NFTG) criteria and 23 minutes for those with a positive Air Medical Prehospital Triage (AMPT) score correlates with survival benefits. Furthermore, the results indicate that the requirement for first responders to have actionable thresholds, revealing that time-saving assessments in trauma situations can be improved by utilising current technology. Boland et al. (2025) also advises EMS systems to tailor their time-saving thresholds, possibly optimising survival benefits, based on particular resources and patient populations.

A systematic review of published and unpublished databases from 1990 to 2023 was performed to evaluate the impact of transportation mode (air versus ground ambulance) on mortality outcomes in trauma patients and to identify key factors influencing these outcomes. Air ambulance (helicopter EMS or HEMS) outperforms ground ambulance in transport speed for trauma patients over longer distances or remote areas, which often yields better survival rates (Michaels et al., 2019). Analyses across various studies consistently favoured air transportation, indicating a potential survival advantage with helicopter transfers. Findings from Alharbi et al. (2025) presented a comprehensive review of 63 studies on the effectiveness of air versus ground transportation for trauma patients, highlighting the impact on mortality rates. Mortality rates can be reduced by adjusting the applied analyses. Alharbi et al. (2025) further added the importance of centralising trauma care at specialist trauma centres as a strategic intervention to address the global challenge of trauma. The overall findings contribute to the ongoing debate regarding the comparative effectiveness of transportation methods, potentially influencing guidelines and practices in trauma care (Alharbi et al., 2025).

A retrospective cohort study using the Pennsylvania Trauma Outcomes Study (PTOS) registry was conducted to assess the impact of direct helicopter transport to trauma centres on survival rates compared to ground transport to non-trauma centres followed by helicopter transfer. Trauma centres are specialised and equipped hospitals that can treat severe cases whereas non-trauma centres stabilise patients in a less critical state or rather transfer such cases. Key findings revealed that direct helicopter transport significantly increased survival odds (aOR 2.78) for severely injured patients. Specific triage criteria, such as GCS ≤13 and hypotension, were identified as indicators for patients (i.e. geriatrics or older adult patients >65) likely to benefit from direct transport (Deeb et al., 2024). This data is beneficial and supports the need to develop clinical criteria for aeromedical inter-facility transfers of adult trauma patients in Namibia. Multiple factors influence transport decisions, particularly in rural regions by reducing mortality rates. When deciding whether to transport someone directly to a trauma centre, proximity to a trauma centre is the most important factor. When transported by GEMS, patients who fit physiological requirements for trauma centre need are more likely to be decompensated and be under triaged. This current study and data from other studies indicate that the delays in definitive care can be harmful, especially for the most severely injured patients who meet the criteria identified in this study, even though the inclination to transport these patients to a nearby hospital may make intuitive sense. The results underscore the importance of direct access to trauma centres in improving outcomes for critically injured patients (Deeb et al., 2024).

Johnsen et al. (2020), in a retrospective cohort study, investigated the role of Helicopter Emergency Medical Services (HEMS) in Norway during major incidents. The study defined major incidents as any incidents requiring extraordinary resources and found HEMS services beneficial for interagency cooperation during major incidents. Fifty (0.16%) of 31,803 missions conducted between 2000 and 2016 met the criteria for major incidents, of which trauma-related injuries due to RTAs (n=28, 56%) were most prevalent, while the most common location of incidents was rural areas (n=35, 70%). Thus, aeromedical IFTs or HEMS search and rescue missions are a benefit to agencies such as road traffic control, the maritime industry, fire brigades and the mining industry. Mines are often situated in very remote areas or deep in the ocean for oil drilling and other explorations. Though there are, as per national requirements, well-established clinics with doctors, nurses, paramedics, and occupational health specialists, when an incident occurs, aeromedical transport is often required for rapid response and IFTs of the patient (Sethi & Subramanian, 2014). The study limitations identified were during retrospective data collection, as the data variables were not systematically integrated into a database. Thus, a recommendation was made for future data to be collected systematically.

A study closer to the Namibian setting highlights the benefits of aeromedical IFTs. The retrospective descriptive study by Pule et al. (2022) assessed the use and benefit of HEMS to the South African health system, but more specifically to aid in managing trauma patients requiring definitive care. The study assessed trauma patients transferred by HEMS to a level I trauma centre in KwaZulu-Natal, South Africa, between 2014 and 2016 and identified 117 missions of which 73.5% (n=86) were aeromedical IFTs and 26.5% (n=31) primary responses (transported by HEMS from the scene). Like the Namibian setting, the results from Pule et al. (2022) showed that most of the patients transported were due to trauma secondary to RTAs (60%), followed by 31% due to intentional injury. The patients were transported from regional facilities to a level I trauma centre, as most of the patients required ICU admission. The cohort of patients presented had a high ISS (>26) and a 30% mortality rate. Key aspects the study identified concerning aeromedical IFTs were that aeromedical platforms can cover vast distances over a short period of time, and since they can access locations with difficult topography, aeromedical platforms promote meeting the “golden hour” by bringing the patients to the destination ICU within 60 minutes. Lastly, the study recommended the development and use of clinical criteria for effective and successful aeromedical IFTs, as it increases patient outcomes, as can be seen in developed countries.

Namibia only has fixed-wing IFTs, though the data speaks towards the general benefits of aeromedical transfers. The rotor-wing aircraft used for many of the aeromedical callouts in Namibia are done so with the

Namibia Police Force (NAMPOL) helicopter. NAMPOL primarily avails itself of rotor-wing aircraft for emergency search and rescue, life-saving and vital humanitarian relief support (DefenceWeb, 2011). Thus, contextually, this study focuses on fixed-wing aeromedical IFTs in the Namibian setting.

2.4 Importance of clinical criteria for aeromedical IFTs

The EMS National Highway Traffic Safety Administration (2006), in the USA, in a consultative meeting, provided general guidance for the unique clinical demands of IFTs. The consultative meeting looked at hospital-to-hospital IFTs, clinic-to-hospital IFTs, hospital-to-rehabilitation IFTs and hospital-to-long-term care facilities. The consultations concluded that benchmarks for IFT criteria are to be developed, as they increased the success of IFTs. This recommendation was made since the aeromedical IFTs are a costly exercise that should only be used for patients who will get the most benefit. Lyng et al. (2021) assessed the benefit of trauma patients requiring IFTs. These benefits indicate that aeromedical IFTs can continue or initiate locally unavailable speciality care by bringing the medical practitioner to the patient and can be used to extract patients from remote areas or areas inaccessible by road, limiting the patient's access to definitive care. The authors recommended that clinical criteria should be developed for aeromedical IFTs. However, these criteria should not just be from random sources but made in conjunction with the necessary clinical oversight from an interdisciplinary team.

Brown et al. (2012), in a comparative study, assessed the benefit of highly specific criteria for triage consideration using aeromedical IFTs in contrast to independent practitioners' decisions. The study assessed 258,387 cases, of which 16% required aeromedical IFTs and 84% were transported by ground ambulances. The triage criteria for aeromedical IFTs had fewer over-triaging in comparison to independent practitioners' decisions, which commonly over-triaged patients. Thus, the effective use of aeromedical IFT was beneficial with predetermined triage criteria.

Thomas et al. (2013) also explored the topic through a multidisciplinary panel of trauma experts, who assessed the effective use of air ambulances in contrast to ground ambulances. The panel in this study concluded that in the absence of well-established clinical criteria for the use of aeromedical IFTs, practitioners are bound to over-triage. Complementary to Brown et al. (2012), a study by El Syeda et al. (2019) also advised that medical oversight is required to complete a successful aeromedical IFT. This is motivated by EMS expertise with continuous feedback to different stakeholders to improve the success rates of IFTs, underpinning the importance of having predetermined clinical criteria for aeromedical IFTs. Kulshrestha & Singh (2016) support the notion of criteria which guide IFTs as it is the most beneficial in severe trauma patients. The study was conducted in India, which is a developing nation; thus, it was recommended that the criteria and guidelines for aeromedical IFTs must be modified to accommodate the clinical state of a developing country.

Similar to the study by Thomas et al (2013), a retrospective study analysed the overutilisation of HEMS for trauma patients between 2018 and 2021 in Ohio state at an urban level I trauma centre. Findings revealed that most transfers do not meet established triage criteria or require immediate intervention (Srivatsa et al., 2025). HEMS and transport systems in developed settings like Ohio are expected to have an organised system in place compared to developing countries. This calls for standardised guidelines to optimise resource use and ensure HEMS is reserved for patients who truly need it. The recommendations by Srivatsa et al. (2025), speak to some of the objectives highlighted in this study.

2.5 Recommended clinical criteria for aeromedical IFTs of adult trauma patients

The recommended clinical criteria for aeromedical IFTs of adult trauma patients are multifaceted. The considerations to be made when presented with a trauma patient in the clinical setting requiring aeromedical transport require practitioners to have a holistic approach. It is recommended by Dumovich and Singh (2021) that medical practitioners first determine the MOI that caused the trauma of the patient before interventional management. The mechanism of injury describes how the patient sustained damage/injury/trauma to their skin, muscles, organs, and bones (Yeates et al., 2021). Laatz (2018), in a Delphi Study, performed in South Africa on aeromedical IFTs call-out criteria, reached a consensus amongst EPs of 82% for falls higher than 6 metres, 80% for jumping in front of a train or moving vehicle and 80% for explosions, that these patients may benefit the most from aeromedical IFTs.

Davies and Chesters (2015), specialists in prehospital emergency medicine and well-experienced with HEMS at the London Air Ambulance and Anglian Air Ambulance, respectively, reviewed anatomical considerations to be made when considering aeromedical IFTs of adult trauma patients and reviewed clinical criteria to be considered for aeromedical IFTs.

Anatomical considerations:

- Head Injuries: A traumatic injury to the head can lead to several complications due to the anatomical structures found in the area. Head injuries are also associated with facial trauma, which can distort the anatomy, resulting in airway complications. Thus, any injury to the anatomy of the head should be considered for aeromedical IFTs (Davies & Chesters, 2015).
- Thoracic and abdominal injuries: These describe anterior and posterior injuries to the chest wall or abdomen. There is a “danger zone” described as the region between the epigastrium and the sternal notch, where cardiac and great vessel injury is high (Rourke et al., 2022). Depending on the MOI in the cases of gunshot wounds and any penetrating trauma, the ability to adequately assess the anatomical damage may be challenging; thus, these patients often require emergency surgery to stop bleeding from

an unidentified source (Renz et al., 2000). Thus, aeromedical IFT to a level 1 trauma facility is recommended.

- Upper and lower extremity injuries: The anatomy of the extremities comprises bones, cartilage, nerves, and major blood vessels such as the femoral vein and artery of the lower extremities. Common trauma-related injuries associated with extremities are crush injuries, amputations, life-threatening blood loss from extremities and nerve damage leading to paralysis. In a study from the National Trauma Database, revascularisation was the most common treatment method used for salvaging limbs after traumatic injury. However, the success of revascularisation was based on the arrival at theatre within an hour of the extremity injury (Alarhayem et al, 2019). Considering the speed needed, aeromedical IFTs have proven to be the better mode of transport.

Black et al. (2004) developed a simple algorithm for prehospital crews, air ambulance personnel and doctors in the ED attending to trauma patients to use when selecting the mode of transport for the patient from the scene to the hospital. In this algorithm, they identified physiological parameters when considering aeromedical transport. These physiological parameters could be used alone or in combination with the MOI and anatomical considerations to determine if the patient is suitable for aeromedical IFTs.

- Patients presenting with a reduced level of consciousness, Glasgow Coma Scale (GCS) <15 (a neurological scale objectively assessing the patient's consciousness after injury).
- Respiratory distress, respiratory rate (RR) <8 or >30 breaths/minute, provided that the patient is intubated and ventilated before transport.
- Signs of shock, systolic blood pressure of less than 90 mmHg, capillary refill greater than 2 seconds and reduced palpable radial or central pulses, provided that the patient has undergone the necessary volume resuscitation and stabilisation before transportation.

2.6 Factors influencing aeromedical IFT

Extended pre-hospital ground transport times have a detrimental impact on morbidity and mortality in trauma patients. It is still unknown how transfer time and the possibility of in-flight deterioration are related. Additionally, it is unclear if retrieval duration plays a major role in the risk of in-flight deterioration. This study investigated the relationship between the length of transfer and the risk of in-flight deterioration in aeromedical trauma patients. A retrospective study was conducted on all trauma patients at Darling Downs Hospital and Health Service based in Toowoomba, Queensland, Australia, who were transported by a LifeFlight Medical physician on an aeromedical platform between January 2020 and December 2022. The findings from Powell (2025) are the first proof to support the physiologically tenable hypothesis that longer aeromedical transfer times are linked to a higher cumulative risk of deference during flight. The risk of in-flight hypotension is positively correlated with the length of transfer, with the majority of this risk happening in the early phases of flight. The majority of the clinically significant risk happens early, especially in the first half hour. Particularly in non-pressurised fixed-wing aircraft, the corresponding altitude and barometric pressure changes following take-off may have a variety of clinical effects.

This study utilised a mixed-methods approach comprising a rapid review of the literature and semi-structured interviews with identified subject matter experts (SME) to explore the current practices of government and charity-funded critical care transport and retrieval organisations. There are various practices on the current clinical, operational, and educational practices of critical care transport and retrieval organisations funded by the government and charities that operate in areas with limited access and bad weather. This study dug into things like how teams were set up, how staff got selected and trained, and how quality and safety were managed. The Intensive Care Society (ICS) and Faculty of Intensive Care Medicine (FICM) guidelines on the transfer of critically ill adults and the Australian and New Zealand College of Anaesthetists (ANZCA) guidelines for the transport of critically ill patients both outlined how the mode of transport should take into account the nature of the illness, the urgency of the transfer, distance, transport availability, mobilisation times, geography, traffic, weather conditions, and cost (Greene et al., 2023). This study correlates with the standards that may be needed to develop clinical criteria for aeromedical inter-facility transfers of adult trauma patients in Namibia. Common features that are considered include specialised teams, clear mission goals, and centralised coordination. The research of Greene et al (2023) looks into how government and charity-funded critical care transport systems operate, especially in tough-to-reach places with challenging weather. When choosing a practice system, there is no one-size-fits-all system as practices varies a lot.

2.7 Conclusion

The body of literature surrounding the topic of developing clinical criteria for aeromedical IFTs of adult trauma patients identified various themes and commonalities across various countries. There is a concern with the rapid increase in trauma-related injuries in both developed and developing countries. Two findings emerging from the trauma literature are the prevalence of RTAs in Namibia, which is consistent with global trends, and this is coupled with patients with an average age of >18 years, as the population is mainly affected by trauma-related incidents

Literature also revealed that patients with trauma-related injuries in LMICs were frequently referred to areas with medical specialities available. Thus, it requires the transfer of these patients over long distances with ground ambulance services. However, this approach increased trauma patients' mortality and morbidity, as trauma patients with high ISS>12 require rapid medical intervention. Aeromedical IFTs, according to the literature, are of great benefit and bridge the gap between rural or remote areas and access to specialised care. Bringing advanced medical practitioners to the hard-to-reach areas will thus activate or continue emergency treatment for patients. Aeromedical IFTs also reduce travelling time, thus increasing the speed at which patients can be admitted to the hospital for definitive management.

Finally, the literature on aeromedical IFTs of adult trauma patients shows notable inconsistencies and lacks clear clinical criteria for patient selection. These inconsistencies result from the high financial costs required to conduct research in the aeromedical field. As a result, a lack of standardisation of clinical criteria may hinder the establishment of best practice protocols. Literature further recommends that medical oversight should be used to govern aeromedical IFTs with well-established clinical criteria for adult trauma patients, as individual practitioners may fall into over-triaging patients. The literature also recommends that best practice protocols should be relevant to the context, i.e., clinical criteria for aeromedical IFTs of adult trauma patients must meet the needs of the Namibian clinical setting. A lack of research in Namibia with reference to the research topic can be seen as a gap for further research development in areas of clinical criteria, trauma in adults and aeromedicine.

CHAPTER 3: METHODOLOGY

3.1 Introduction

The study was conducted using a modified Delphi methodology (quantitative descriptive research design) consisting of (1) a scoping review of literature, (2) the establishment of an SC (expert working group) and finally (3) the online Delphi rounds (Alaze et al., 2025). This design is suitable for developing clinical criteria for aeromedical IFTs of adult trauma patients in Namibia, as it promotes policymaking, organisational decision-making, and informs direct practice (Brady, 2015).

The scoping review sought to comprehensively review literature on aeromedical IFTs of adult (≥18 years) trauma patients to develop a clinical criteria framework (Objective 1). The SC consisted of a dynamic team of professionals from within in-hospital, prehospital and medical training backgrounds, with aeromedical IFT experience. This SC guided the researcher in developing the framework for clinical criteria for aeromedical IFTs of adult trauma patients in Namibia and in completing the pilot survey to refine the survey statements for the EPs (Objective 2). The EPs completed two rounds of the Delphi and sought to obtain consensus on clinical criteria for aeromedical IFTs of adult trauma patients in Namibia. The outcome of the Delphi rounds directly identified clinical criteria and supported the development of a CDST to guide the utilisation of aeromedical IFTs of adult trauma patients in Namibia (Objective 3).

In this study, an adult was defined as any person aged 18 years or older (Legal Assistance Centre, 2019). The study was the first of its kind in the Namibian setting. The researcher aimed to produce primary data through the Delphi design (Anderson et al., 2021).

3.2 Phase 1: Scoping review

3.2.1 Research design

The first phase of research was a *preparation phase* comprising a scoping review of the literature to identify a framework for developing clinical criteria for aeromedical IFTs of adult trauma patients in Namibia. The scoping review methodology aims to synthesise evidence to identify new knowledge, identify key characteristics or factors related to a concept and inform practice (Aromataris & Munn, 2020).

3.2.2 Eligibility criteria

The scoping review was not restrictive when it came to identifying the literature, as its core methodology is to provide a broad scope on a body of work. The researcher used the Population, Concept and Context (PCC) eligibility criteria from the JBI Manual for Evidence Chapter 10 to include and exclude literature (Peters et al., 2020). The sources of literature were not limited to primary research but were rather left open-ended to allow for a broader search of the literature and thus effectively map evidence.

3.2.2.1 Inclusion criteria

The inclusion criteria for the scoping review were:

- *Population:* Literature pertaining to adult trauma patients.
- *Concept:* Literature addressing clinical criteria for aeromedical IFTs**.**
- *Context:* Literature about the Namibian setting or developing countries, without limiting inclusion to these contexts alone.
- *Types of evidence sources:* All types of evidence, including primary research, evidence synthesis, policy documents, grey literature, etc.

3.2.2.2 Exclusion criteria

The exclusion criteria for the scoping review were:

- *Population*: Literature focused on paediatric or neonatal patients, as well as adult patients with non-trauma conditions.
- *Concept:* Literature that did not discuss aeromedical IFTs/aeromedical transport/aeromedical clinical criteria.
- *Context:* None.
- *Types of evidence sources:* None.

3.2.3 Search strategy

The researcher undertook comprehensive database searches for published, unpublished and grey literature (Charif, 2021). Databases specific to the healthcare setting, such as UpToDate, PMC, MEDLINE, CINAHL, Cochrane Library and EMBASE, though not exclusively, were searched. Google Scholar and other health sciences databases for grey/unpublished literature (reports, conference papers, dissertations, bibliographies and any other unpublished work), such as the Sigma Repository, OpenDOAR and ProQuest, were also searched.

The researcher identified key search terms to search the literature as part of the scoping review (Peters et al., 2020).Searches were not limited in terms of date of publication or language. The researcher utilised the online translator Google Translate to translate foreign language articles and reports.

The search strategy comprised the following stages: (1) the researcher identified the EBSCO database to search, on 23 April 2023 followed by the analysis and indexing of the keywords “trauma AND clinical criteria”,

”clinical criteria OR dispatch criteria OR call out criteria”, “aeromedical transport OR aeromedical evacuation OR medevac AND trauma” and “ adult trauma OR aeromedical transportation” and terms such as “ air ambulance AND clinical criteria AND trauma OR aeromedical transportation” in the titles and abstracts retrieved, (2) the identified keywords and terms from the first stage were used to search across all databases, (3) the reference lists of identified reports and articles were reviewed for additional sources, and (4) consideration was given to contacting authors of the sources to identify additional reports and articles for further information, though none were needed.

This search strategy aimed to identify themes for the development of a draft clinical criteria framework for the SC to consider and discuss. The draft clinical criteria framework allowed the researcher to develop a survey for the SC, who guided the researcher by completing the pilot questionnaire for the Delphi rounds for EP completion and to provide additional comments and suggestions. The SC guided the researcher to refine and improve the questionnaire.

3.2.4 Sources of evidence selection

For the scoping review, source selection was conducted by two reviewers. In this case, the researcher served as reviewer one (R1) while a second reviewer (R2) was recruited to screen the eligibility of the literature, utilising the stipulated eligibility criteria. Stoll et al. (2019), in a systematic review, concluded that using a second reviewer during the entire literature screening process increased the number of relevant studies identified. Aromataris and Munn (2020) recommend that a pilot test of source selectors be done first to refine the eligibility criteria for the scoping review. This was done as follows:

- The researcher randomly selected 25 titles/abstracts, using an online number randomiser application known as the Research Randomizer (Randomizer, 2024).
- The two reviewers (R1 and R2) screened the results independently against the eligibility criteria.
- The reviewers met to discuss challenges and to make recommendations for changes to the eligibility criteria; however, no adjustments were needed.
- During the piloting stage, the reviewers had a ≥75% agreement, and the formal screening thus commenced thereafter on the 05th May 2023.

The eligibility assessment process consisted of two phases: (1) screening of titles and abstracts and (2) full-text eligibility. The search results were uploaded to the Online Web-based Application, Rayyan (Ouzzani et al., 2016). Screening commenced on the 12th May 2023. The two reviewers independently and in duplicate screened the titles and abstracts for potential eligibility. Disagreements were resolved through discussion.

The full-text articles and reports of potentially eligible titles or abstracts were retrieved and assessed by the two reviewers independently and in duplicate for eligibility against the eligibility criteria. Disagreements were noted during the selection process, and an attempt was made to resolve the conflicts between the two reviewers. The reviewers subsequently enlisted the help of a 3rd reviewer to make an independent decision for all unresolved conflicts, as recommended by Aromataris and Munn (2020).

3.2.5 Data extraction

Both reviewers, independently and in duplicate, extracted data using a pre-tested data extraction form **(Appendix 1).** The following key information was extracted as per the recommendation of Valaitis et al. (2012) and can be found in the table of evidence **(Appendix 2):**

- Author(s)
- Year of publication
- Origin/country of origin (where the source was published or conducted)
- Aims/purpose.
- Population and sample size within the source of evidence (if applicable)
- Methodology
- Intervention type, comparator, and details of these (if applicable)
- Outcomes and details of these (if applicable)
- Key findings that relate to the scoping review question/s.

3.2.6 Analysis of evidence

The researcher reviewed the extracted data, the data was open-coded during the extraction process (Pollock et al., 2022). During the data extraction process, the researcher sought to identify themes and concepts to develop the framework of clinical criteria for phase 2 of the study and express the analysis of the data descriptively. This was conducted with R2 and the oversight of the research supervisors. Data was summarised thematically in a table format, highlighting key findings in the evidence. Attention was paid to frequencies such as the country of origin of studies, the particular methods applied, e.g., RCT. The JBI Scoping Review recommends that only basic qualitative analysis be applied to the contents of the extracted data in a scoping review, as this retains the descriptive approach to the analysis (Peters et al., 2020).

3.2.7 Presentation of results

Data presentation is an important medium to communicate the usefulness and uptake of the results of a scoping review. The presentation of the results can take the form of graphs, tables, diagrams or even colour (South & Rodgers, 2023). The findings of this scoping review are presented in a table describing and summarising the characteristics of included sources and a table of included studies, as recommended by Onwuegbuzie & Dickinson (2008), in the results chapter.

3.3 Study setting (Phases 2 and 3)

Namibia is a sparsely populated country in Southern Africa, divided into 14 regions, namely: Erongo, Hardap, ||Karas//>, Kavango-East, Kavango-West, Khomas, Kunene, Ohangwena, Omaheke, Omusati, Oshana, Oshikoto, Otjozondjupa and Zambezi. The majority of the population lives in urban areas, with the Ohangwena region and Oshana regions being the most densely populated. However, the capital city, Windhoek, has the highest number of occupants, with over 486,186 residents (Shimuafeni, 2024).

As previously highlighted, the Namibian health system comprises a dual system that caters for both the public and private sectors. The MOHSS is the custodian of public health, including facilitating the licensing and registration of private health facilities under the Hospital and Health Facilities Act 36 of 1994 (Legal Assistance Centre [LAC], 2023). There are currently 844 private health facilities registered, catering for 18% of the population. Of which the majority are medical aid holders, and fewer out-of-pocket paying clients, due to inflated pricing (MoHSS, 2023). According to the health reform by the MoHSS, the Namibian public health system refers patients from Primary Healthcare (PHC) sites, district hospitals, intermediate hospitals and a referral hospital (Christians, 2020). According to Christians (2020), the health care worker-to-patient ratio is 3 per 1000 population, which is above the recommended WHO standard.

In a mortality report of Namibians between 2018 and 2021, it was found that trauma-related mortality rates for adults from both sexes ranked in the top 10. With self-inflicted injuries at number 2, followed by RTAs, the mortality trends differed for patients older than 60 years, with no trauma-related cause of death in the top 10 leading causes of death (Namibia Statistic Agency[NSA], 2023). This study aimed to support trauma care pathways in Namibia through developing clinical criteria to enhance equitable aeromedical IFT of adult trauma patients.

The intended research (Phases 2 and 3) was for the Namibian health care setting in both the public and private sectors, covering rural and urban health care providers who serve in the decision-making capacity for aeromedical IFTs of adult trauma patients in-hospital and pre-hospital.

3.4 Phase 2: Steering committee (SC)

3.4.1 Research design

During the *second phase* of the study, an SC was established. According to Palm & Hansson (2018), the establishment of an SC when using a modified Delphi Study design introduces more structure into the research process. The SC also strengthens the study by illuminating the challenges and possibilities in the research process. Haven et al. (2020) describe the SC as an advisory team trained in multiple disciplines that guides the execution of the study and helps in selecting EPs for the Delphi rounds.

The primary aim of the SC was to comprehensively discuss the identified clinical criteria framework and themes from the scoping review of the literature, thus allowing the development and refinement of the questionnaire for the Delphi rounds with EPs.

3.4.2 Study population and sampling

Experts from the prehospital and in-hospital sectors with experience in the Namibian setting as decision makers in aeromedical IFTs of adult trauma patients were selected as members of the SC based on the below eligibility criteria (Table 3.1) and using a purposive sampling technique. The researcher identified and secured seven (7) independent individuals according to the set-out eligibility criteria as recommended by (Dayan, 2016).

Table 3.1: Eligibility criteria for steering committee

Steering Committee	
Inclusion criteria	**Exclusion criteria**
1. Advanced Life Support (ALS) Paramedics > 5 years of clinical/operational experience in the Namibian pre-hospital setting. 2. Medical Officer (MO) 3. Senior Registered Nurses 4. Pilot	1. Advanced Life Support (ALS) paramedics with < 5 years of clinical/operational experience in the Namibian pre-hospital setting. 2. Medical students/Healthcare students 3. Enrolled Nurses

The identified SC members each received an invitation letter to participate in the study (**Appendix 3**). The letter detailed the research aims and objectives and gave a clear layout of the responsibilities of the SC members. The SC members had to respond via email to confirm acceptance and participation in the study. The researcher invited the identified SC members who met the inclusion criteria on 7 May 2023. The SC members signed and returned the letters upon acceptance to be part of the study.

3.4.3 Data collection

A total of three meetings were conducted with the SC members, one to explain the timelines of the research, one to present the findings from the scoping review and one to present the draft for the pilot survey. The researcher prepared a PowerPoint Presentation, presented during an online Microsoft (MS) Teams meeting, detailing the background, aims, objectives and methodology of the study to the SC. This was to give enough depth for their future contributions.

The second meeting held with the SC was to give feedback on the results from the scoping review. In an online MS Teams meeting, the researcher highlighted the various processes that were followed by the primary researcher and the R2 to extrapolate the most accurate results from the scoping review. In this meeting, the researcher presented the thirty-three (33) included studies for their consideration in **Appendix 2.** Prior to the final meeting with the SC, the researcher met with the research supervisors to review the details of the draft survey and made amendments prior to submitting the final draft to the SC for their input. In the final meeting with the SC, they piloted the survey.

During the pilot survey, the steering committee made additions and subtractions to the framework statements by using a 5-point Likert scale (strongly disagree to strongly agree) to express their input without an overarching bias, but also to promote anonymity during feedback engagements (Shirazi et al., 2021). Each of the SC members had the opportunity to come up with additional written comments to the statements, including new concepts that had not been explored yet. The SC members gave input on three occasions, with most of the feedback being done online.

Following the outcomes from the pilot survey, the final survey was adjusted to refine statements for the EPs. The statements which obtained consensus in the pilot survey were automatically included in the final survey for the EPs. The statements which did not reach consensus in the pilot survey were analysed on the backdrop of the framework from the scoping review. The researcher reviewed the inclusion or total exclusion of these statements that did not reach consensus with the guidance of the supervisors and, more specifically, in relation to the Namibian context, e.g., criteria that suggested the aeromedical IFT of a patient injured by a bear was excluded, as contextually, Namibia does not have any wild bears.

3.4.4 Data analysis

The SC responses were downloaded from MS Forms in an MS Excel for Windows, Version 365 Spreadsheet (Microsoft, 2021). The data was cleaned and coded for data analysis using IBM SPSS Statistics for Windows (Version 30.0) (IBM Corp, 2024). The data, obtained from Likert-scale items and therefore ordinal, were analysed descriptively with absolute and relative frequencies and presented in heat plots.

Based on the discussions, data from the pilot survey and participant comments were combined in Excel and reviewed with the research supervisors. Comments were assessed against the backdrop of the framework from the scoping review and refined in relation to the Namibian context. Finally, the questionnaire was revised and refined for the Delphi rounds.

3.5 Phase 3: Delphi rounds

3.5.1 Research design

The *third phase* of the study was the Delphi study survey rounds, which allowed for interaction with expert panel participants whilst maintaining anonymity. The desired consensus for this study was 75%. The Delphi approach helped to expand awareness and consolidate the expert perspectives on clinical criteria for aeromedical IFTs of adult trauma patients in Namibia, whilst addressing literature gaps due to the limited information available on the topic (Nasa et al., 2021).

During the completion of the survey as a characteristic of the Delphi rounds, the EPs were encouraged to keep their inputs of the study anonymous to avoid compromise of the results. The researcher gave structured feedback to the panellists without revealing their identities.

3.5.2 Study population and sampling

Keeney et al. (2021) advised that a non-probability method of snowball sampling should be used to identify EPs in line with the inclusion and exclusion criteria for the study in question. The researcher identified the EPs based on the eligibility criteria as stipulated in Table 3.2 by approaching the SC, various hospitals, and medical institutions in the state and private health sectors for referrals to eligible participants (convenience sampling). Additionally, EPs who completed the questionnaire were requested to refer the study invitation to other individuals known to them who meet the inclusion criteria (snowball sampling).

Table 3.2: Eligibility criteria for expert panellist

Expert panellists	
Inclusion criteria	**Exclusion criteria**
1. Emergency Medical Care Specialists 2. Anaesthesiologists 3. Neurosurgeon 4. Orthopaedic Specialists 5. Medical Practitioners 6. Advanced Life Support (ALS) Paramedic with >10 years of experience	1. Advanced Life Support (ALS) Paramedics <10 years of experience 2. Senior Registered Nurses 3. Pilot

The range for the sample size in a Delphi design, according to Barrett and Heale (2020), is between 10 and 1000 participants. A recent study recommended the selection of a double-digit sample size of between 30 and 50 EPs for the Delphi rounds (Mcgrath et al., 2020). This recommendation was supported by Robba et al. (2020) in a study that developed a brain ultrasonography consensus on skill recommendations and competence levels within the critical care setting. The researcher aimed to invite a sample of 40-50 panellists as the researcher anticipated higher levels of attrition during the Delphi rounds (Haven et al., 2020). Laatz (2018) advises that a minimum cut-off of 8 respondents is required for each criterion or round to maintain a representative sample size. The researcher used a minimum cut-off of 10 respondents for each criterion during the Delphi rounds.

3.5.3 Data collection

The Delphi methodology aimed to facilitate an anonymous process while aiming to reach consensus of at least 75% in the case of the intended study, which aimed to develop clinical criteria for aeromedical IFTs of adult trauma patients in Namibia. The Delphi rounds were conducted online; the researcher emailed the survey link to EPs, who completed the survey on MS Forms. The researcher encrypted the survey with passwords to secure the research data.

The clinical criteria suggested by the SC for aeromedical IFTs of adult trauma patients in Namibia were synthesised by listing the various criteria separately, identifying duplicates, then merging them and listing unclear criteria separately. Thereafter, a collated list was sent to the participating EPs to evaluate the appropriateness for the Namibian setting. In the survey, the experts voted using the 5-point Likert ratings "strongly agree to strongly disagree". The survey also comprised a section after all criteria were listed, where panellists could make statements, highlight concerns, justify opinions, and add additional criteria to be included.

3.5.3.1 Delphi round 1

The researcher compiled the initial draft of the survey; thereafter, received inputs from the research supervisors who reviewed the sections, questions and statements. Thereafter, the draft survey was sent to the SC for final inputs. Final edits were made by the researcher and research supervisors.

The survey questionnaire was preceded by an information leaflet **(Appendix 4)** that provided detailed information about the researcher and purpose, procedures and scope of the study. The information leaflet also described the methodological approach of the Delphi, providing respondents with the necessary details to navigate the completion and subsequent rounds of the Delphi. Immediately after the information leaflet, an informed consent statement **(Appendix 5)** was included, which informed the respondents about the study, that their data would be kept confidential and that once they agreed to proceed with the survey, they would not be able to withdraw their response, as the data will be captured in such a way that the responses cannot be linked back to the respondents. It was required of the respondents to select the "agree" or "disagree" option (tick box consent), indicating their choice.

In round one of the Delphi, the questionnaire **(Appendix 6)** consisted of a mix of sections, statements and questions that the survey respondents had to complete. The sections were clearly delineated to allow for ease of reference. *Section A* of the survey focused on respondent "Demographics" and had a total of five (5) questions. *Section B* focused on "Trauma Scoring Systems and Physiology" with a total of five (5) questions. *Section C* looked at "Distance, Time, Capabilities and Resources" with two (2) questions only. "Clinical Procedures/Interventions" was under *Section D* with only two (2) questions. *Section E* had four (4) questions which focused on "Specific Types of Injuries and Special Populations". The last section was *Section F* with two (2) questions highlighting "relative contraindications".

The questionnaire was sent out electronically via email, WhatsApp Messenger and by sharing a uniquely designed QR code. Weekly reminders were sent to the hospitals, EPs, and training institutions to remind their contacts of the survey, with a minimum of four (4) monthly reminders and an average total of almost thirty-two (32) reminders to the various stakeholders.

3.5.3.2 Delphi round 2

For the second Delphi round, the researcher re-evaluated the statements that did not reach consensus in round one. The statements were restructured, and new statements were created with the guidance of the research supervisors to allow the respondents to view the restructured statements as "new" statements. The respondents' comments were further synthesised, and if it was appropriate for an existing theme, it was added to the questionnaire under that theme. However, if the comment was completely new and appropriate for the survey, a new statement was drafted and also added under the theme "new" statements. Comments that were not in line with study aims and objectives, e.g., comments made about a different patient population or clinical condition that was non-trauma related, were excluded as they fell under the established exclusion criteria. The original information leaflet **(Appendix 4)** was condensed **(Appendix 7)** and incorporated in Delphi round two.

The researcher gave structured yet anonymous feedback via email to the EPs by summarising expressed percentages for each criterion from round one of the Delphi, which reached 75% (agree + strongly agree) consensus. The feedback further expanded the number of criteria that were voted on and how many obtained consensus. The participants were then invited to participate in round two of the Delphi, which was indicated to be shorter in structure and would thus take less time to complete. The second round had a shorter execution time due to time constraints, with only a three-week time frame for completion. This would allow the respondents to give their input from a fresh perspective.

3.5.4 Data analysis

The data that was collected on Microsoft Forms was extracted in MS Excel (Microsoft, 2021), cleaned and coded for analysis through univariate descriptive statistics using SPSS version 30, released in 2024 (IBM Corp, 2024) with the assistance of the research supervisors.

The demographic (nominal and ordinal data) and Likert scale (ordinal data) data from both Delphi rounds were expressed using frequencies and percentages, with consensus agreement (agree and strongly agree) expressed as percentages (%). The cut-off for consensus was ≥75% consensus for each statement. The demographic data were summarised in a table, and the Likert scale data in heat plots. The qualitative data obtained through the comments made by the participants were also summarised and kept in a narrative form.

Following completion of the second Delphi round, all statements that reached in consensus were reviewed and tabulated, with the corresponding percentage agreement for each statement displayed, to present the final set of clinical criteria for aeromedical IFTs in Namibia.

3.5 Development of the aeromedical IFTs CDST for adult trauma patients in Namibia

The CDST for the initiation of aeromedical IFTs for adult trauma patients in Namibia was developed through an iterative process using a consensus-based approach. However, before consensus could be established, a framework for best practice and standardisation needed to be developed, hence meeting the needs of objective 1 of the study, which was to establish this framework through the scoping review.

The establishment of the clinical criteria was based on the Delphi rounds. These Delphi rounds had *a priori* threshold percentage level of consensus as determined before the data collection process. This consensus also formed part of the framework for the criteria. This was expressed as statements which reached a level of agreement per Delphi round of >75%, which is considered to be the standard for consensus, as setting the consensus levels too low could affect the study's quality (Diamond et al., 2014). Whereas, setting consensus too high can lead to several Delphi rounds and may yield fewer criteria (Barrios et al., 2021).

The statements that obtained consensus of >75% from both Delphi round 1 and Delphi round 2 were collated in a table and reviewed per their themes. Thereafter, the researcher and research supervisors reviewed the results, ensuring there were no errors in the data. A discussion was held to determine if it was needed to proceed to a third round of the Delphi rounds. It was not methodologically advised due to high participant attrition in round two of the Delphi.

The final addition to developing the clinical criteria for the initiation of aeromedical IFT for adult trauma patients in Namibia was a collaborative effort by the researcher and research supervisors to translate the final consensus statements into a draft CDST. This CDST took the form of a flow diagram, as it allows the criteria to be translated into a simple and practical form, which would make it easier to implement and distribute to practitioners. After draft designs, colours and templates, the researcher was only able to get feedback from two of the seven SC committee members.

The two SC committee members only commented on the comprehensibility and simplicity of the draft decision tool. These comments were incorporated into the design and layout of the draft decision tool. However, the researcher could not present the final draft to the SC and could therefore not assess the tool for practicality and completeness to add to the reliability of the tool (Wilson et al., 2025). It is, however, advised that designers of CDST test the tool for usability through a process of cognitive walk-through, where the researcher and supervisors can discuss the tool by following it to identify challenges (Cubukcu & Canbaz, 2025). The final contributions by the researcher and the research supervisors produced the "Aeromedical IFTs CDST for Adult Trauma Patients in Namibia", presented in the results chapter.

3.6 Data management

Employing good data management is important in research to enhance research transparency, validity and reproducibility of the study findings (Roje, 2023). This type of data in this study comprised electronic data mainly in the form of Excel files, PDF documents, links to the questionnaires, MS Teams channel platform with supervisors and the live working document of this thesis. The researcher planned with the research supervisors to use MS Teams as the official platform to communicate and share data. Here, the researcher was able to create various folders for the different data types and stages of the research. The researcher was also able to label the data according to the versions due to several updates throughout this study.

The researcher restricted access to the data to themselves, the research supervisor, and the co-supervisor. The researcher ensured the data was password-protected and stored as an encrypted file on the private MS Teams channel with multifactor authentication. This way, the researcher was able to remotely access the data, but the MS Teams channel also allowed for automatic backup of the data. The questionnaire information leaflet clearly stipulated to the EPs how the data was being collected, what the researcher intended to do with the data and where the data might be shared in the case of this study. The researcher stipulated that they were seeking permission from the respondents to also share data for journal publication.

The data was anonymised upon submission of the questionnaire and therefore did not contain any personally identifiable information of the EPs. To ensure that the appropriate ethical processes were followed, the respondents were presented with an informed consent **(Appendix 5)** form before proceeding with the questionnaire or exiting it. Data will be retained for 10 years as required by the Namibia University of Science and Technology (NUST) Research, Technology and Innovation Policy and Guidelines. When deleting data from electronic devices, it is advised to use specialised software which makes data irretrievable after being deleted (Roje, 2023).

3.7 Study limitations

It was an educated assumption that no clinical criteria existed and that the research problem existed anecdotally. Additionally, no official statistics or research in the Namibian setting exists to support the opinions of experts. There was a limited number of experts who met the inclusion criteria to support the study and to meet the study population. Evidence of sample population attrition throughout the progression of the two Delphi Study rounds was observed. As the EPs had an expected time commitment, their availability to participate in the various Delphi Study rounds was often inconsistent.

One of the major limitations of this study was that there was a delay in the research process. The data that was collected for the literature review and the scoping review were collected in March 2023 and May 2023, respectively. The researcher faced delays with the progress of the research project due to personal and professional pressures. The researcher, being a junior in the research fraternity, made several novice mistakes, particularly around time management and understanding the scope of research at this level of academic writing. The data collection process only took place in 2025; herein, one can argue that although there has not been much shift in the aeromedical sector, the study is limited to the evidence released from 2023 since the last searches. And it may not reflect emerging trends or changes in this field. The generalisability is thus reduced due to the older data in the literature review and the scoping review. Considering that in 2024, America had a major political turnaround, which affected policies pertaining to the aviation sector (Lopes & Foresti, 2025). Namibia was also affected at some point by travel bans. There has also been a steep rise in air crashes in the past two years, with a 2.56 % rise in 2024 compared to 2023, a 1.87% rise in air crashes globally. Thus, these trends and patterns are excluded from this data (International Civil Aviation Organisation[ICAO], 2025). Key strengths of the study design were that it had a clear purpose and allowed for the research objectives to be easily answered. However, the use of a scoping review of literature may have allowed the introduction of low-quality evidence due to a lack of appraisal criteria.

The Delphi rounds were completed over more than 8 weeks in round 1 and more than 4 weeks in round 2. This resulted in participants' attrition, particularly in round 2. Bi-weekly reminders were sent out to participants whose emails were recorded, though a direct link could not be made to who the email addresses belonged to. This resulted in those participants who already completed the survey also getting these bi-weekly reminders, which was a bit arduous.

The data analysis process was quite simple; however, during the Delphi rounds 1 and 2, there were several comments left by the EPs which had to be manually sorted to establish themes by the researcher. This was challenging and also risked the introduction of opinion biases in terms of what should be included in the subsequent rounds versus what should be excluded. The assistance from the supervisors aided in a more objective analysis of these comments and thus their inclusion into round 2 of the Delphi.

Internal validity was established by minimising selection bias of the SC and EPs by identifying a clear set of eligibility criteria relevant to the Namibian setting. In round 1 of the Delphi, the EPs' demographics had a broad representation of the medical specialisation from the prehospital and in-hospital settings. The data collection tool utilised the Likert Scale for the pilot survey, rounds 1 and 2 of the Delphi, maintaining consistency and reliability. Overall, anonymity was preserved during the pilot survey and both Delphi rounds by having no identifiable markers. Data was also coded before its analysis. The researcher anticipated attrition during the Delphi rounds but was able to retain the recommended number of participants required to vote on each criterion. Criteria recommended by the SC during the pilot survey and the criteria voted on by the EPs during the two Delphi rounds were contextualised to the Namibian setting, LMICs with resource limitations and a similar geography.

The study aimed to invite between 40 and 50 EPs and have a minimum of 10 respondents per criterion, taking participants' attrition levels into account. The invitation reached could not be determined as it was dependent on snowballing; however, responses to the survey in round 1 indicated that the sample of 29 respondents per criterion, compared to the target of 10 respondents per criterion, was well above target. A different reflection was shown in round 2 of the Delphi due to an over 50% respondent attrition. There were only 14 respondents for each criterion, although the significantly lower representative sample size per criterion still reached its target. The sample size, albeit a double-digit number, did not represent a true reflection of the EPs who met the inclusion criteria of all institutions in Namibia.

Only two rounds of the Delphi were conducted due to high levels of participant attrition. The decision to stop the Delphi rounds after the 2^{nd} round was due to the reliability of the data being questioned, if a third round was completed with lower responses than those obtained in round 2. The risk of introducing response bias into the Delphi also increased as the EPs felt compelled to agree with some of the criteria due to its repetition. As more than 50% participants dropped between Delphi round 1 and Delphi round 2, the chance of a further drop of survey participants had another round considered, and that would place the sample size well below the targeted and recommended sample size. This would also lead to representative bias and increased variability. The drop in the sample size reflected lower statistical power and limited generalisability.

3.8 Ethical approvals and considerations

The study obtained ethical clearance from the NUST Faculty Ethics Committee (Appendix 8) and the MoHSS Research Committee (Appendix 9).

The researcher emphasised the importance of maintaining the anonymity and confidentiality of the study population, as their unbiased opinions contributed to the quality of the research. To meet the necessary ethical requirements, the researcher shared a study participation form with the SC (Appendix 3), and the EPs were able to view a virtual information sheet with a tick box informed consent form (Appendix 5), for Round 1 of the Delphi. For Round 2, feedback (Appendix 10) from Round 1 and an adjusted information sheet (Appendix 7) with a continuation of the voluntary participation were included before the completion of the Round 2 questionnaire. In both the study participation form for the SC and the information sheet for the EPs, it was clearly stated that by agreeing to participate in the study, the researcher was committed to keeping the background information of the SC and EPs confidential and anonymous.

To provide the EPs with feedback after the first round of the survey and send the second-round survey to the participants of round one, the EPs were asked to provide an email address. No other identifiable information was recorded. To ensure anonymity, the email addresses of participating EPs were collected separately from the submitted Round 1 Delphi Questionnaire. The feedback and second-round survey were then sent to the email list.

The researcher also stated in the study participation forms to the EPs that during the Delphi rounds, their participation would be anonymous, with no personal indicators attached to them or other panellists. In addition, they were informed that the email addresses would be collected separately and therefore could not be linked to their responses. The forms were electronically completed with a tick box (informed consent) indicating "agreement to continue with the study" or "disagreement" thus exiting the questionnaire. The researcher and supervisors were the only ones with access to the background information of the study population.

The study objectively made efforts to minimise risks to study participants. Through rigorous data safety measures that ensured that the survey completion was anonymous and that there were no personal identifying markers to link responses to the respondents. Results were coded with only the researcher and supervisors who had access, and it was password-protected. Survey participants, including the SC, were provided with a full academic background of the researcher, including contact details. There was transparency provided about the parameters of the inclusion and exclusion criteria in the survey information leaflet. All study aims and objectives were also detailed in the information leaflet before the participants completed the survey. And finally, the researcher explained the data collection and dissemination process. The survey participants were informed that after their completion and submission of the survey, they could not withdraw their participation; their anonymity would, however, be maintained as the survey was designed in such a way that responses could not be connected to a specific respondent.

3.9 Research dissemination

The target audience for research dissemination is:

- The Ministry of Health and Social Services (MoHSS).
- Private hospitals and privately owned prehospital emergency medical care establishments.
- Aviation companies that specialise in aeromedical transfers of patients.
- Medical aid companies, as they form part of the pool that gives financial approval or medical insurance when patients request or require aeromedical IFTs.
- The Allied Health Professions Board at the Health Professions Council of Namibia (HPCNA).
- MVA Fund of Namibia, the SOE is mandated to design, promote, and implement crash and injury prevention measures in Namibia.
- Academic institutions that may further develop the research findings and include them in teaching material.
- Agencies which promote health locally and internationally, like the WHO.

3.10 Conclusion

The methodological approach for this study comprised three phases. Phase 1 was a scoping review of existing literature on aeromedical IFTs of adult (≥18 years) trauma patients to develop a clinical criteria framework. This was an iterative approach with data searches, data screening and data synthesis, with a second reviewer. The R2 was recruited to increase the quality of the included studies, as the scoping review method allows for it. There was a pre-tested data extraction form designed and utilised throughout the data extraction phase, and a concise table of included studies compiled from the final 33 included studies.

Phase 2 saw the establishment of the SC to guide the researcher and participate in the pilot study, which was refined and used to further identify the themes and statements for the EPs to complete during the Delphi Rounds (Phase 3).

The 3rd phase of research comprised the Delphi rounds, the approach sought to harness expert opinions through various rounds to obtain a consensus of >75% by completing a survey. Though a large sample population existed who fulfilled the inclusion criteria for the EPs, there was an overall low survey response, with participant attrition noted in the second round of the Delphi, highlighting a key study limitation with the Delphi methodology, particularly in the Namibian setting. The study was also limited due to reduced generalisability as the searches of the literature review and the scoping review were from 2023 due to a delay in the research progress. Overall, the methodology allowed for a clear approach to prepare for the data collection phase of the study with minimal deviations.

CHAPTER 4: RESULTS

4.1 Introduction

In this chapter, the results of the study are presented with reference to the study objectives. Phase 1 outlines the findings from the comprehensive scoping review of literature on aeromedical IFTs of adult trauma patients to develop a clinical criteria framework to elicit expert opinion. Phase 2 reports the results from the pilot survey completed and comments/suggestions provided by the SC, which identified and refined statements used in the subsequent Delphi rounds (Phase 3). Finally, results from the two rounds of the Delphi are presented.

4.2 Phase 1: Scoping review

4.2.1 Search results

A comprehensive literature search across various medical databases identified 1409 articles for potential inclusion. The researcher removed 405 duplicate articles. R1 and R2 screened the titles and abstracts of 1004 articles after removing the duplicates (Figure 4.1).

Attention was paid to whether the population was adult trauma patients, focusing on the concept of aeromedical IFTs in the Namibian setting, that of developing countries, however, not limited to these settings only. The online screening tool Rayyan was utilised by both R1 and R2, allowing for more efficiency and accuracy of screening results (Ouzzani et al., 2016).

After screening, 120 articles proceeded to full-text eligibility assessment, with 87 articles excluded. The excluded articles did not address clinical criteria for aeromedical IFTs of adult trauma patients. A total of 33 articles met the inclusion criteria (Figure 4.1).

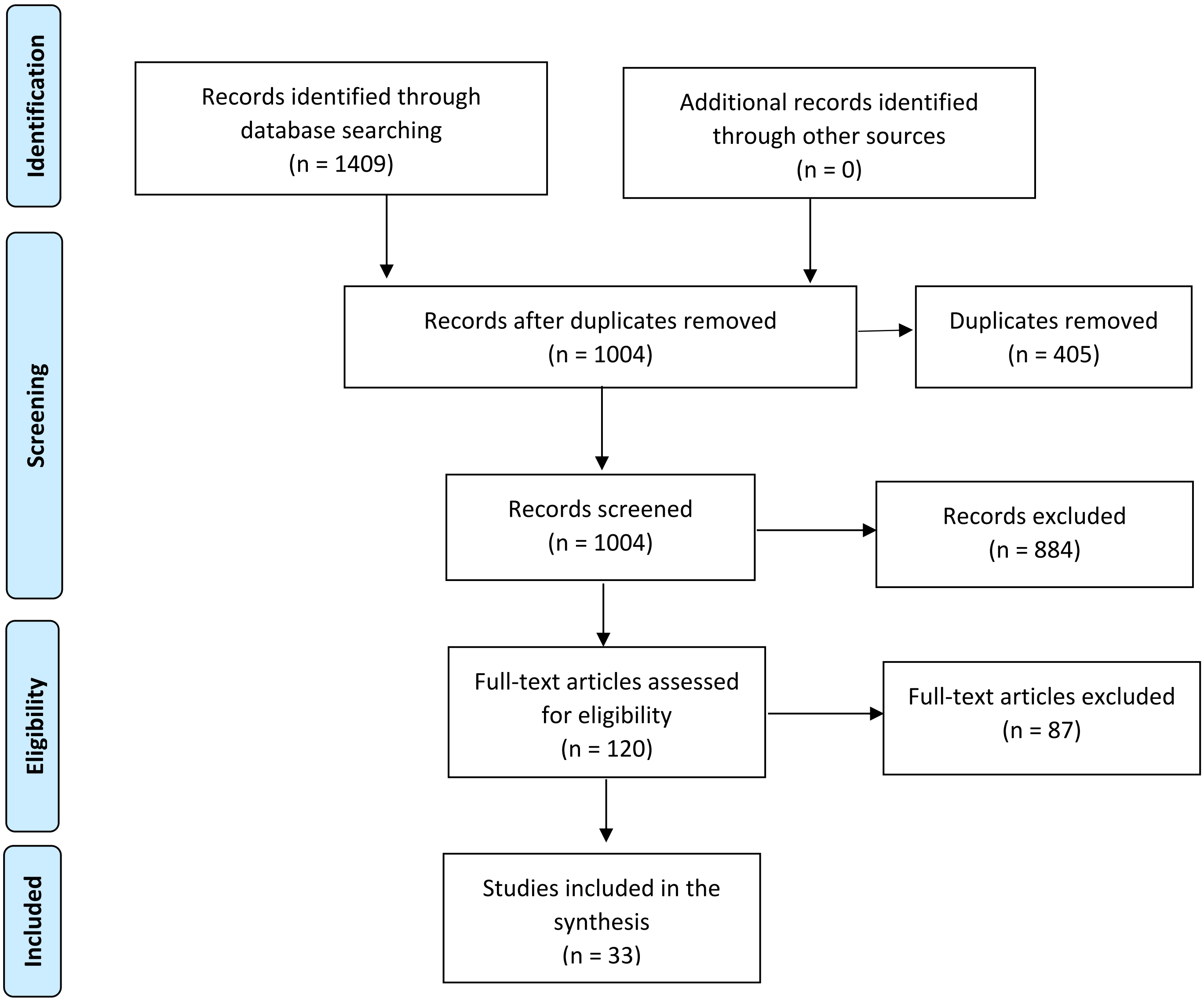


Figure 4.1: PRISMA flow diagram of included studies

4.2.2 Characteristics of included sources

The 33 publications identified addressed various themes about clinical criteria for aeromedical IFTs of adult trauma patients from different geographical regions, with the majority originating from the USA (n=12, 36.4%). All included publications were written in English.

The publication timeline spans from 1955 to 2023; however, most articles were from 2017-2019 (n=11, 33.3%) (Table 4.1). The justification for including publications older than 20 years was that there were very few and limited studies evaluating the direct impact of aeromedical transport on patient care (Loyd, 2024). Included sources comprised various publication/report types; however, mostly retrospective studies (n=14, 42.4%).

Table 4.1: Characteristics of included sources

Characteristics	Frequency	Percentage (%)
Publication year		
1955-1999	3	9.1
2002-2006	4	12.1
2008-2010	6	18.2
2013-2016	4	12.1
2017-2019	11	33.3
2020-2023	5	15.2
Publication type		
Policy / expert opinion	2	6.2
Descriptive study	6	18.2
Retrospective study	14	42.4
Observational study	8	24.2
Cross-sectional study	1	3.0
Case series	1	3.0
Case study	1	3.0
Country of origin		
United Kingdom	1	3.0
United States of America	12	36.4
Canada	2	6.1
Haiti	1	3.0
India	1	3.0
France	2	6.1
South Sudan	1	3.0
Afghanistan	2	6.1
Iran	1	3.0
Iraq	2	6.1
Ireland	1	3.0
Kuwait	1	3.0
Germany	2	6.1
Bhutan	1	3.0
Turkey	2	6.1
Korea	1	3.0
Total	**33**	**100.0**

4.2.3 Key results/Findings of included studies

From the existing literature, a concise table of the final 33 included studies was compiled, identifying the eight main themes summarised in Table 4.2. The key features of the 33 included papers are synthesised in (Appendix 2).

Table 4.2 Findings of included studies

Theme	Description	References
Theme 1: Benefits of Aeromedical transport relating to the time-saving advantage	Access to remote locations and the availability of highly skilled professionals.	Brown & Gestring., 2013; Butler et al., 2017; Davis et al., 2005; DeGennaro et al., 2016; Hooker et al., 2008)
Theme 2: Context specifics	Focusing on the various challenges faced by developed and developing countries, highlighting the resource limitations.	DeGennaro et al., 2016; Fang et al., 2010; Maddry et al., 2022; Oner & Hakan, (2006).
Theme 3: Mortality predictors	Relating air versus ground patient transport.	Farzan et al., 2023; Kotwal et al., 2018; Butler et al., 2017; Cannon et al., 2018; DeGennaro et al., 2016; Farzan et al., 2023: Joshi & Sharma 2010; Kotwal et al., 2018)
Theme 4: Clinical limitations to aeromedical transport	Focusing on the contraindications, such as untreated pneumothorax and environmental stressors	Farzan et al., 2023; Joshi & Sharma, 2010; Ranjan & Renjhen, 2017; Corbet & Nelson, 1955).
Theme 5: Triage and trauma scoring systems	Looked at specific tools to more accurately guide the choice of air versus ground transport	Brown & Gestring, 2013; Dhawan et al., 2021; Madiraju et al., 2017; Maher et al., 2019).
Theme 6: Clinical Indicators	Focusing on trauma and the patient's clinical presentation, and thus their need for aeromedical transport	Maddry et al., 2022; Butler et al., 2017; Cannon et al., 2018; Corbet & Nelson, 1955; DeGennaro et al., 2016; Eveson et al., 2020; Farzan et al., 2023; Galvagno et al., 2014; Gibbons et al., 2017; Joshi & Sharma, 2010; Mize et al., 2019).
Theme 7: Multidisciplinary staffing,	Recommended that the ideal setup of the staff for an aeromedical IFT should comprise practitioners such as paramedics, nurses and flight medical doctors specialising in trauma surgery.	Andrew, 1994; Brown & Gestring, 2013; Butler et al., 2017; Davies & Chesters, 2015; Davis et al., 2005; DeGennaro et al., 2016; Duchateau et al., 2009; Galvagno et al., 2014; Luft et al., 2018).
Theme 8: Skill and procedural requirements.	Highlighted what procedures patients in an aeromedical flight needed on average and what skill set the treating practitioners required.	Davies & Chesters, 2015; DeGennaro et al., 2016; Duchateau et al., 2009).

The themes described were presented to the SC in Phase 2 of the study to guide their decisions on what ought to be included in the surveys during the Delphi Rounds with the EPs.

4.3 Phase 2: Steering committee

A total of eight (8) invitation letters were sent out to potential SC members who met the inclusion criteria. However, only seven (7) SC members accepted the invitation. The members who accepted the invitation are presented in Table 4.3.

Table 4.3: Demographics of steering committee

Professional role	n	%
Advanced Life Support/Paramedic with 5 or more years' experience	3	42.9
Emergency Medicine Specialist	1	14.3
Senior Registered Nurse	1	14.3
Senior Medical Officer/General Practitioner	2	28.5
Total	**7**	**100.0**

The seven (7) SC members reviewed the results from the scoping review of literature from *Phase 1* and through an anonymous survey, the components of the clinical criteria were identified for the EPs to vote on during the Delphi Rounds. This was considered the pilot survey, but the results still went through deeper analysis by the researcher and supervisors.

The SC members identified the preferred triage or trauma tool used in the ED, and from a list of three (3), the SC voted for the South Africa Triage Scale (SATS) as the most preferred tool (71.4%). The Revised Trauma Score (RTS) and the ISS were tied in second place with 14.3% (Table 4.4).

Table 1.4: Preferred triage or trauma tool used in the department.

Triage or Trauma tool	n	%
South African Triage Scale (SATS)	5	71.4
Revised Trauma Score (RTS)	1	14.3
Injury Severity Score (ISS)	1	14.3
Total	**7**	**100.0**

In addition, the SC members voted on the six (6) trauma and triage scoring tools identified during the scoping review results. The SC ranked them as follows: SATS in first place with 71.4%, RTS in second place with 57.1%, ISS in third place with 57.1% with, TRISS, ATS, and the Kampala Trauma Score (KTS) were joint in fourth place with 14.3% (Table 4.5).

Table 4.5: Ranking of trauma and triage scoring tools.

	Ranked 1	Ranked 2	Ranked 3	Ranked 4	Ranked 5	Ranked 6
South African Triage Scale (SATS)	71.4		28.6			
Trauma-related Injury Severity Score (TRISS)	14.3	42.9	14.3	28.6		
Revised Trauma Score (RTS)		57.1	28.6			
Injury Severity Score (ISS)	14.3		14.3	57.1	14.3	
Abbreviated Trauma Score (ATS)			14.3			14.3
Kampala Trauma Score (KTS)				14.3	85.7	14.3

Finally, the SC voted on the identified clinical themes, selecting the statements most suitable for inclusion in the Delphi rounds for EPs to evaluate. These statements are summarised in Table 4.6. The percentage of agreement is indicated by a combination of the percentage total of "strongly agree" and "agree". These statements informed the clinical criteria for aeromedical interfacility transfers of adult trauma patients in Namibia.

Of the 32 statements voted on, there were only 11 statements which obtained consensus in the pilot survey. The criterion under the theme ‘physiology’ received 4/4, which is a 100% level of agreement in line with theme 6 of this study. Under the “distance/time/capabilities/resources” theme, 2/4 statements reached consensus, which is in line with theme 1 of this survey. Procedures/Interventions reached 3/7 of the consensus statements. Followed by the “specific types of injuries” which had the most criteria but only reached consensus on 2/11. The statements under the theme “relative contraindications” were 6, of which 0 reached consensus, certainly not aligning with theme 4 of this study. The statements that did not reach consensus in the pilot survey were reviewed by the researcher and the research supervisors. Some statements were removed, rephrased or replaced by new statements.

Table 4.6: Summary of clinical statements in pilot survey with SC

No.	Statement	Agreement (%)
	Physiology	
1	Inability to maintain and protect his/her airway.	100.0
2	Predicted clinical course in relation to airway management and respiratory support.	100.0
3	Vital sign measurement trends that are of clinical concern.	85.8
4	Oxygenation and ventilation status	100.0
	Distance, time, capabilities and resources	
5	Distances between referring and receiving facilities are greater than 250 km.	85.7
6	Local resource unavailability (e.g. ambulances, appropriate level of care, EMS staff and equipment).	85.7
7	Excessive out-of-hospital time	71.4
8	Availability of night landing for fixed-wing aircraft.	57.4
	Procedures/Interventions	
9	Endotracheal Intubation	71.5
10	Continuous drug infusions	71.4
11	Chest Drain/Chest Decompression	85.8
12	Intravenous fluid, blood/blood products	85.7
13	CPR received (with ROSC) or anticipated deterioration to cardiac arrest that would require CPR.	85.7
14	Cricothyroidotomy/FONA	42.9
15	Mechanical Ventilation (e.g. CPAP, BiPAP, SIMV, PC, VC).	28.6
	Specific types of injuries	
16	Severe Burns	71.4
17	Sharp object protruding from the abdomen with hemodynamic instability	71.4
18	Threatened Upper Extremity Injury	85.7
19	Traumatic Brain Injury (Moderate-Severe)	85.7
20	Pelvic fracture with hemodynamic instability	71.5
21	Head Injury	28.6

22	Chest injuries from high-impact mechanisms, e.g., gunshots, blasts, and crush injuries, which can lead to various sequelae.	71.4
23	Long bone fractures, e.g. femur fractures, tib/fib fractures with hemodynamic instability or a threatened limb.	57.1
24	Polytrauma	71.4
25	Subluxation of the cervical vertebra with neurological deficits.	71.5
26	Hemoperitoneum requiring urgent surgical intervention	71.5
Relative contraindications		
27	Unrelated eye injury/surgery in the past 7-14 days	42.9
28	CPR was performed with ROSC, with a poor prognosis	71.4
29	Spinal injury, unless spinal motion restriction is in place or immobilisation.	57.2
30	Untreated and severe pneumothorax	57.2
31	Recent abdominal surgery/abdominal injury, as the gas in the peritoneum/GI tract can get entrapped with an increase in cabin altitude.	57.1
32	Acute blood loss with haematocrit of <30%	42.9

4.4 Phase 3: Delphi round 1

The questionnaire was distributed to various EPs across Namibia. Only 30 participants agreed to complete. However, only 29 (96.7%) participants met the inclusion criteria. One (1) participant did not meet the inclusion criteria despite completing the entire survey. As a result, the data was removed, and the data from the remaining 29 questionnaires were analysed.

4.4.1 Demographic information

The sample contained a balanced representation of males (n=15, 51.7%) and females (n=14, 48.3%) (Table 7). Most respondents were doctors (n=20, 69.0%), of whom most were Senior Medical Officers/General Practitioners (n=17, 58.6%). The sample also contained responses from 9 (31.0%) ALS/Paramedics with ≥10 years' experience.

Of the 29 respondents, 48.3% (n=14) were from the public sector and 51.7% (n=15) from the private sector. Twelve (41.4%) respondents each had 1-5 years and more than 10 years of professional experience, while 15 (51.7%) had 1-5 years of experience and involvement in clinical decision-making for patients requiring aeromedical IFTs.

Table 4.7: Demographics of expert panellists for Delphi Round 1

Gender	n	%
Male	15	51.7
Female	14	48.3
Professional role		
Advanced Life Support/Paramedic with 10 or more years' experience	9	31.0
Emergency Medicine Specialist	2	6.9
General Surgeon	1	3.4

Senior Medical Officer/General Practitioner	17	58.6
Doctors' vs Paramedics		
Advanced Life Support/Paramedic	9	31.0
Doctor	20	69.0
Sector		
Public	14	48.3
Private	15	51.7
Professional experience		
Less than 1 year	1	3.4
1-5 years	12	41.4
6-10 years	4	13.8
More than 10 years	12	41.4
Experience and involvement in clinical decision-making		
Less than 1 year	4	13.8
1-5 years	15	51.7
6-10 years	2	6.9
More than 10 years	8	27.6
Total	**29**	**100.0**

4.4.2 Trauma scoring systems

The trauma or triage scoring tool, SATS (n=17, 59.0%), was identified as the most used, followed by the RTS and ISS (Table 4.8). There were four (13.4%) respondents who made comments. Of which three (10.3%) indicated that no trauma or triage scoring tool is currently in use, while one respondent (3.4%) identified the use of the Interagency Integrated Triage Tool (IITT) as a tool currently being used in the MoHSS in Windhoek.

Table 4.8: Trauma or Triage scoring tools (Used in Departments)

	N	%
South African Triage Scale (SATS)	17	59.0
Revised Trauma Score (RTS)	4	13.8
Injury Severity Score (ISS)	4	13.8
Interagency Integrated Triage Tool (IITT)	1	3.4
None	3	10.0
Total	**29**	**100.0**

The three (3) trauma or triage scoring tools, namely SATS, RTS and TRISS, were ranked based on how suitable respondents deemed the tool to be. SATS were most ranked 1st (55.2%), with TRISS most ranked 2nd (41.4%) and 3rd (48.3%) (Figure 4.2).

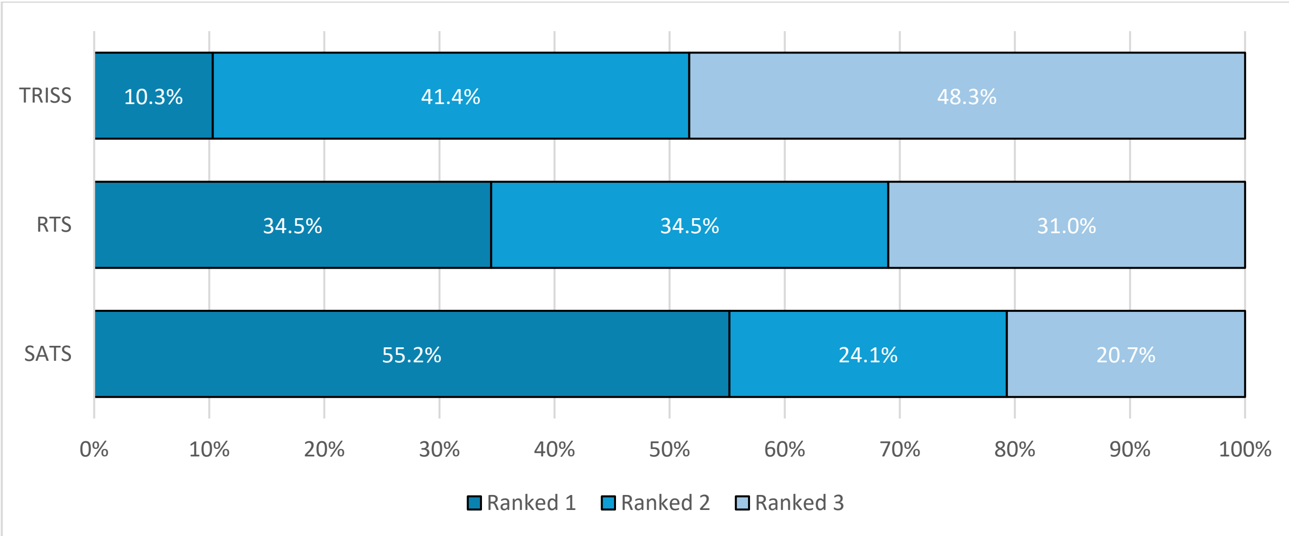


Figure 4.2: Trauma or Triage scoring tools (Ranking)

4.4.3 Physiological parameters and clinical status

Figure 4.3 displays a heat plot of responses for the sub-category of physiological parameters and clinical status. All four statements related to airway, ventilation and vital signs trends reached consensus (>75% agreement, i.e., voted "agree" or "strongly agree"). The two statements, "Ability to maintain oxygenation and ventilation" and "Anticipated deterioration, requiring definitive airway management", both attained 100% consensus.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total agreement (≥75%)
Ability to maintain and protect airway patency.	0.0%	0.0%	6.9%	13.8%	79.3%	93.1%
Ability to maintain oxygenation and ventilation.	0.0%	0.0%	0.0%	17.2%	82.8%	100.0%
Anticipated deterioration, requiring definitive airway management.	0.0%	0.0%	0.0%	13.8%	86.2%	100.0%
Vital trends (BP, Sats, RR, HR, HGT, ECG and GCS).	0.0%	0.0%	6.9%	13.8%	79.3%	93.1%

0%
100%

Abbreviations: BP: Blood Pressure, **Sats:** Saturation, **RR:** Respiratory Rate, **HR:** Heart Rate, **HGT:** Hemoglucose Test, **ECG:** Electrocardiograph, **GCS:** Glasgow Coma Score.

Footnote: Colorbar (vertical strip) illustrates the gradient used, from green (0%) to red (100%), representing the percentage of responses in each Likert category. The colour of the *Total Agreement (≥75%)* column reflects consensus: **green** indicates the predefined consensus threshold (≥75% agreement) reached, whereas **red** indicates not reached.

Figure 4.3: Physiological parameters and clinical status statements (Heat Plot)

4.4.4 Distance, time, capabilities and resources

All four statements related to distance, time, capabilities and resource consideration for aeromedical IFT of adult trauma patients reached consensus (>75% agreement, i.e., voted "agree" or "strongly agree") (Figure 4.4). The statement "A lack of appropriate local EMS resources (ambulance /staff /equipment) availability' reached the highest consensus (93.1%), followed by "A distance of >250 km by road" (89.7%).

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total agreement (≥75%)
A distance >250km by road.	0.0%	0.0%	10.3%	20.7%	69.0%	89.7%
A lack of appropriate local EMS resources (ambulance /staff /equipment) availability.	0.0%	3.4%	3.4%	31.0%	62.1%	93.1%
A lack of night landing capacity for flights.	6.9%	3.4%	3.4%	27.6%	58.6%	86.2%
Extended out-of-hospital time	0.0%	3.4%	13.8%	27.6%	55.2%	82.8%

0%

100%

Abbreviations: EMS: Emergency Medical Services

Footnote: Colour bar (vertical strip) illustrates the gradient used, from green (0%) to red (100%), representing the percentage of responses in each Likert category. The colour of the *Total Agreement (≥75%)* column reflects consensus: **green** indicates the predefined consensus threshold (≥75% agreement) reached, whereas **red** indicates not reached.

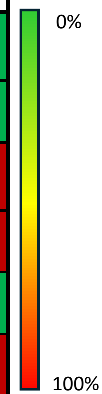
Figure 4.4: Distance, time, capabilities and resources statements (Heat Plot)

4.4.5 Clinical procedures/interventions

This subcategory comprised six statements relating to received or anticipated clinical procedures or interventions for which an aeromedical IFT should be considered. Three statements related to advanced airway management, mechanical ventilation and Cardiopulmonary Resuscitation (CPR) with Return of Spontaneous Circulation (ROSC) obtained consensus (>75%), while the remaining three did not (Figure 4.5).

For adult trauma patients who may require IV fluid and/or blood transfusion during IFTs, expert responses varied. A total of 17.2% (n=5) disagreed, and 6.9% (n=2) strongly disagreed with considering this as an indication for aeromedical IFT, while 13.8% (n=4) remained neutral. For continuous drug infusion, the results can be summarised as the total percentage of disagreement for this criterion for aeromedical IFT was 13.8% (n=4). The overall level of agreement was only 62.1% (n=18) as a large number of respondents were neutral at 24.1% (n=7). The three statements that did not obtain consensus included chest drain or needle decompression, intravenous (IV) Fluid and/or blood transfusion and continuous drug infusions. Only 58.6% of the experts agreed that adult trauma patients who may require or have had a Chest Drain or Needle Decompression performed should be considered for an aeromedical IFT.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total agreement (≥75%)
Endotracheal intubation or supraglottic device placement	3.4%	3.4%	17.2%	34.5%	41.4%	75.9%
Mechanical ventilation	0.0%	3.4%	10.3%	27.6%	58.6%	86.2%
Chest drain or needle decompression	0.0%	13.8%	27.6%	17.2%	41.4%	58.6%
IV fluid and/or blood transfers	6.9%	17.2%	13.8%	34.5%	27.6%	62.1%
CPR with ROSC	0.0%	3.4%	17.2%	27.6%	51.7%	79.3%
Continuous drug infusions	0.0%	13.8%	24.1%	27.6%	34.5%	62.1%



Abbreviations: CPR: Cardiopulmonary resuscitation, **ROSC:** Return of spontaneous circulation, **IV:** Intravenous

Footnote: Colour bar (vertical strip) illustrates the gradient used, from green (0%) to red (100%), representing the percentage of responses in each Likert category. The colour of the *Total Agreement (≥75%)* column reflects consensus: **green** indicates the predefined consensus threshold (≥75% agreement) reached, whereas **red** indicates not reached.

Figure 4.5: Clinical procedures/Interventions

4.4.6 Specific injuries

This section focused on specific injuries to consider when making clinical decisions regarding aeromedical IFT of adult trauma patients and included the largest number of statements (9). All nine statements obtained a consensus of ≥75% with agreement (voted agree or strongly agreed) (Figure 4.6).

Overall, all statements attained more than 82.0% agreement. The statement on spinal injuries, which included subluxation of the cervical vertebra with neurological deficits, obtained the highest overall agreement level of 93.1% (n=27), followed by the statement on chest injuries from high impact mechanisms with 89.7% (n=26), closely followed by hemoperitoneum requiring urgent surgical intervention with 89.6% (n=26).

The comments summarised under this section saw experts advocating for the necessity of patients with the identified injuries to be transported by aeromedical transport. Experts commented that patients' chances of survival would be affected by their injury profile. Some experts also specifically stated that patients with polytrauma should be referred to levels of high care or where specialists are readily available.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total agreement (≥75%)
Moderate (GCS 9-12) or severe (GCS 8 or below) TBI or signs of increased ICP.	0.0%	6.9%	10.3%	24.1%	58.6%	82.7%
Spinal injuries, including subluxation of the cervical vertebra, with neurological deficits.	0.0%	0.0%	6.9%	13.8%	79.3%	93.1%
Chest injuries from high-impact mechanisms, e.g., gunshots, blasts, and crush injuries, can lead to various sequelae.	0.0%	3.4%	6.9%	34.5%	55.2%	89.7%
Hemoperitoneum requiring urgent surgical intervention.	0.0%	3.4%	6.9%	24.1%	65.5%	89.6%
Object protruding from the abdomen and hemodynamic instability.	0.0%	6.9%	6.9%	20.7%	65.5%	86.2%
Pelvic fracture with hemodynamic instability.	3.4%	6.9%	3.4%	27.6%	58.6%	86.2%
Threatened extremity injuries.	0.0%	3.4%	13.8%	20.7%	62.1%	82.8%
Polytrauma	0.0%	0.0%	13.8%	20.7%	65.5%	86.2%
Severe Burns (>15% any full-thickness burns, circumferential burns, high-voltage burns, including lightning and inhalation burns)	0.0%	6.9%	10.3%	31.0%	51.7%	82.7%

0% — 100%

Abbreviations: **GCS**: Glasgow coma scale, **TBI**: Traumatic brain injury, **ICP**: Intracranial pressure

Footnote: Colour bar (vertical strip) illustrates the gradient used, from green (0%) to red (100%), representing the percentage of responses in each Likert category. The colour of the *Total Agreement (≥75%)* column reflects consensus: **green** indicates the predefined consensus threshold (≥75% agreement) reached, whereas **red** indicates not reached.

Figure 4.6: Specific injuries statements (Heat Plot)

4.4.7 Special populations

Experts had a 79.3% (n=23) agreement for considering aeromedical IFT in obstetric trauma patients with a gestational age of 26 weeks or more, while a further 17.2% (n=5) of the experts were neutral. The second criterion, geriatric patients ≥60 years, did not obtain consensus, with an overall agreement of about 50.0% (n=15) (Figure 4.7).

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total agreement (≥75%)
Obstetric patients with a gestational age of 26 weeks or more.	0.0%	3.4%	17.2%	37.9%	41.4%	79.3%
Geriatric patients (60 years or older)	0.0%	3.4%	44.8%	37.9%	13.8%	51.7%

0% — 100%

Footnote: Colour bar (vertical strip) illustrates the gradient used, from green (0%) to red (100%), representing the percentage of responses in each Likert category. The colour of the *Total Agreement (≥75%)* column reflects consensus: **green** indicates the predefined consensus threshold (≥75% agreement) reached, whereas **red** indicates not reached.

Figure 4.7: Special population statements (Heat Plot)

The comments for this section were mixed; some experts stated that the patient's injuries determined their need for aeromedical IFT consideration. Other experts advocated that obstetrics patients should only be referred via aeromedical IFT if the receiving facility had a premature unit for the consideration of the neonate.

Several experts commented on the challenges paediatric patients may experience during an aeromedical IFT, as well as remarks on medical conditions such as myocardial ischemia and stroke patients, and the interventions that they may require. Unfortunately, these comments did not align with the study, which focused on adult trauma patients.

4.4.8 Relative contraindications

This section had the lowest level of consensus, with only one criterion obtaining a consensus of 86.2% (n=25). Many of the statements did not obtain consensus and were rephrased to allow experts to rate them anew in the second round of the Delphi (Figure 4.8).

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total agreement (≥75%)
Untreated and severe pneumothorax.	0.0%	6.9%	6.9%	20.7%	65.5%	86.2%
Unrelated eye surgery (7-14 days).	10.3%	17.2%	20.7%	27.6%	24.1%	51.7%
ROSC with poor prognosis	13.8%	13.8%	6.9%	17.2%	48.3%	65.5%
Spinal injury with inadequate immobilisation.	3.4%	3.4%	20.7%	24.1%	48.3%	72.4%
Acute blood loss with haematocrit <30%.	3.4%	10.3%	13.8%	13.8%	58.6%	72.4%
Recent abdominal surgery/untreated abdominal injury with confirmed entrapped gas in the peritoneum/GI tract.	6.9%	6.9%	20.7%	17.2%	48.3%	65.5%

0%

100%

Abbreviations: **ROSC:** Return of spontaneous circulation, **GI:** Gastrointestinal

Footnote: Colour bar (vertical strip) illustrates the gradient used, from green (0%) to red (100%), representing the percentage of responses in each Likert category. The colour of the *Total Agreement (≥75%)* column reflects consensus: **green** indicates the predefined consensus threshold (≥75% agreement) reached, whereas **red** indicates not reached.

Figure 4.8: Relative contraindications (Heat Plot)

4.5 Phase 3: Delphi round 2

The survey was sent to 25 of the 29 EPs across Namibia who completed round 1 of the Delphi. Four (4) of the EPs did not submit their email addresses after the completion of round 1 of the Delphi. And because the survey is anonymous, the researcher could not identify these respondents. Fourteen (56.0%) of the 25 EPs completed round 2 of the Delphi.

4.5.1 Demographic information

Of the 14 respondents in round 2, 5 (35.7%) were male and 9 (64.3%) female (Table 9). Half of the respondents were paramedics (n=7, 50.0%), while 6 (42.9%) of the doctors were Senior Medical Officers/General Practitioners (n=6, 42.9%). Eight (57.1%) respondents were from the public sector, and 6 (42.9%) from the private sector (Table 4.9).

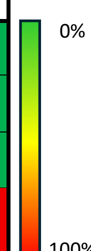
Table 4.9: Demographics of expert panellists for Delphi round 2

Gender	**n**	**%**
Male	5	35.7%
Female	9	64.3%
Professional role		
Advanced Life Support/Paramedic with 10 or more years' experience	7	50.0%
Emergency Medicine Specialist	1	7.1%
Senior Medical Officer/General Practitioner	6	42.9%
Doctors' vs Paramedics		
ALS Paramedic	7	50.0%
Doctor	7	50.0%
Sector		
Public	8	57.1%
Private	6	42.9%
Total	14	100.0%

4.5.2 Trauma scoring systems

Expert Panellists rated the SATS (n=13, 92.9%) as the most appropriate or effective trauma or triage scoring tools for use in making decisions regarding aeromedical IFTs of adult trauma patients, followed by the RTS (n=12, 85.7%) and the ISS (n=11, 78.5%) (Figure 4.9). All three reached consensus (≥75%). The IITT tool did not reach consensus (n=9, 64.3%).

	Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	**Total agreement (≥75%)**
South African Triage Scale (SATS)	0.0%	0.0%	7.1%	50.0%	42.9%	92.9%
Revised Trauma Score (RTS)	0.0%	0.0%	14.3%	78.6%	7.1%	85.7%
Injury Severity Score (ISS)	0.0%	7.1%	14.3%	71.4%	7.1%	78.5%
WHO Interagency Integrated Triage Tool (IITT)	0.0%	21.4%	14.3%	42.9%	21.4%	64.3%



Footnote: Colour bar (vertical strip) illustrates the gradient used, from green (0%) to red (100%), representing the percentage of responses in each Likert category. The colour of the *Total Agreement (≥75%)* column reflects consensus: **green** indicates the predefined consensus threshold (≥75% agreement) reached, whereas **red** indicates not reached.

Figure 4.9: Trauma or Triage Scoring Tools (Heat Plot)

Based on revisions after Round 1 of the Delphi, experts re-ranked their preferences for trauma or triage scoring tools (Figure 4.10). The SATS and RTS tools ranked 1st with 35.7% (n=10), 42.9% (n=12) ranked SATS second, 57.1% (n=17) ranked ISS third, and 57.1% (n=17) ranked IITT fourth.

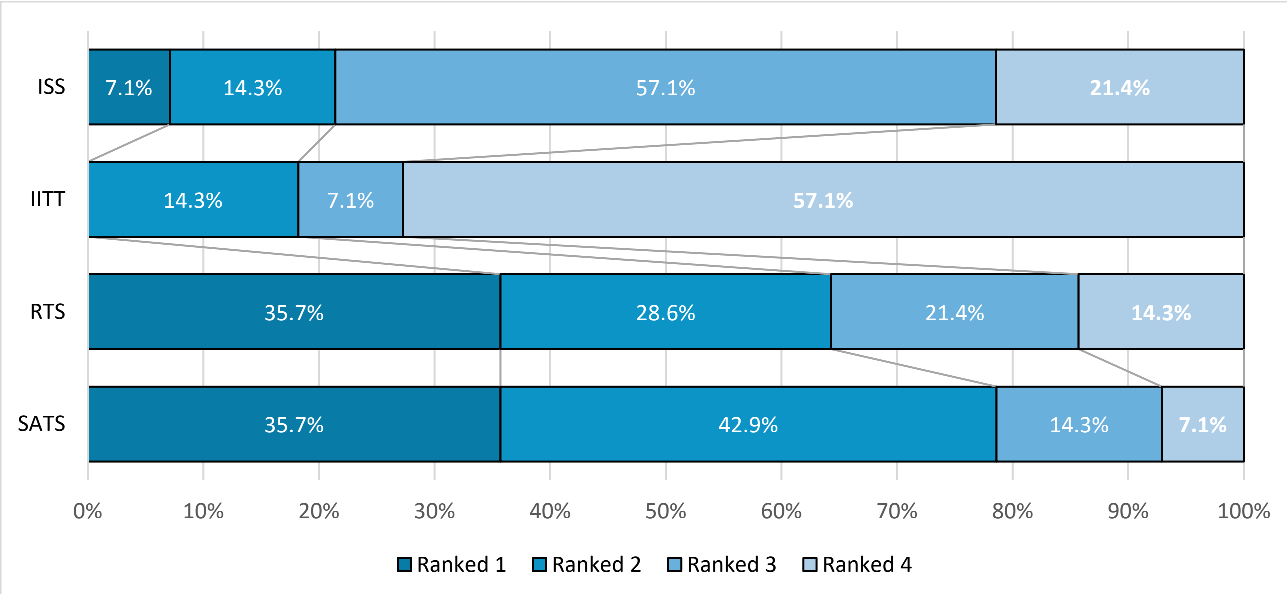


Figure 4.10: Trauma or Triage Scoring Tools (Ranking)

4.5.3 Clinical procedures/Interventions and special populations: Unresolved statements round 1

Four statements were revised from round 1 of the Delphi. Only two statements reached an agreement. Ongoing administration of IV fluids and/or blood products reached a consensus of 78.6% (n=11), and continuous drug infusions that require close monitoring and titration with 92.9% (n=13). The remaining two statements obtained <60% agreement (Figure 4.11).

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total agreement (≥75%)
Presence of a chest drain or needle decompression	0.0%	14.3%	28.6%	42.9%	14.3%	57.2%
Ongoing administration of IV fluids and/or blood products	0.0%	7.1%	14.3%	28.6%	50%	78.6%
Continuous drug infusions that require close monitoring and titration	0.0%	0.0%	7.1%	50%	42.9%	92.9%
Geriatric trauma patients, aged 60 years or older	0.0%	21.4%	28.6%	50%	0.0%	50.0%

0% – 100%

Footnote: Colour bar (vertical strip) illustrates the gradient used, from green (0%) to red (100%), representing the percentage of responses in each Likert category. The colour of the *Total Agreement (≥75%)* column reflects consensus: **green** indicates the predefined consensus threshold (≥75% agreement) reached, whereas **red** indicates not reached.

Figure 4.11: Clinical procedures/Interventions and special populations, unresolved statements (Heat Plot)

4.5.4 Relative contra-indications: unresolved statements round 1

Five statements were reviewed, and experts had to revote on these. Only one statement related to ROSC with poor prognosis reached consensus, with 78.6% (n=11). The remaining four statements did not reach a consensus of >75% (Figure 4.12).

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total agreement (≥75%)
Eye surgery (unrelated to current trauma)	0.0	28.6	21.4	21.4	28.6	50.0
ROSC with poor prognosis	0.0	14.3	7.1	14.3	64.3	78.6
Spinal injury (inadequate immobilisation)	0.0	14.3	14.3	42.9	28.6	71.5
Acute Blood loss (<30% haematocrit)	7.1	7.1	21.4	28.6	35.7	64.3
Recent abdominal surgery	7.1	0.0	42.9	21.4	28.6	50.0

0%

100%

Footnote: Colour bar (vertical strip) illustrates the gradient used, from green (0%) to red (100%), representing the percentage of responses in each Likert category. The colour of the *Total Agreement (≥75%)* column reflects consensus: **green** indicates the predefined consensus threshold (≥75% agreement) reached, whereas **red** indicates not reached.

Figure 4.12: Relative contra-indications, unresolved statements (Heat Plot)

4.5.5 New relative contra-indications statements

Two new statements were crafted from Round 1's comments. Neither statement obtained (≥75%) consensus (Figure 4.13). The statement related to hemodynamic instability obtained an overall agreement of 71.5% (n=10), with 42.9% (n=6) of respondents strongly agreeing.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree	Total agreement (≥75%)
Anticipated risk of deterioration	0.0	28.6	7.1	35.7	28.6	64.3
Hemodynamic instability	14.3	14.3	0.0	28.6	42.9	71.5

0%

100%

Footnote: Colour bar (vertical strip) illustrates the gradient used, from green (0%) to red (100%), representing the percentage of responses in each Likert category. The colour of the *Total Agreement (≥75%)* column reflects consensus: **green** indicates the predefined consensus threshold (≥75% agreement) reached, whereas **red** indicates not reached.

Figure 4.13: New relative contra-indications (Heat Plot)

4.6 All Delphi round statements reaching consensus.

Table 4.10summarises all statements that reached consensus of ≥75% during the Delphi Rounds. The theme on injuries obtained the highest number of consensus statements with nine (9), closely followed by the theme on clinical procedure/interventions, with five (5) statements, which reached consensus. Physiological parameters, clinical status, distance, time, capabilities and resources were tied in 3rd place, with each collecting four (4) statements which obtained consensus. Trauma scoring systems, relative contraindications and special populations obtained consensus for three (3), two (2) and one (1) statements, respectively.

Table 4.10: Statements reaching consensus.

No.	Statement	Agreement (%)
	Triage & Trauma Scoring Systems	
1	South African Triage Scale (SATS)	92.9
2	Revised Trauma Score (RTS)	85.7
3	Injury Severity Score (ISS)	78.5
	Physiological parameters andclinical status	
4	Ability to maintain and protect airway patency.	93.1
5	Ability to maintain oxygenation and ventilation.	100.0
6	Anticipated deterioration, requiring definitive airway management.	100.0
7	Vital trends (BP, Sats, RR, HR, HGT, ECG and GCS).	93.1
	Distance, time, capabilities and resources	
8	A distance > 250km by road.	89.7
9	A lack of appropriate local EMS resources (ambulance /staff /equipment) availability.	93.1
10	A lack of night landing capacity for flights.	86.2
11	Extended out-of-hospital time	82.8
	Clinical procedures/Interventions	
12	Endotracheal Intubation or Supraglottic Device Placement	75.9
13	Mechanical Ventilation	86.2
14	CPR with ROSC	79.3
15	Ongoing administration of IV fluids and/or blood products	78.6
16	Continuous drug infusions that require close monitoring and titration	92.9
	Injuries	
17	Moderate (GCS 9-12) or severe (GCS 8 or below) TBI or signs of increased ICP.	82.7
18	Spinal injuries, including subluxation of the cervical vertebra, with neurological deficits.	93.1
19	Chest injuries from high-impact mechanisms, e.g., gunshots, blasts, and crush injuries which can lead to various sequelae.	89.7
20	Hemoperitoneum requiring urgent surgical intervention.	89.6
21	Object protruding from the abdomen and hemodynamic instability.	86.2
22	Pelvic fracture with hemodynamic instability.	86.2
23	Threatened extremity injuries.	82.8
24	Polytrauma	86.2
25	Severe Burns (>15% any full-thickness burns, circumferential burns, high-voltage burns, including lightning and inhalation burns)	82.7
	Special populations	
26	Obstetric patients with a gestational age of 26 weeks or more.	79.3
	Relative contraindications	
27	Untreated and severe pneumothorax.	86.2
28	ROSC with poor prognosis	78.6

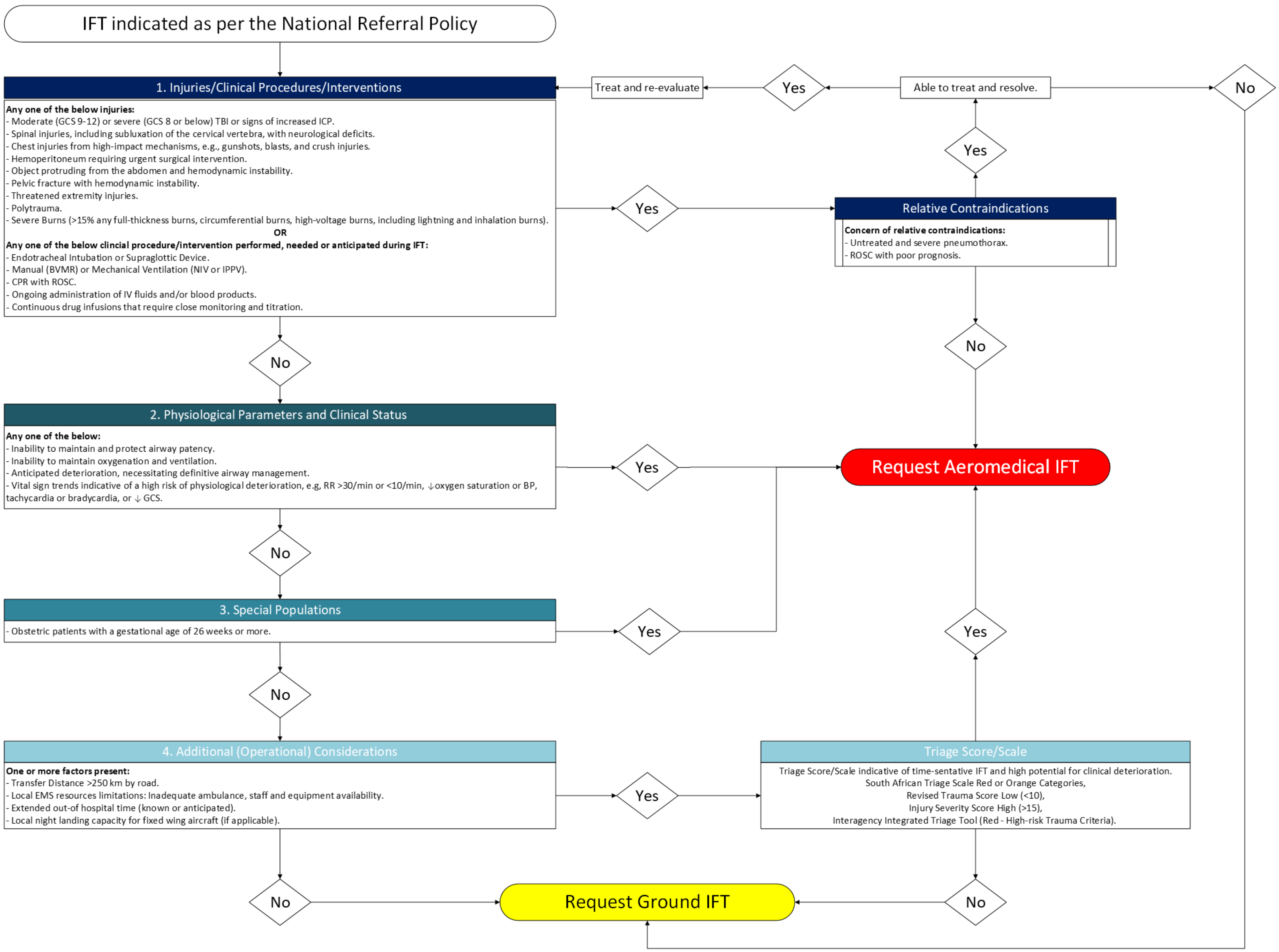
4.7 Draft aeromedical IFTs clinical decision support tool for adult trauma patients in Namibia

A total of 28 final clinical criteria statements were identified from the EPs during the Delphi rounds, across 6 domains: triage and trauma scoring systems, physiological parameters and clinical statements, distance-time-resource-capabilities, clinical procedures/interventions, injuries, special populations and relative contraindications. All 28 clinical criteria statements reached the a priori consensus of >75% and were incorporated into the final draft of the CDST for aeromedical IFT of adult trauma patients in Namibia **(Figure 4.14).**

4.8 Conclusion

The results indicated that literature derived from the scoping review in phase 1 is regionally dominated by evidence from the developed countries, with the USA having the highest number of included studies. Retrospective study designs were most commonly used. These 33 included studies are summarised in Appendix 2, which led to the identification of 8 major themes, which formed the foundation of the clinical framework. In phase 2, there was a balanced representation of SC members from the public and private sectors. The in-hospital and prehospital representation of practitioners was also equal. Phase 3 of the Delphi Rounds comprised two robust rounds of data collection, iteration and feedback. In round 1 of the Delphi, there were 29 participants; in round 2, there were only 14 participants. The Delphi rounds started with 32 clinical criteria statements, of which 28 reached consensus after the two rounds. These consensus statements are reflected in the CDST **(Figure 4.14).**

AEROMEDICAL INTERFACILITY TRANSFER (IFT) CLINICAL DECISION SUPPORT TOOL FOR ADULT TRAUMA PATIENT



Footnotes: BP - Blood Pressure, CPR - Cardiopulmonary Resuscitation, GCS - Glascow Coma Scale, ICP - Intercranial Pressure, IFT - Interfacility Transfer, ISS - Injury Severity Score, ROSC - Return of Spontaneous Circulation, RR - Respiratory Rate, RTS - Revised Trauma Score.

Figure 4.14: Aeromedical IFTs clinical decision support tool for adult trauma patients

CHAPTER 5: DISCUSSION

5.1 Introduction

This study was conducted in sequential phases to establish clinical criteria for aeromedical IFTs of adult trauma patients in the Namibian context. A comprehensive Scoping Review (Phase 1) of the literature was conducted, identifying clinical criteria used locally, regionally, and internationally to guide medical practitioners when requesting IFT for adult trauma patients. This phase was instrumental in setting the stage to develop the clinical criteria framework. The findings of the scoping review were presented to a multi-disciplinary team from the public and private health sectors in Namibia, who made up the SC (Phase 2). The SC gave input on the evidence from the scoping review to refine the framework to be used in Phase 3 of this study. The SC subsequently completed a pilot survey, which aided the researcher in further refining the framework and clinical criteria statements, highlighting relevance to the Namibian context.

Phase 3 of the study employed the modified Delphi technique to identify clinical criteria for aeromedical IFT of adult trauma patients in Namibia through consensus (>75% agreement) based statements by EPs. The Delphi consisted of two rounds, which further refined the clinical criteria. The findings from phase 3 culminated in the development of a CDST, informed by the final consensus-based clinical criteria statements, for aeromedical IFTs of adult trauma patients in Namibia. This chapter critically and comprehensively interprets the research findings while establishing the results within the context of the literature.

5.2 Development of the clinical criteria framework

5.2.1 Phase 1: Scoping review

The first objective of this study was to conduct a scoping review of literature to establish a clinical criteria framework to elicit expert opinions. This scoping review thus meticulously identified and synthesised the appropriate existing literature on clinical criteria for aeromedical IFT of adult trauma patients in Namibia. It was deemed methodologically appropriate to include sources from any setting, as there are limited studies done on aeromedicine globally and practically no studies done in the Namibian setting, thus best to include all sources on the topic (Loyd, 2024). Hence, the researcher conducted a comprehensive search for literature to ensure that the review was conceptually wide enough to avoid excluding studies that could be relevant, considering that global literature is sometimes very diverse, with clinical criteria embedded in it (de Carvalho et al., 2021).

A total of 1409 articles were identified through the database searches, of which 33 articles met the inclusion criteria**.** A high-rate of 1376 studies were excluded during the scoping review, indicating that most of the literature on aeromedicine is either descriptive, non-trauma related or not based on the adult population. It further suggests a scarcity of literature which is more clinical and specifically addresses or informs criteria on aeromedical IFTs for trauma patients. The limited eligible literature also instantiates an inconsistent field, punctuating the malalignment between the existing literature and the practical needs of clinicians responsible for decision-making when coordinating aeromedical IFTs of adult trauma patients in a high-acuity trauma setting like Namibia. This gap in the literature necessitated this study's objective to establish a framework for developing clinical criteria for aeromedical IFTs of adult trauma patients specific to the Namibian context.

All articles were published in English, with a notable surge between 2017 and 2019. This may indicate an increase in the global interest pertaining to aeromedical care for trauma patients. A greater number of articles originated from the USA (36.4%), followed by countries such as Canada, France and Germany. This suggests a geographical imbalance (Harris et al., 2015). Countries with high-income, developed aeromedical systems and adequate resource availability may have overshadowed the review results, leaving LMICs under-represented (Hadian et al., 2025). This imbalance may impact how clinical criteria developed in a well-resourced health system may not translate well into an environment characterised by long transfer distances, inadequate resource availability, and public-private aeromedical systems such as Namibia. The lack of literature available on LMICs and the African setting underscores the valuable contribution this study will make to the existing literature and the Namibian setting (Neill et al., 2023).

Secondary data dominated the results, with retrospective studies (42.4%) representing the largest portion. Literature suggests that non-experimental studies, such as case control studies, cohort studies and cross-sectional studies, are ethically more acceptable in the aeromedical context. This is due to the inherent challenges faced and etiological infeasibilities encountered when conducting experimental research on critically injured patients (Youngquist & Gee, 2011). Retrospective studies can also reflect misalignment of evidence, considering that the majority of the studies were from developed countries, which may not reflect the challenges of long distances and resource constraints often found in LMICs. Evidence from the scoping review should be interpreted cautiously for Namibian policy makers, as it is not truly indicative of the context-specific challenges.

5.2.2 Theme 1: Time-saving benefits

The benefits of aeromedical IFT include the time-saving advantage, access to remote locations and the availability of highly skilled professionals. Distance is an indirect measure of time; thus, the time-saving benefit related to aeromedical IFT reflects the recommendation from one of the included studies of the scoping review on the time benefit between air versus ground transfers of trauma patients. The study found that ground transfers take longer by >20 minutes compared to air transfers of patients (Brown & Gestring, 2013).

In 2023, a joint position statement on, *Appropriate and Safe Utilisation of Helicopter Emergency Medical Services,* included additional time considerations that are often not immediately recognised (Lyng et al., 2021b). This statement also confirmed that air transfers have a 15-minute time advantage compared to ground transfers. This is due to air transport routes being more direct compared to ground transfers, which may experience variable speed limits and delays caused on roads due to RTAs, road works and animals, to name a few (Lyng et al., 2021a). This is reflected in Figure 5.1. The findings in this study thus reinforce the practical need for time-sensitive decision-making criteria for practitioners who are left with the decision-making capacity relating to aeromedical IFTs in the Namibian context.

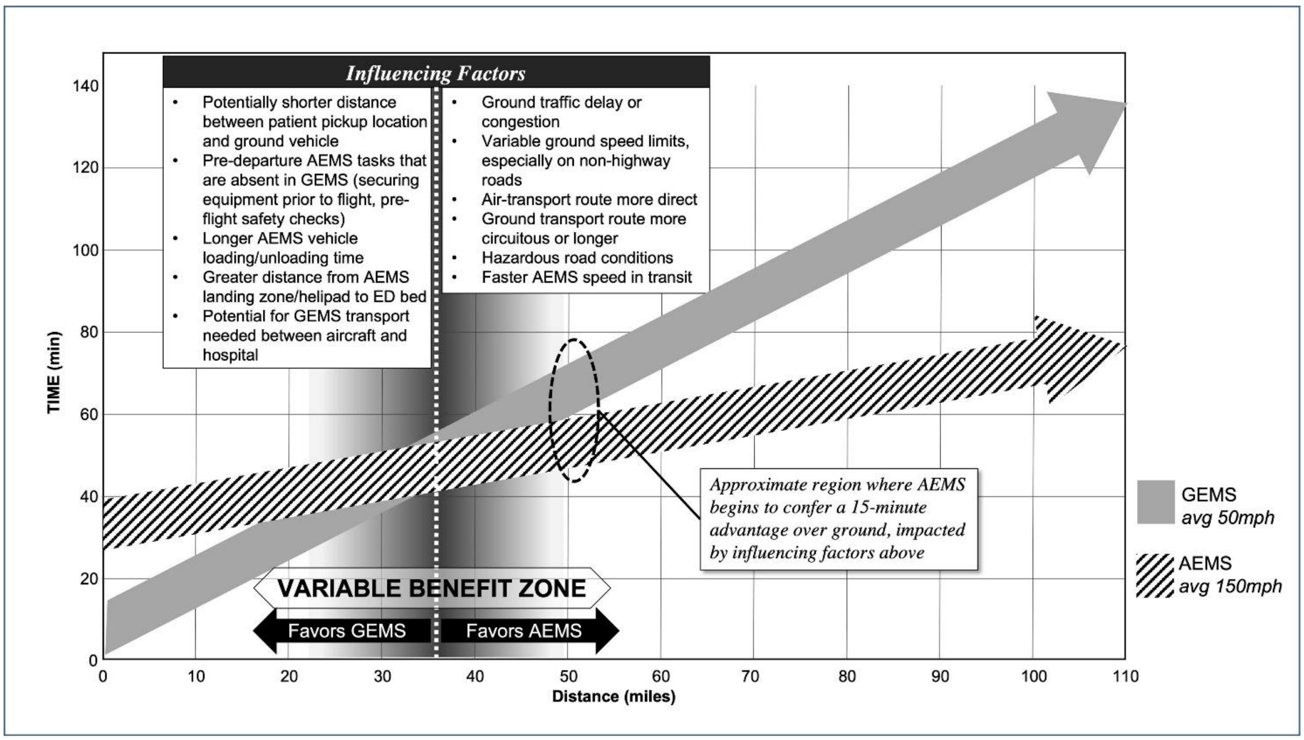


Figure 5.1: Conceptual model ground EMS vs Aeromedical EMS time-saving benefit (Lyng et al., 2021a)

5.2.3 Theme 2: Context specifics

The scoping review findings also revealed context-specific gaps because the majority of the studies were conducted in first-world countries with a different socio-economic profile. This reflects a limitation in terms of applicability for developing countries such as Namibia, which has recently been reclassified from an upper-middle-income country to an LMIC by the World Bank (2025).

Developing countries face challenges of resource limitations, vast distances and limited aviation infrastructure, such as landing strips and the availability of aircraft particularly configured for aeromedical IFTs, resulting in poor feasibility (Mould-Millman et al., 2017). An included study from the scoping review looked at how a developing country with similar socio-economic and infrastructural challenges as Namibia benefits from the use of aeromedical transport. Haiti is a mountainous country with poor roads that make ground ambulance transport over long distances difficult and even dangerous. There are only a few hospitals that offer high-quality intensive care, and they are not evenly distributed geographically throughout the country, making the utility of aeromedical IFT even greater in this setting than in many developed countries (Degennaro et al., 2016).

5.2.4 Theme 3: Mortality predictors

Some literature suggests that aero medically transferred trauma patients may experience better clinical outcomes, including lower mortality rates, compared to those who are transferred by road ambulance (Vines et al., 2018). In a retrospective analysis from one of the included studies in the scoping review, it was found that most dispatch protocols rely on estimated ground transport time or distance in the decision to request aeromedical resources (Davis et al., 2005). This is important to note, as the association of improved mortality rates over longer transfer distances by air versus road transfers can be seen in an observational study based on the transfer of major trauma patients from the northern French Alps to definitive care (Ageron et al., 2020). The study used the TRISS predictive score of mortality and found that the Standard Mortality Ratio (SMR) was lower in the group of patients transferred by air compared to those transferred by road.

Two other studies from the scoping review also recommended the use of TRISS to predict the mortality of aeromedical IFTs compared to road IFTs (Brown & Gestring, 2013; Phillips et al., 1999). These results reflect developed countries with functional systems and thus higher rates of survival despite patient acuity. As transfers are rapid, there is continuous monitoring and advanced care in-flight and sometimes specialised staff as part of the transfer team (Masterson et al., 2020). Namibia has system constraints; there must be clear clinical criteria to guide when aeromedical IFTs are justified, safe, and resource appropriate. The mortality predictors may reflect differently for LMICs such as Namibia. Hence, the importance of this study is to develop clinical criteria for the initiation of aeromedical IFTs of adult trauma patients.

5.2.5 Theme 4: Relative contraindications

Trauma is a major burden of disease globally and is reflected through various MOI and anatomical injury patterns. In 2019, LMICs accounted for nearly 90% of deaths, with RTAs being the leading cause, with 1.35 million deaths annually, affecting the adult population extensively (Lou et al., 2025). In a Turkish retrospective review conducted on the air transport of trauma patients, it was found that of the 287 patients transported between January 2020 and May 2021, 125 patients were transferred by fixed-wing aircraft and 162 by HEMS. The most common indication for air transport in this study was due to multi-trauma, more specifically, blunt force thoracic trauma and fractures (Yorulmaz & Gökçe, 2022). Patients presenting with thoracic or chest wall injuries are 75% more likely to present with a pneumothorax (Beyer et al., 2025). The evidence from the scoping review indicated that several relative contraindications to aeromedical IFTs exist, with particular interest shown in conditions worsened by aviation physiology in cases such as an untreated pneumothorax and patients with acute blood loss leading to <30% haematocrit (Farzan et al., 2023; Joshi & Sharma, 2010; Ranjan & Renjhen, 2017). An untreated pneumothorax can rapidly progress to a tension pneumothorax, which can be fatal if not promptly treated (Beyer et al., 2025). Owing to the fatal nature of a tension pneumothorax, its management in LMICs is often affected due to the lack of robust trauma systems to mitigate risks of the rising mortality through prompt recognition and effective treatment (William & Charles, 2022). A patient with acute blood loss and <30% haematocrit is relatively contraindicated in the absence of blood transfusion mid-flight (Sunde et al., 2022).

Other contraindications found in the scoping review are: the increase in pressure during the ascent of an aircraft, which can result in the rise of intra-orbital or ocular pressure, which is then exerted on the optic nerve, leading to long-term vision impairment (Gündüz et al., 2025; Joshi & Sharma, 2010). Another external stressor that can affect a patient with a spinal injury in the absence of the appropriate immobilisation is the turbulence experienced by the aircraft, and thus cabin vibrations, can worsen a spinal injury (Suriyawongse, 2021). Finally, abdominal surgeries with gas entrapped in the GI may lead to the development of an air/gas embolism, which can lead to severe complications such as perforation, wound dehiscence and Deep Vein Thrombosis (DVT) development, just to name a few (Ranjan & Renjhen, 2017; Silverman & Gendreau, 2009). These relative contraindications form part of the clinical criteria framework and are there to guide practitioners not to inappropriately activate the aeromedical IFT systems if these conditions have not been managed first.

5.2.6 Theme 5: Triage and trauma scoring systems

The review results suggest that standard triage tools used for ground ambulance transfers were also used for aeromedical IFT. Trauma and triage scoring systems have characteristics that uniquely identify them as either anatomical, measuring anatomical injury severity (e.g. ISS, etc.), followed by the characteristics of physiology, which measures dynamic components of acute injury (e.g., TS and RTS, etc.), and lastly, trauma and triage scoring systems can be characterised by combined traits (e.g., TRISS) (Kaya et al., 2025). All system designs should have a characterisation of severity (Rapsang & Shyam, 2015). Because the scoping review was broad and had no date exclusions due to the limited available research in the aeromedical field, one study was conducted in 1994 in the UK on the military and civilian aeromedical experiences between 1964 and 1969 (Andrew, 1994). As early as 1964, the criteria used for aeromedical patient evacuation were a Trauma Score (TS) between 5-10. The TS uses Systolic Blood Pressure (SBP), Respiratory Rate (RR), and GCS scores to determine urgency. Scores can range from 3-15; scores ranging between 5-10 indicate the need for immediate transfer of a patient (Maher et al., 2019). The study suggest that patients with TS scores of 5-10 have a better chance of survival via aeromedical IFT compared to road transfers; however, TS of greater than 10 suggest no significant difference between outcomes for air versus road transfers (Andrew, 1994).

Aeromedical IFT yields increased benefits when stratified with triage or trauma scoring systems. In another study the benefits of an anatomical score and a combined score were assessed for added benefit to aeromedical IFT namely ISS. This score is calculated by assigning an AIS measured from minor to unsurvivable against a corresponding score of 1-6 to 9 parts of the body (head, face, neck, thorax, abdomen, spine, upper extremity, lower extremity and external or other). The ISS can range from 1 to 75 if multiple injuries are scored by adding the scores from the three highest AIS (Weaver et al., 2020). Injury severity scores between 16 and 60 enhanced benefits to severely injured patients requiring aeromedical IFTs (Brown & Gestring, 2013). The second score that was assessed was TRISS. This score was used to predict actual deaths of patients who were transferred by air or ground. In a study conducted comparing the mortality rates of air-transferred patients compared to the cohort transported by road saw a 52% mortality reduction. This may be due to the patients being directly transferred to trauma centres instead of non-trauma facilities in the case of road-transferred patients (Baxt & Moody, 1983).

Hospitals are not just centres for patient care but also serve as vital centres for research, enhancing clinical practice and addressing public health challenges (Gautam, 2025). Two studies from the scoping review were conducted in hospitals with research focusing on scoring systems and criteria to be used for aeromedical IFT activation. The first study is a cross-sectional study conducted at the Army Hospital, Patient Transfer Unit (PTU) of India, to formulate a protocol for the activation of Critical Care Air Transport for aeromedical transport teams (CCATT) (Dhawan et al., 2021). A statistical analysis was done of the two scoring systems: an original scoring system of the CCATT and a new modified scoring system of the CCATT used at this facility to conduct aeromedical IFT, evaluating sensitivity, specificity and agreement.

The original scoring system of CCATT attained 100% sensitivity over the 7 parameters, which include: (1) nature of illness, (2) hemodynamic stability, (3) airway integrity, (4) requirement for oxygen, (5) chest injuries, (6) risk of ongoing haemorrhage and (7) central nervous system. And is scored out of 20, with scores greater than 12 requiring the activation of CCATT. The original scoring system of CCATT had poor agreement with a kappa coefficient of 0.162 and equally low levels of specificity of 54%. On the other hand, the new modified scoring system of CCATT showed good agreement with Kappa coefficient of 0.895. This was due to the inclusion of early warning physiological scores. The new modified scoring system of CCATT also had 7 parameters, starting with: (1) Heart Rate (HR), (2) SBP, (3) RR, (4) temperature, (5) central nervous system, (6) oxygen requirements and (7) saturation levels. The first four parameters of the new modified scoring system of CCATT are physiological parameters; the scores range from 0-2 (elective evacuation), 3-5 (urgent evacuation with an Air Transport Team (ATT) and then scores greater than 6 require the activation of CCATT. The new modified scoring system had a 92% sensitivity and 97% specificity (Dhawan et al., 2021).

The second hospital-based study was a retrospective analysis study conducted in a Level II trauma centre in Ireland. The study assessed patients' need for emergency aeromedical services (EAS) (Quinlan, 2017). It was stated that the use of EAS was new to this hospital, thus data was collected about the patients from the patient logs, MOI, age, location and if there was any loss of consciousness. Despite the collection of this data from the patients' logs, details such as the MOI did not make it into the final EAS algorithm or appropriate hospital access criteria, which consisted of only three parameters, i.e., (1) anatomical parameters, (2) physiological parameters and (3) life-threatening injuries (Quinlan, 2017).

Several trauma systems use the MOI of a patient as a decision criterion for patient transport (Pswarayi et al., 2025). However, evidence from this scoping review, along with other studies, suggests that MOI alone is not a true clinical parameter or criterion for aeromedical IFTs of adult trauma patients (Boyle et al., 2008). The evidence analysed from this scoping review indicates that there was no clinical tool recommended with MOI as a preceptor for aeromedical IFTs. Though some articles mentioned them, they do not equate to aeromedical IFT criteria, but practitioners should keep a high index of clinical suspicion in view of MOI, especially in cases of significant occult injury.

In a single trauma centre study before 2005, patients were admitted with a severe MOI only (Cohort 1: 2001 to 2005). However, after 2005, this trauma centre introduced two new triage criteria for admissions: anatomical and physiological criteria (Cohort 2: 2007 to 2010). The study compared the two cohorts and found that the MOI cohort resulted in over triaging, whereas the anatomical and physiological cohort reduced over triaging from 66% to 9%. The patients with MOI as triage criteria and no other clinical criterion were referred to community hospitals; however, if major injuries were identified, these patients were referred to trauma centres (Stuke et al., 2013). As per the current national referral policy guidelines in Namibia criteria guide practitioners to refer patients from district, regional and national health centres based on their clinical presentation and not their MOI in isolation (MoHSS, 2015). The importance of this study was to develop aeromedical IFT clinical criteria for adult trauma patients in Namibia.

5.2.7 Theme 6: Clinical indicators

One of the findings from this scoping review is that the physiological parameters such as GCS, SBP, saturation oxygenation and ventilation in adult trauma patients require the highest priority during clinical decision making (Cannon et al., 2018). This is because these clinical parameters can indicate if the patient is presenting with shock and thus requires more emergent care, or if the patient is presenting with respiratory failure with worsened clinical outcomes in the presence of severe trauma (Daya et al., 2020; Newgard et al., 2020). This is followed by injuries as per the anatomical regions: head trauma, TBIs, thoracic injuries with signs of a pneumothorax or flail chest, pelvic or femur fractures, spinal cord fractures, burns and any injury which may endanger an extremity (Reno, 2010). These findings reinforce the importance of aeromedical IFT benefiting those who need it the most. Although the findings from this study echo current literature, there are some methodological weaknesses and limitations in generalisability due to inconsistencies found in the literature pertaining to specific clinical indicators.

5.2.8 Theme 7: Multidisciplinary staffing

Multidisciplinary staffing was reflected in many of the studies in this scoping review (Degennaro et al., 2016; Duchateau et al., 2009; Renz et al., 2000). According to literature, an ideal aeromedical team comprises paramedics, nurses and specialist physicians with trauma experience (Galvagno et al., 2014). Outcomes of patients in an aeromedical IFT with a multidisciplinary treating team had improved outcomes as patients were easily stabilised, had fewer complications and improved outcomes (Degennaro et al., 2016). Low and middle income countries experience different staffing challenges with disproportioned staff-to-patient ratios and variations pertaining to the staffing in the private versus public sectors. The idea of three crew members responding to an aeromedical occurs seldom in Namibia, as most aircraft do not have the weight-bearing capacity for five pax and two crew members, as the aircraft used for aeromedical IFT are small, and weight considerations should always be taken for aeromedical IFTs (Farzan et al., 2023).

5.2.9 Theme 8: Skill and procedural requirements

Results from the scoping review indicate that skills performed by a practitioner during an aeromedical IFT are an indication of the practitioner's capabilities. A regional study by Vlok,Wylie and Stassen (2023) on HEMS usage in over four provinces in South Africa, was conducted over 12 months. There was a total of 916 patients included of which 713 were IFT by air. These results indicated that the biggest cause of trauma was as a result of blunt force trauma (n=184,20.1%). Clinical interventions and procedures conducted in-flight were ETT (n=428, 45.2%), IVI placement (n=867, 94.7%), sedation (n=430, 46.9%) and analgesia (n=329, 3.9%). This indicates that patients who are transported by aeromedical IFT are generally presenting with airway compromise, depressed GCS and higher levels of pain (Vlok et al., 2023). The results from this study also highlight the need for vascular access for medication, fluid administration and predictive clinical course (Maddry et al., 2021).

Overall, this scoping review demonstrates that international literature is necessary for guidance on aeromedical IFTs although it lacks the needed context specificity required for the Namibian setting. The sparsely published literature on studies addressing clinical criteria for aeromedical IFT in LMICs amplifies the importance of this review. This addresses this gap by situating global evidence within the Namibian aeromedical setting. On the finer scope of this review, methodological weaknesses can be seen in contextual applicability and weak transferability of findings to LMICs with resource restrictions. The discordance between what is considered the ideal multi-disciplinary staffing model is not applicable to LMICs, leading to low levels of feasibility and highlighting the need for local context-specific models.

5.2.10 Phase 2: Steering committee

Phase 2 of this study comprised establishing a multi-disciplinary SC to review the clinical criteria framework derived from the main themes emerging from the scoping review, to refine the framework and statements included in the Delphi rounds. The composition of SC members ensured adequate representation of the private and public health sectors. The varied professional backgrounds of the SC offered valuable insight into the clinical decision-making practices across emergency care, prehospital setting and the in-hospital setting. This multidisciplinary input aligns with best practice recommendations for the effective application of the Delphi methodology (Best et al., 2025).

Building on this collaborative foundation, the SC participated in a pilot survey to evaluate and vote on the various clinical iterations that would further anchor the framework. Part of the results from the pilot survey indicated the preferred triage and trauma scores. The main tools proposed by the literature and contextually relevant to the Namibian setting were the SATS, RTS and ISS. The South African Triage Score received the highest consensus reflecting its widespread use in EDs across Southern Africa and its proven adaptability in a resource-constrained environment, such as developing countries (Luft et al., 2020). The preference for SATS indicates African regional alignment, particularly amongst LMIC and UMIC, where it has already been implemented in countries such as Somalia, Malawi, Ghana and South Africa, to mention a few (Meyer et al., 2018). The use of SATS in these regions is also for its versatility, as it is used in both the prehospital and in-hospital settings. The South African Triage Score prioritises clinical criteria when considering transfer needs for patients (Sunyoto et al., 2014).

The SC further reached consensus on four categories. The first, physiological parameters, proven to be universally clinically relevant for the request of aeromedical IFT, obtained high consensus, while the second, resource, time and capabilities, reached above 70% consensus, speaking to Namibia's geographically vast distances and infrastructural limitations in providing trauma care. The third, clinical procedures, had varying degrees of consensus. This disparity speaks to the dual health care system in Namibia, where some establishments may be able to fulfil certain operational requirements and others not, particularly in the aeromedical space. Finally, specific injuries, the 4th category, highlighted the main injuries requiring aeromedical IFTs with high consensus. This is consistent with recommendations made by the literature that these injuries are life-threatening and should be considered for aeromedical IFTs (Galvagno et al., 2014).

The interpretation of the results from phase 2 is that the SC was able to recommend themes for the Delphi rounds and solidified their input by the results from the pilot survey, which was done anonymously. This way, the SC was able to use evidence from literature to contextualise it to the Namibian setting. The results from the pilot survey and input from the SC also emphasise the need for versatile clinical criteria which incorporate urgency, time, capabilities and distance considerations.

Although distance limitations and physiological parameters mimic those of developed countries with fewer financial constraints, on the other hand, resource unavailability and extended out-of-hospital times reflect the unique challenges of LMICs (Mould-Millman et al., 2017). Moreover, the affirmation of SATS as the preferred triage tool indicates that practitioners gravitate towards standardised clinical tools which are easy to use and have already been incorporated into local and regional trauma systems.

Two significant comments were made by the SC to further strengthen and contextualise the framework. The SC recommended the inclusion of a special population to identify criteria for adult obstetrics patients and geriatrics patients. The inclusion of the special population was further refined by the researcher and the research supervisors based on the literature.

The American College of Surgeons 2021 established an expert panel that reviewed national guidelines for injured patients. The experts recommended geriatrics >65 with signs of hemodynamic instability as a criterion red and thus immediate transfer to the highest level trauma centre (Newgard et al., 2022). They also recommended the inclusion of obstetrics patients with >20 week pregnancies as category yellow patients who should be transferred to a trauma centre within a geographical area, as they were considered a moderate risk (Newgard et al., 2022).

The second comment that had a significant influence was the recommendations by the SC to include the WHO IITT as a triage scoring system for expert opinion, which was relevant to the Namibian contextualisation of criteria. The SC advised the addition of the WHO IITT as there is an internal reform within the MOHSS, which indicated that the government health agency is moving away from SATS, as its main triaging tool and adopting the WHO IITT, which is more applicable for limited-resourced environments like LMICs (Mitchell et al., 2021).

In summary, phase 2 employed the SC to review the evidence of the literature from phase 1 and to apply it by formulating clinical statements for the Delphi rounds. The pilot survey gave further validation to clinical statements indicating the feasibility of actually developing an aeromedical IFT CDST specific to the Namibian context, as evidenced by the literature and the experiences of experts.

5.3 Phase three: Delphi rounds

Aeromedical IFT criteria are important in a trauma system as they ensure the appropriate and safe transport of trauma patients to definitive care. This has proven to yield better clinical outcomes and reduced mortality rates (Andrews et al., 2024). This modified Delphi study aimed to develop clinical criteria for aeromedical IFTs of adult trauma patients in Namibia through expert consensus. A Delphi technique is a scientific method to organise and structure expert opinions on thought-provoking topics, with limited information available on the topic (Chuenjitwongsa, 2017). The Delphi method is often used in the field of health sciences as it is useful when constructing policies, Clinical Practice Guidelines (CPGs) and clinical criteria (Williams et al., 2017).

One of the key features of the Delphi technique is that it allows experts to participate and give comments anonymously. The methods used in this Delphi were quantitative descriptive methods through two rounds of data collection from experts through highly structured anonymous group interactions (Woodcock et al., 2020). The findings from this Delphi reflect similar alignment to regional and international clinical criteria within LMICs with resource limitations (African Union Mission in Somalia (AMISOM)—Burundi, 2018). A simple tool was created from the consensus statements called the Aeromedical IFT CDST for Adult Trauma patients in Namibia. This tool aims to support health practitioners with decision-making capacity to recognise clinical criteria in adult trauma patients who require rapid aeromedical IFT. **Figure** 5.2 reflects the pathway of this two-round modified Delphi, culminating in the identification of clinical criteria and development of the CDST.

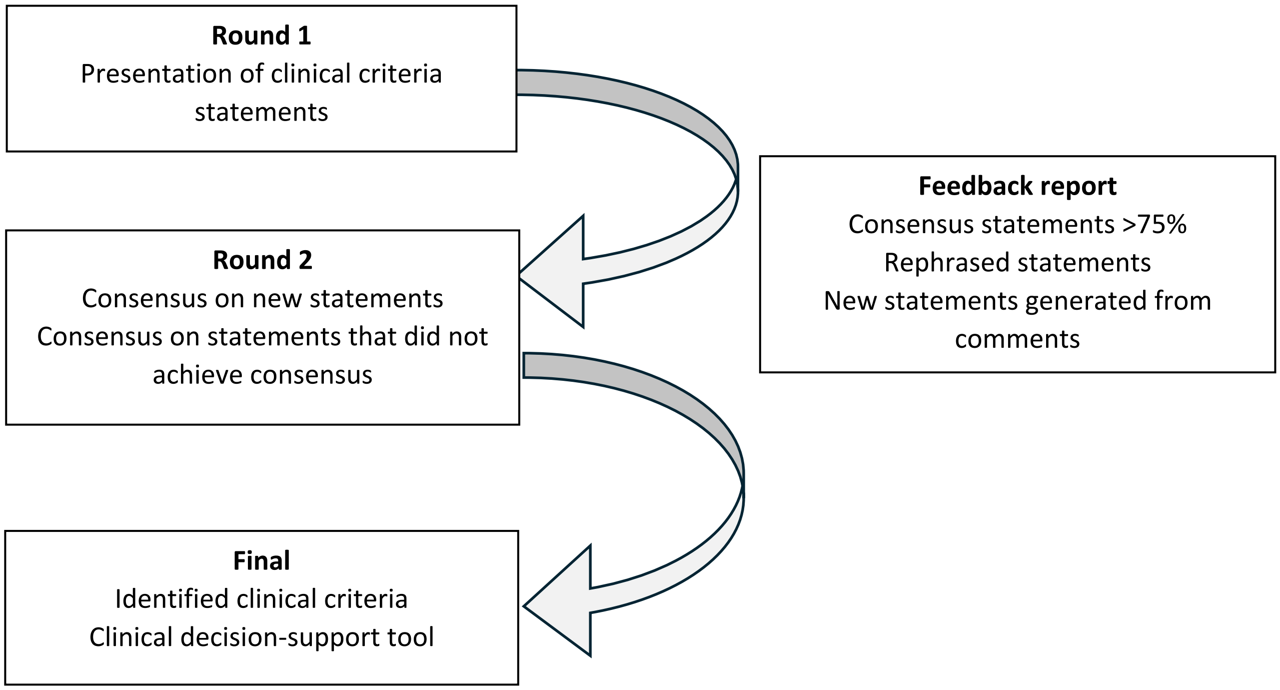


Figure 5.2: Two-round modified Delphi

The global impact of trauma cannot be overlooked, as it is a burden and disproportionately spread in LMICs like Namibia, with several health resource limitations (Law & Vanderploeg, 2011), hence, the importance of clinical criteria because the criteria can inform practice and thus improve patient clinical outcomes; thus indirectly lessening the burden of trauma contextually (Stewart et al., 2019). The Delphi method is considered as consensus-seeking evidence falling on the lowest level of the hierarchy of evidence; however, the methods of the Delphi are useful in emerging fields, such as in this study, which is looking at the development of clinical criteria for aeromedical IFT of adult trauma patients in Namibia (Sekayi & Kennedy, 2017).

The wisdom of crowds describes that the principle of the aggregate opinion of a group is more accurate than the opinion of an individual (Simoiu et al., 2019). Similarly, the Delphi method can be described as a strategic process of addressing a problem as a group of individuals (Barrett & Heale, 2020). The Delphi method was initially designed for business forecasting by using expert panellists to address a complex problem, assuming that the collective judgements of a group are more valuable than those of an individual (Nasa et al., 2021). This is, however, where the similarities between the “wisdom of crowds” and the “Delphi methods“ end. There are key characteristics to appraise the strength of a Delphi study. In this study, experts were asked to identify clinical criteria of aeromedical IFTs of adult trauma patients by establishing a consensus of >75%.

Expert panellists completed a two-round modified Delphi and reached consensus on some criteria which would form part of the development of clinical criteria for aeromedical IFT of adult trauma patients in Namibia. The results from the two rounds of the Delphi echo some themes as found in literature pertaining to clinical criteria, trauma and aeromedical IFTs. Some of the results also indicate certain parameters of consensus as contextualised feedback from the EPs on the Namibian setting.

5.3.1 Specific injuries

The section on specific injuries had the highest number of consensus statements, highlighting that EPs considered the patient's injury profile as one of the most central reasons for requesting aeromedical IFTs. This aligns with literature that considers injury severity scores based on anatomical and physiological parameters as a strong mortality predictor (Andara et al., 2022). The agreement on severe TBI, spinal injuries with neurological deficits, hemodynamic instability and pelvic injuries indicates EPs' alignment with recommendations made by the American College of Surgeons trauma triage criteria, which refers such patients rapidly to Level 1 trauma centres as they require time-sensitive interventions, where delay to definitive care can worsen clinical outcomes (Newgard et al., 2022).

Despite Namibia's resource limitations and underdeveloped trauma system, EPs' feedback from the Delphi indicates that the clinical perceptions and decision-making patterns of local practitioners align with those of the global community on trauma management (Fresku et al., 2024). This further indicates that EPs understand which injuries will receive the greatest benefit from aeromedical IFT, where certain specialist care is not readily available. However, Namibia's vast landscape, limited aeromedical fleets and imbalanced distribution of specialists do not guarantee improved patient outcomes. Thus, contextual examination of the feasibility and system-level impact of aeromedical IFT should be further studied (Van Hoving et al., 2008). The emergence of the results under this section highlights the need for standardised criteria to mitigate the reliance on the judgement of an individual practitioner, which can lead to inequities and variance (Björklund et al., 2021).

5.3.2 Trauma and triage scores

The trauma and triage scores that had the highest level of consensus included the SATS, RTS and ISS. These scoring systems primarily measure physiological and anatomical parameters (Kaya et al., 2025). They are well structured, give clear instructions and prevent practitioner subjectivity. This finding illustrates that practitioners in high acuity trauma settings prefer the use of standardised clinical decision support tools to reduce cognitive load (Wilson et al., 2025). The findings also indicate that public and private practitioners in Namibia share a common understanding of the ease of reference and international alignment of these scores, which are valuable in practice. Furthermore, the results of these scores suggest that practitioners would be open to a structured CDST to aid in managing the aeromedical IFT (Dhawan et al., 2021).

However, this study has shown great variation across different countries and the scoring systems which they use, such as field triage algorithms, injury severity scales and physiological scoring methods. This signifies an important limitation to the practice of research comparability (Duchateau et al., 2009). Expert Panellists in this study confirmed these variations, which also mimic the Namibian public-private health system. Pertaining to the results from the study, these scores may be interpreted differently on the basis of resource constraints in the public health sector and ease of patient escalation to the private sector, reemphasising the need for a standard CDST contextualised to the Namibian setting (Sethi & Subramanian, 2014). The study results indicate consensus with well-developed scores, highlighting the gaps in LMICs with resource constraints, infrastructural variance and thus the need for a context-specific CDST for aeromedical IFT of adult trauma patients in Namibia.

5.3.3 Clinical procedures/Interventions

Continuous drug infusions and advanced monitoring indicate that trauma patients requiring aeromedical IFT are inherently high acuity patients (Laverty et al., 2020). Underpinning the need for a sufficiently equipped and qualified multidisciplinary team, as recommended by literature, these teams need to be able to maintain clinical and physiological stability of patients during aeromedical IFTs (Hardcastle et al., 2011). Patients requiring aeromedical IFT should be stabilised and adequately monitored prior to and during aeromedical IFT (Bharath et al., 2025). These are some of the foundational guidelines of safe aeromedical practice due to the already challenging practice of aeromedical IFT, as aircraft used in LMICs are generally narrow, which can make it difficult to reach and treat an unstable patient (Neill et al., 2023).

5.3.4 Physiological parameters and clinical status

Experts had the highest level of agreement on criteria pertaining to the patient's physiological stability, such as the ability to maintain airway, oxygenation and ventilation and vital sign trends, as the best pre-transfer requirements with high consensus. This resonates with regional and international criteria, which prioritise airway patency and respiratory adequacy prior to an aeromedical IFT(Park et al., 2020). It also strengthens the recommended criteria from this study on a broader scope, as there is clear alignment across the context, and despite resource constraints, that airway and ventilation adequacy are paramount to the decision to initiate an aeromedical IFT (Araiza et al., 2021).

5.3.5 Distance, time, resources and capabilities

Expert Panellists identified local resource constraints as a very important determinant for the decision to request an aeromedical IFT, reflecting the operational realities in Namibia's fragmented, resource-constrained trauma system, similar to other LMICs (Whitaker et al., 2019). However, treatment aims are the same as those of developed countries, that is, to improve the survival of patients. These results reflect that although clinical urgency is important, it should be balanced against the feasibility of the logistics, such as weather conditions, availability of pilots, night landing capacity and the capabilities of the referring hospital. This is similar to what was observed in the findings from a study in Haiti on patients requiring air transfers with various distance, time and capability challenges (Degennaro et al., 2016). Infrastructure and resource limitations are one of the greatest barriers to an effective trauma system. The lack of available resources and infrastructure also hampers equal access to aeromedical care services, particularly in LMICs (Zamani et al., 2025)

5.3.6 Special populations

Opinions by EPs on the special populations, namely, geriatric and obstetrics patients, with reference to trauma and their need for aeromedical IFTs, indicated a divergence from the international evidence base. Obstetric patients with a gestational age of >26 weeks or more obtained consensus in round 1 of the Delphi study. This suggests that EPs identified the additional risk associated with obstetrics patients with signs of trauma (Giacalone et al., 2022).

In contrast, the second statement under special populations was geriatrics older than 60 years, which did not obtain consensus despite going through both rounds of the Delphi. These findings do not necessarily mirror what is found in international literature, where geriatric patients, by virtue of their age, are considered to have higher morbidity and mortality results with more complex aeromedical IFT needs (Prorok et al., 2022). These results in relation to international literature on clinical criteria for aeromedical IFT of geriatric patients stem from the studies conducted in developed countries with an ageing population (GBD 2023 Disease and Injury and Risk Factor Collaborators, 2025). Since there is no globally standardised clinical criterion for aeromedical IFT of adult trauma patients, a call for a more refined, patient-centred criterion, including various comorbidities and different risks pertaining to special populations, should be considered (Ambatipudi & Havens, 2025).

5.3.7 Relative contraindications

The literature did not identify true contraindications for aeromedical IFTs, however, relative contraindications for which practitioners should take caution namely, untreated and severe pneumothorax, unrelated eye surgery (7-14 days), ROSC with poor prognosis, spinal injury with inadequate immobilization, acute blood loss with haematocrit <30% and recent abdominal surgery/untreated abdominal injury with confirmed entrapped gas in the peritoneum/GI tract, were highlighted. Albeit no obsolete contraindications were identified in this study, context-specific and risk benefits should be coupled with physiological stability, transfer distances and resource availability in decision making.

5.4 Aeromedical IFTs CDST for adult trauma patients in Namibia

The development of this CDST **(Figure 16)** was grounded on the basis of establishing a standardised, evidence-based and Namibian contextualised support tool to inform practice for clinicians and relevant decision makers on clinical criteria for aeromedical IFT of adult trauma patients. The parameters reflect the final 28 statements of consensus from this Delphi study.

Prior to this study, no clinical tool existed to support practitioners in making consistent, timely decisions regarding aeromedical IFTs. The National Referral Policy (2015) of Namibia also did not address the referral process specifically to aeromedical IFTs. This tool aims to reduce the variation in practice pertaining to aeromedical IFTs in both the public and private health settings (MoHSS, 2015). In addition, the tool aims to reduce the delay in definitive referrals for aeromedical IFTs and prevent the inefficiencies of the use of the very costly aeromedical resource.

The CDST is anchored on international evidence and contextualised to Namibia. The methodological process, which is the foundation of this tool, was based on a higher threshold of consensus statements that were >75% this was to ensure that the clinical decision-making tool was reliable through the high-confidence consensus statements. The final format of this clinical decision-making tool on aeromedical IFTs of adult trauma patients in Namibia was made to enhance usability, reduce cognitive load and support rapid decision-making in often incredibly stressful, high-stakes trauma environments for practitioners. The CDST design enables practitioners to navigate through injuries, procedures/interventions, while integrating physiological parameters, assess for special populations, consider operational factors, calculate relevant triage or trauma scores, rule out relative contraindications, and finally make the decision to refer the patient for aeromedical IFT or ground ambulance (Cubukcu & Canbaz, 2025).

The tool requires validation and evaluation, which can be done through field testing, so as to get user feedback from practitioners in operational capacities. This will help to strengthen the reliability and applicability across the Namibian setting. Penultimately, this CDST indicates a step towards standardising clinical criteria for the initiation of aeromedical IFTs of adult trauma patients in Namibia. By offering a structured evidence-based clinical decision-making tool to support consistent, timely decision-making and thereby improving patient outcomes while appropriately utilising available aeromedical resources (Mwandri & Metcalfe, 2025).

5.5 Contribution of the Study

This study adds to the existing body of knowledge by being the first piece of literary research conducted in the Namibian setting on the development of clinical criteria for aeromedical IFTs of adult trauma patients. The study's contributions, particularly its methodological approach through a scoping review of the literature, identified unique challenges faced by LMICs and developed countries in aeromedical IFTs. Highlighting the unique challenges in the health setting when resources are limited. The Delphi methodology in this study re-emphasised the effect of limited rounds and its impact on the reliability and generalizability of study results, which future researchers can consider when using the methodology.

The outcomes of this study can be considered by the MoHSS for inclusion in their National Referral Policy Guideline for physicians across Namibian state healthcare facilities, outlining clinical criteria for aeromedical IFTs. There is currently a gap in the National Referral Policy Guidelines for Namibia specifically addressing the aeromedical IFT gap.

International organisations such as the WHO and other donors can refer to the outcomes of this study and channel aeromedical care resources to people in remote areas of Namibia. The study findings can be used to create uniformity across all health stakeholders regarding aeromedical IFTs and thus improve interagency engagements in Namibia.

Finally, the development of clinical criteria for aeromedical IFT of adult trauma patients in Namibia allowed the researcher to develop a tool (Figure 4.14), specific to the Namibian setting, which if validated can provide industry synergy.

5.6 Summary

Altogether, the scoping review established evidence that aeromedical IFT is an important tool to use in a trauma system and can improve trauma outcomes. However, well-defined, context-specific clinical criteria have not been established, particularly in developing countries. Framework development is a key factor when considering criteria development; it should thus be robust and methodologically accurate. This finding of fact justified the progression of this study through the establishment of an SC in phase 2, which served as a guide and another level of quality assurance to the framework development for the establishment of clinical criteria for aeromedical IFT of adult trauma patients, specific to the Namibian context. The Delphi method used in phase three formed the core of this study as it built consensus through expert opinions, through a well-structured process of conceptualisation and the conduction of the Delphi rounds. The results from the Delphi rounds were also used to design the draft CDST that can be circulated to relevant stakeholders by simplifying the criteria through an easy-to-follow guide. This amalgamation showed the union of the evidence of literature from the scoping review and the context-specific expert input based on consensus statements.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

The recommended clinical criteria for aeromedical IFTs of adult trauma patients are multifaceted. The considerations to be made when presented with a trauma patient in the clinical setting requiring aeromedical IFT transport require practitioners to have a holistic approach. The body of literature surrounding the topic of developing clinical criteria for aeromedical IFTs of adult trauma patients in Namibia identified various themes and commonalities across various countries. Owing to the rapid increase in trauma-related injuries in LMICs, this study aimed to utilise the perceptions of experts to critically and systematically ponder the clinical criteria for aeromedical IFT of adult trauma patients in Namibia.

6.2 Conclusions

This study found that overall, existing literature on clinical criteria for aeromedical IFT of adult trauma patients is limited. And there are currently no known studies on aeromedical IFT in the Namibian setting. With the growing burden of trauma globally and in LMICs, effective trauma systems require a prompt response to the needs of trauma patients. The availability of aeromedical resources can be used to strengthen trauma systems and serve as a link between patients and specialist care (Bastian & Fulton, 2014).

Literature suggests that aeromedical IFTs used in response to trauma cases add a time-saving benefit when compared to ground transfers. This time-saving benefit is, however, the most useful to rural and austere settings where patient transfers are over long distances and often difficult terrains for ground transport (Maddry et al., 2022). The scoping review of literature identified key themes pertaining to aeromedical IFTs and informed the framework for the Delphi rounds. These themes focused on: time-saving benefit, multidisciplinary staffing, mortality indicators, relative contraindications, special populations, specific injuries, trauma scoring systems, and limited representation of LMICs. Thirty-three articles met the pre-set inclusion criteria for this study on the development of clinical criteria for aeromedical IFT of adult trauma patients. The majority of the studies were reflective of a developed country that is well-resourced and able to effectively respond to the trauma needs of a population (Toner et al., 2017). This allowed for the appropriate literature to steer the study process as the results from the scoping review echoed throughout the different study phases, including in the CDST. The SC comprised a team of industry experts in the prehospital and in-hospital fields who were an important part of this study. They reviewed the framework derived from the scoping review and refined it further through the completion of a pilot survey, where comments were added for consideration or adoption by the researcher.

The Delphi methodology has attracted much attention to health sciences over recent years due to its unique structure based on anonymity, feedback and iteration. It is, however, beneficial for emerging concepts, as in the case of this study (Brady, 2015). The results from the Delphi rounds yielded suitable clinical criteria in relation to the Namibian context, with 28 consensus statements from domains such as physiological parameters, clinical interventions, specific injuries, special populations and relative contraindications. The clinical criteria express a broad consideration of domains, with some domains agreeing with international literature recommendations for criteria and some speaking to the Namibian context specifically. Namibia is a geographically vast country with centralised health services. Experts agree that patients requiring transfers over distances >250km should be transferred by aeromedical IFT. The literature suggests using various triage and trauma scoring systems to refer trauma patients to aeromedical IFT. Though there were variations in the literature, the EPs agreed on three main scores: with SATS dominating this category, followed by RTS and ISS. The consensus statements were translated into a CDST for a simplified reference to be considered for use in practice.

This study added to the body of knowledge in the literature on the development of clinical criteria for aeromedical IFT of adult trauma patients through a rigorous scoping review of the literature. Herein, contextual knowledge gaps relating to LMICs were identified in relation to clinical criteria for aeromedical IFT of adult trauma patients. It also contributed to context-specific knowledge about the Namibian setting based on the Delphi rounds, which provided expert opinions on clinical criteria for aeromedical IFT of adult trauma patients in Namibia. And with the design of the draft CDST, the study can contribute to further policy development pertaining to clinical criteria development for aeromedical IFTs of adult trauma patients in Namibia. The low response rates during the Delphi resulted in non-representatives of EPs in the fields of surgery, anaesthesiology, etc. These experts may, however, hold key knowledge on the subject of this study, as they are the registered specialists who would ideally lead treatment of the trauma patients, depending on the patient's clinical presentation (Ngoie et al., 2025). There were only two Delphi rounds constructed, which may question the statistical validity of the study to truly inform practice (Keeley et al., 2016). There is still room in the Namibian setting for future concepts on aeromedical care to be explored.

6.3 Recommendations

The findings of this study offer knowledge contribution and several implications for practice, policy and future research related to aeromedical IFTs of adult trauma patients in the Namibian context.

6.3.1 Implications for practice

There are three main outcomes which aeromedical services should aim for: initiation or continuation of locally unavailable or specialist care; rapid delivery of patients to definitive care for time-sensitive interventions; and retrieval of patients from remote or otherwise inaccessible areas that limit timely access to the necessary care (Lyng et al., 2021a). These preceptors aim to improve patients' clinical outcomes, reduce mortality rates and guide clinical practice (Lentz et al., 2021).

On developing clinical criteria for aeromedical IFT of adult trauma patients, this study has several implications for practice in Namibia. One of the first contributions is the addition of evidence-based clinical criteria, which will aid practitioners in making objective and structured decisions when facilitating aeromedical IFT. The construction of the CDST is forged from the consensus of EPs from the public and private sectors, thus its use is relevant in both public and private clinical settings, allowing for standardisation of care. Because of the limited aeromedical resources in Namibia, the evidence from this study will enhance appropriate resource allocation to time-sensitive and clinically appropriate cases. The study evidence will create the opportunity for upskilling of practitioners, specifically in areas such as airway management, sedation and hemodynamic stabilisation, aligning with procedural demands commonly observed in aeromedical IFT (King et al., 2019). This will build capacity amongst the aeromedical IFT retrieval teams.

The study findings identified clinical criteria specifically related to physiological and anatomical parameters, aligning with international literature but adapted to the Namibian context (Neill et al., 2023). These physiological and anatomical parameters provide direct measurable outcomes and, in turn, ensure that the most critically injured patients have early access to definitive care, thus avoiding delays, which currently contribute to morbidity and mortality (Khodarahmi et al., 2025). Evidence from this study relates to international research on improving aeromedical IFT practices. In a retrospective Turkish study, the clinical outcomes of trauma patients who were transferred by HEMS from the scene to a dedicated trauma centre were analysed, using a scoring tool to determine transfer criteria. The scoring tool assessed three clinical criteria: GCS, age and SBP (GAP) to assess patient aeromedical transfer protocols. The study found that using a scoring tool helped practitioners make more informed transfer decisions on the basis of physiological parameters, anatomical structures and age of the patients. This resulted in a drop in patient delays, particularly for patients with clinical conditions that were time sensitive (Arı & Usul, 2025).

The study findings, once validated, can also be used to strengthen coordination between rural, intermediate and tertiary health facilities. By streamlining communication, reducing IFT disputes and ensuring receiving facility readiness to provide advanced trauma patient care upon patient arrival. Allowing rural practitioners with limited resources, distance-time challenges to maintain a high index of suspicion and promptly activate aeromedical IFT when more advanced clinical interventions and procedures are required (Araiza et al., 2021). These include, but are not limited to, the need for mechanical ventilation, endotracheal intubation and continuous drug infusions, just to name a few (National Highway Traffic Safety Administration[NHTSA], 2006). The early activation of aeromedical IFT is important in specific cases, such as TBIs with suspicion of ICP, polytrauma patients, as agreed on by EPs' consensus in this study. An expansive detail of clinical criteria can be found in the CDST **(Figure 4.14)**.

In summary, consensus derived from this study offers a foundation for the standardisation of clinical criteria of aeromedical IFT of adult trauma patients in Namibia. Criteria derived from this study will also better advise triage protocols by increasing precision, which would make the accuracy of patient allocation better. The compilation of the criteria statements and construction of the CDST will aid practitioners in streamlining transfer decisions, which will better utilise the very costly aeromedical resource. Patient health will also be enhanced as practitioners can refer to the CDST for aeromedical referral guidance, ensuring that the patient who needs the aeromedical referral actually benefits from it.

6.3.2 Implication for policy

It is recommended that the CDST should undergo a stepwise evaluation and validation process to ensure usability, accuracy and contextual alignment to the Namibian health system. This can take the form of pilot testing a single centre, e.g., Intermediate Hospital Oshakati, to observe user applicability, especially those working closely with rural communities. Only thereafter should the aeromedical IFTs CDST for Adult trauma patients in Namibia be adopted into the Namibian national framework and considered for addition to the National Referral Policy Guidelines. These policy guidelines were last updated in 2015, according to reflected in the MOHSS database (MoHSS, 2015). Continuous evaluations and refinement of frameworks bring about greater validation (Ngoie et al., 2025).

This study also found that infrastructural resource constraints in the healthcare systems of LMIC require intense capital investments to improve systems (Pelletier, 2023). Expert Panellists indicated that the absence of night landing capacity can hamper aeromedical IFT. This is a key infrastructural element without which certain night aeromedical IFT cannot take place. Thus, a joint approach from the MoHSS and the Ministry of Works and Transport can address these shortcomings, especially in strategic locations.

A policy that can be broadly reviewed from the findings of this study is the general review of all curricula of healthcare practitioners involved in the process of aeromedical IFT of any trauma patients. Recommending for the inclusion of a unit of study based on aeromedical IFT, covering at least aviation physiology, safety, clinical management and logistic coordination (Imoehl et al., 2020). This will promote curriculum standardisation while allowing students to adopt a stratified knowledge of aeromedical IFT, particularly when team retrievals are required (Steuerwald et al., 2024).

Finally, evidence states that the health sector has one of the lowest levels of digital innovation, which is inherently expected, especially considering the ethical considerations surrounding patient information (Stoumpos et al., 2023). Governing authorities need to re-examine some policies that may hamper digital innovation in the health sector in Namibia, without compromising patient trust and confidentiality.

6.3.3 Implications for research

The use of the Delphi technique is important in health sciences as it helps to identify key areas, reach consensus and recommend clinical guidelines (Shang, 2023). Future research should build on the methodological challenges observed in the Delphi, particularly on participation attrition, which was one of the most common challenges experienced by researchers conducting Delphi studies. Further research can be done on survey participant retention strategies by incorporating incentives into the Delphi rounds (Cunningham et al., 2015). Incentivising survey respondents should be handled cautiously, and not to compromise ethical standards of the research. Participant responses could not be linked back to them, and therefore, researchers have to be cautious not to compromise data quality for survey responses in the face of incentives (Stecklov et al., 2018).

Research into the optimisation of the Delphi design can be further explored as the literature suggests that it is the use of ranking questions which can contribute to participant fatigue and disengagement when compared to rating questions (Del Grande & Kaczorowski, 2023). The research questions were generally long and had additional explanations attached to them, which may have deterred participants from completing the survey. As there were several tools described using abbreviations, this, however, requires expansion to add context for the survey respondents. The evidence suggests that concise questions or statements often evoke higher survey responses compared to longer statements. Additionally, attrition can be seen in studies where the sample size is larger, when the criteria or items to be voted on are more, and the arrangement of the survey can deter participants, leading to participant attrition (Cooper et al., 2018).

Targeted investigations can be conducted into domain-specific barriers, as this study highlighted low response and population exclusion of physician specialists. In a study on physician response rates to web-based surveys, it was found that one of the key reasons for a drop in the survey participants in the medical discipline was a “lack of time” or a “lack of survey burden” (Cunningham et al., 2015). The demographic representation of the survey participants in this study indicated a very low participation from those in the surgical fraternity. In round 1, there was one surgical representative; however, this participant dropped out in round 2 of the Delphi.

In the Namibian setting, qualitative or mixed method studies can be employed where there is both public and private sector representation at times, company policies may not allow medical practitioners to participate in any survey; thus, researchers should appeal to corporate governance when designing surveys that may speak to them and allow for survey participation (Sekayi & Kennedy, 2017).

Finally, future research should focus on observational studies to assess the external validation of the clinical criteria for aeromedical IFT of adult trauma patients in Namibia. This will provide evidence of how the criteria measures up in a real clinical setting, how decision-making for aeromedical IFT is affected and how timely the IFTs are conducted. There is a need to assess system efficiencies and, most importantly, observe patient outcomes (Mwandri M & Metcalfe, 2025). The continued evaluation and refinement of the clinical criteria will be essential in maintaining relevance, usability and alignment with the Namibian regional needs in an ever-changing care landscape (Cubukcu & Canbaz, 2025; Wilson et al., 2025).

REFERENCES

Adeloye, D., Thompson, J. Y., Akanbi, M. A., Azuh, D., Samuel, V., Omoregbe, N., & Ayo, C. K. (2016). The burden of road traffic crashes, injuries and deaths in Africa: a systematic review and meta-analysis. *Bulletin of the World Health Organization*, *94*(7), 510-521A. https://doi.org/10.2471/blt.15.163121

African Union Mission in Somalia (AMISOM)—Burundi. (2018). *Overview Delphi Survey: AMISOM Contributing Countries Continued Provision of Troops*. 1–22. http://www.rand.org/topics/delphi-method.html.

Ageron, F. X., Debaty, G., Savary, D., Champly, F., Albasini, F., Usseglio, P., Vallot, C., Galvagno, S., Bouzat, P., Bouzat, P., Albasini, F., Champly, F., Chapiteau, L., Haller, E., Hoareau, C., Levrat, A., Rancurel, E., Savary, D., Thouret, J. M., Venchiarutti, D. (2020). Association of helicopter transportation and improved mortality for patients with major trauma in the northern French Alps trauma system: An observational study based on the TRENAU registry. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine*, *28*(1), 1–9. https://doi.org/10.1186/s13049-020-00730-z

Alaze, A., Finne, E., Razum, O., & Miani, C. (2025). A questionnaire for a conceptual framework and interdisciplinary public health research using the Delphi technique—development and validation. *Frontiers in Public Health*, *13*(April), 1–9. https://doi.org/10.3389/fpubh.2025.1436569

Alharbi, S. A., Toit, P., Copson, J., & Smith, T. O. (2025). Factors Influencing Outcomes of Trauma Patients Transferred in Trauma Systems by Air or Ground Ambulance : A Systematic Review Factors Influencing Outcomes of Trauma Patients Transferred in Trauma Systems by Air or Ground Ambulance : A Systematic Review A. *Prehospital Emergency Care*, *29*(7), 935–947. https://doi.org/10.1080/10903127.2024.2440016

Alarhayem, A. Q., Cohn, S. M., Nunez, O., Eastridge, B., & Rasmussen, T. (2019). Impact of time to repair on outcomes in patients with lower extremity arterial injuries. Journal of Vascular Surgery, 69(5), 1519–1523. https://doi.org/10.1016/j.jvs.2018.08.179

Ambunda, P., & Lourens, A. (2022). Severe traumatic brain injuries secondary to motor vehicle crashes in two Namibian regions: A retrospective review. African Journal of Emergency Medicine, 12(3), 225–230. https://doi.org/10.1016/j.afjem.2022.05.006

Andara, R., Kadar, P. D., & Albar, H. F. (2022). Comparison of Injury Severity Score (ISS), New Injury Severity Score (NISS), Revised Trauma Score (RTS), and Trauma and Injury Severity Score (TRISS) In Predicting

Mortality In Polytrauma Patients At Haji Adam Malik General Hospital. *International Journal of Scientific and Research Publications (IJSRP)*, *12*(5), 400. https://doi.org/10.29322/ijsrp.12.05.2022.p12551.

Andrew, D. R. (1994). Helicopter ambulances in critical care. *Journal of the Royal Army Medical Corps*, *140*(1), 22–25. https://doi.org/10.1136/jramc-140-01-05

Andrews, T., Meadley, B., Cameron, P., Gabbe, B., Beck, B., & Dicker, B. (2024). *Review article : Pre-hospital trauma guidelines and access to lifesaving interventions in Australia and Aotearoa / New Zealand*. *January*, 197–205. https://doi.org/10.1111/1742-6723.14373

Anderson, A. M., Comer, C., Smith, T. O., Drew, B. T., Pandit, H., Antcliff, D., Redmond, A. C., & McHugh, G. A. (2021). Consensus on pre-operative total knee replacement education and prehabilitation recommendations: a UK-based modified Delphi study. *BMC musculoskeletal disorders*, *22*(1), 352. https://doi.org/10.1186/s12891-021-04160-5

Anghele, M., Moscu, C., Dragomir, L., Lescai, A., Anghele, A., & S, A. A. (2025). *Management of Polytraumatized Patients : Challenges and Insights into Air Transfer*. 1–15.

Aranda, J. (2017). Aeromedical transport. *CDEM*, nd. Retrieved from CDEM, https://www.saem.org/about-saem/academies-interest-groups-affiliates2/cdem/for-students/online-education/m3-curriculum/emergency-medical-services-(ems)/aeromedical-transport.

Aromataris, E., & Munn, Z. (2020, 01 20). *JBI Manual for Evidence Synthesis.* Retrieved from JBI: https://doi.org/10.46658/JBIMES-20-01

Arı, E., & Usul, E. (2025). Analysis of Adult Trauma Patients Carried by Helicopter Ambulance According to GAP Score. *The Anatolian Journal of General Medical Research*, *35*(2), 122–129. https://doi.org/10.4274/anatoljmed.2025.93585

Ashipala, D. O., & Langendorf, L. (2022). Experiences of spinal cord injury patients admitted to the rehabilitation unit at the national referral hospital in Khomas region, Namibia. *African Journal of Disability*, *11*, 1–8. https://doi.org/10.4102/AJOD.V11I0.1018

Barrett, D., & Heale, R. (2020). What are Delphi studies? *Evidence Based Nursing, 23*(3), 68-69. https://doi.org/10.1136/ebnurs-2020-103303

Black,, J. J., Ward, M., & Lockey,, D. (2004). Appropriate use of helicopters to transport trauma patients from incident scene to hospital in the United Kingdom: An algorithm. *Emergency Medicine Journal*, 355-361. https://doi.org/10.1136/emj.2002.004473

Barrios, M., Guilera, G., Nuño, L., & Gómez-Benito, J. (2021). Consensus in the delphi method: What makes a decision change? *Technological Forecasting and Social Change*, *163*(December 2020). https://doi.org/10.1016/j.techfore.2020.120484

Bastian, N. D., & Fulton, L. V. (2014). Aeromedical evacuation planning using geospatial decision-support. *Military Medicine*, *179*(2), 174–182. https://doi.org/10.7205/MILMED-D-13-00432

Baxt, W. G., & Moody, P. (1983). The Impact of a Rotorcraft Aeromedical Emergency Care Service on Trauma Mortality. *JAMA*, *249*(22), 3047–3051. https://doi.org/10.1001/jama.1983.03330460029027

Best, R. W., Campbell, J. T., Edwards, M. C., & Cline, L. L. (2025). An Overview of the Delphi Method's Origin, Modifications, and Use to Augment Instrument Development and Data Collection: A Research Note. *Journal of International Agricultural and Extension Education*, *32*(1). https://doi.org/10.4148/2831-5960.1497

Beyer, C. A., Ruf, A. C., Alshawi, A. B., & Cannon, J. W. (2025). Management of traumatic pneumothorax and hemothorax. *Current Problems in Surgery*, *63*, 101707. https://doi.org/10.1016/j.cpsurg.2024.101707

Bharath, F., Hanekom, S., Estherhuizen, T., & Lupton-Smith, A. (2025). Return to work of major trauma survivors from a private level 1 trauma centre in South Africa. *European Journal of Trauma and Emergency Surgery*, *51*(1). https://doi.org/10.1007/s00068-024-02712-7

Björklund, M. K., Cruickshank, M., Lendrum, R. A., & Gillies, K. (2021). Randomised controlled trials in pre-hospital trauma: a systematic mapping review. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine*, *29*(1), 1–16. https://doi.org/10.1186/s13049-021-00880-8

Boyle, M. J., Smith, E. C., & Archer, F. (2008). Is mechanism of injury alone a useful predictor of major trauma? *Injury*, *39*(9), 986–992. https://doi.org/10.1016/j.injury.2008.03.015

Brady, S. R. (2015). Utilizing and Adapting the Delphi Method for Use in Qualitative Research. *International Journal of Qualitative Methods*, 1-6. https://doi.org/10.1177/1609406915621381

Brown, J., Forsythe, R., Stassen, N., & Gestring, M. (2012). The National Trauma Triage Protocol. *Journal of Trauma and Acute Care Surgery*, 319-325. https://doi.org/10.1097/ta.0b013e3182572bee.

Brown, J. B., & Gestring, M. L. (2013). Does helicopter transport impact outcome following trauma? *Trauma*, *15*(4), 279–288. https://doi.org/https://doi.org/10.1177/1460408613497153

Butler, W. P., Steinkraus, L. W., Fouts, B. L., & Serres, J. L. (2017). A Retrospective Cohort Analysis of Battle Injury Versus Disease, Non-Battle Injury-Two Validating Flight Surgeons' Experience. *Military Medicine*, *182*, 155–161. https://doi.org/10.7205/MILMED-D-16-00166

Cannon, J., Pamplin, J., Zonies, D., Mason, P., Sine, C., Cancio, L., McNeill, J., Colombo, C., Osborn, E., Ricca, R., Allan, P., DellaVolpe, J., Chung, K., & Stockinger, Z. (2018). Acute Respiratory Failure. *Military Medicine*, *183*, 123–129. https://doi.org/10.1093/milmed/usy151

Charif, B. A., Plourde, K. V., Guay-Bélanger, S., Zomahoun, H. T., Gogovor, A., Straus, S., et, al. (2021). Strategies for involving patients and the public in scaling-up initiatives in health and social services: protocol for a scoping review and Delphi survey. *BMC Systematic Reviews*, 55.

Christians, F. (2020). Country profile-Primary healthcare and family medicine in Namibia. *African Journal of Primary Health Care and Family Medicine*, 1.

Cubukcu, H. C., & Canbaz, H. (2025). Usability assessments in clinical decision support systems. *Northern Clinics of Istanbul*, *12*(3), 372–377. https://doi.org/10.14744/NCI.2024.22316

Davies, G., & Chesters, A. (2015). Transport of the trauma patient. *British Journal of Anaesthesia*, 33-37.

Davis, D. P., Peay, J., Serrano, J. A., Buono, C., Vilke, G. M., Sise, M. J., Kennedy, F., Eastman, A. B., Velky, T., & Hoyt, D. B. (2005). The impact of aeromedical response to patients with moderate to severe traumatic brain injury. *Annals of Emergency Medicine*, *46*(2), 115–122. https://doi.org/10.1016/j.annemergmed.2005.01.024

Daya, M. R., Cheney, T. P., Chou, R., Fu, R., Newgard, C. D., O'Neil, M. E., Wasson, N., Hart, E. L., & Totten, A. M. (2020). Out-of-hospital Respiratory Measures to Identify Patients With Serious Injury: A Systematic Review. *Academic Emergency Medicine : Official Journal of the Society for Academic Emergency Medicine*, *27*(12), 1312–1322. https://doi.org/10.1111/acem.14055

Dayan, A. D. (2016). *Analgesic use of inhaled methoxyflurane : Evaluation of its potential nephrotoxicity*. https://doi.org/10.1177/0960327115578743 de Carvalho, G., Schmid, A., & Fischer, J. (2021). Classifications of health care systems: Do existing typologies reflect the particularities of the Global South? *Global Social Policy*, *21*(2), 278–300. https://doi.org/10.1177/1468018120969315

Deeb, A., Teng, C. Y., & Peitzman, A. B. (2024). *Direct Trauma Center Access by Helicopter Emergency Medical Services is Associated with Improved Survival after Severe Injury*. *278*(4), 1–20. https://doi.org/10.1097/SLA.0000000000005812.Direct

DefenceWeb. Eurocopter's EC145 helicopter will strengthen the Namibia Police Air Wing. *The Namibian*. https://defenceweb.co.za/aerospace/aerospace-aerospace/eurocopters-ec145-helicopter-will-strengthen-the-namibia-police-air-wing/

Degennaro, V., Owen, J., Chandler, J., & McDaniel, R. (2016). Operational implementation and lessons learned from Haiti's first helicopter air ambulance. *Injury*, *47*(5), 1001–1006. https://doi.org/10.1016/j.injury.2015.12.001.

De Klerk, V. C. (2007, July 25). *Understanding the perpetrators of violent crimes against children.* Retrieved from The Konrad Adenauer Foundation: https://www.kas.de/c/document_library/get_file?uuid=57387675-b13c-1e3b-8d44-5885ad2db7ba&groupId=252038

Dehouche, N. (2022). The injury severity score: an operations perspective. *BMC Medical Research Methodology*, 48.

Dhawan, M., Joshi, M. C., & Dudeja, P. (2021). Scoring system for activation of critical care air transport team for aeromedical evacuation. *Medical Journal Armed Forces India*, *77*(4), 397–402. https://doi.org/10.1016/j.mjafi.2020.02.003

Doctors without Borders. (2022, 07 27). *Air operations unit - MSF Logistique*. Retrieved from Doctors without Borders: https://www.msflogistique.org/air-operations-unit.html

DuBois, E., Schmidt, A., & Albert, L. (2021). Location of trauma care resources with inter-facility patient transfers. *Operations Research Perspectives*, https://doi.org/10.1016/j.orp.2021.100206.

Dumovich, J., & Singh, P. (2021). Surgical management of severe lower extremity injury. *StatsPearls*, https://doi.org/10.1007/s00068-024-02662-0?urlappend=%3Futm_source%3Dresearchgate.net%26utm_medium%3Darticle.

EMS National Highway Traffic Safety Administration. (2006). *Guide for Interfacility Patient Transfer National Highway Traffic Safety Administration Guide For Interfacility Patient Transfer Guide for Interfacility Patient Transfer National Highway Traffic Safety Administration.* Washington: National Academy Press.

Farzan, N., Hashem Montazeri, S. M., Beiranvand, A., Alavi, S. M., & Vahedian, M. (2023). Are all helicopter dispatches really necessary? a cross-sectional study. *Journal of Injury & Violence Research*, *15*(1), 21–25. https://doi.org/10.5249/jivr.v15i1.1778

Fedor, P., Burns, B., Lauria, M., & Richmond, C. (2018). Major Trauma Outside a Trauma Center: Prehospital, Emergency Department, and Retrieval Considerations. *Emergency Medicine Clinics of North America*, *36*, 203–218. https://doi.org/10.1016/j.emc.2017.08.010

Fresku, E., Kraja, J., & Marku, M. (2024). Perceptions of Health Personnel Regarding the Utilization of Health Information Systems. *Albanian Journal of Trauma and Emergency Surgery*, *8*(2), 1475–1483. https://doi.org/10.32391/ajtes.v8i2.402

Galvagno, S. M. J., Mabry, R. L., Maddry, J., Kharod, C. U., Walrath, B. D., Powell, E., & Shackelford, S. (2018). Measuring US Army medical evacuation: Metrics for performance improvement. *The Journal of Trauma and Acute Care Surgery*, *84*(1), 150–156. https://doi.org/10.1097/TA.0000000000001715

Gautam, M. P. (2025). The Importance of Research in Hospitals: A Pathway to Better Healthcare. *Journal of Bharatpur Hospital*, *1*(2), 66–68. https://doi.org/10.3126/jobh.v1i2.80923

Garner, A. A., Fearnside, M., & Gebski, V. (2013). The study protocol for the Head Injury Retrieval Trial (HIRT): A single centre randomised controlled trial of physician prehospital management of severe blunt head injury compared with management by paramedics. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine*, nd.

Gerecht, R. (2014, March 10). *Understanding When to Request a Helicopter for Your Patient*. Retrieved from Journal of Emergency Medical Services: https://www.jems.com/operations/ambulances-vehicle-ops/understanding-when-request-helicopter-yo/.

Giacalone, S., Kottmann, A., Darioli, V., Carron, P. N., Desseauve, D., Albrecht, R., & Pasquier, M. (2022). Clinical characteristics and haemodynamic state of patients undergoing interhospital transfer for postpartum haemorrhage: A study of a single-centre helicopter emergency medical service. *European Journal of Obstetrics and Gynecology and Reproductive Biology*, 48-55.

Global Health Observatory Data Repository . (2022, July 24). *Global Health Observatory Data Repository (African Region)*. Retrieved from World Health Organization: https://apps.who.int/gho/data/node.main-afro.VIOLENCEAGAINSTWOMEN?lang=en

Greene, A., Dion, P. M., Nolan, B., Trachter, R., Vu, E., & Trojanowski, J. (2023). Overcoming distance : an exploration of current practices of government and charity - funded critical care transport and retrieval organizations. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine*, 1–12. https://doi.org/10.1186/s13049-023-01125-6

Gündüz, Ş. H., Sever, T. H., Yarımağa, İ., & Tezel, O. (2025). Evaluation of the Intraocular Pressure Following Helicopter Flight. *Microgravity Science and Technology*, *37*(6), 2–5. https://doi.org/10.1007/s12217-025-10215-2

Hadian, M., Rezapour, A., Shafaghat, T., Bahariniya, S., Heidari, E., Jabbari, A., & Khanbebin, M. J. (2025). A scoping review of future research trends and priorities in health systems. *Health Research Policy and Systems*, *23*(1), 133. https://doi.org/10.1186/s12961-025-01404-x

Hardcastle Timothy Craig, Steyn Elmin, Boffard Kenneth, Goosen Jacques, Toubkin Mande, Louster Andre, Allard Denis, Moeng Steve, Muckart David, Brysiewicz Petra, & Wallis Lee. (2011). Guidelines for the assessment of trauma centres for South Africa. *South African Medical Journal*, *101*(3), 189–194.

Harris, M., Macinko, J., Jimenez, G., Mahfoud, M., & Anderson, C. (2015). Does a research article's country of origin affect perception of its quality and relevance? A national trial of US public health researchers. *BMJ Open*, *5*(12), 1–9. https://doi.org/10.1136/bmjopen-2015-008993

Harman, N., Conroy, E., Lewis, S., Murray, G., Norrie, J., Sydes, M. R., & et, al. (2015). Exploring the role and function of trial steering committees: Results of an expert panel meeting. *Trials*, 597.

Haven, T. L., Errington, T. M., Gleditsch, K. S., van Grootel, L., Jacobs, A. M., Kern, F. G.,Mokkink, L. B. (2020). Preregistering Qualitative Research: A Delphi Study. *International Journal of Qualitative Methods, 19*, 1-13. doi:https://doi.org/10.1177/1609406920976417

Hawilo,, H., & Taneja,, R. (2020). Interfacility helicopter transfers for critically ill patients: Always the right choice? *Critical Care*, https://doi.org/10.1186/s13054-020-02846-1.

He, Z., Bishwajit, G., & Yaya, S. (2019). Prevalence of alcohol and tobacco use among men and women in Namibia. *International Journal of Environmental Research and Public Health*, https://doi.org/10.3390/ijerph16010059.

IBM Corp. (2024). IBM SPSS Statistics for Windows (Version 30.0). *Computer Software*. https://www.ibm.com/analytics/spss-statistics-software

Joshi, M. C., & Sharma, R. M. (2010). Aero-medical considerations in casualty air evacuation (CASAEVAC). *Medical Journal Armed Forces India*, *66*(1), 63–65. https://doi.org/10.1016/S0377-1237(10)80097-8

Johnsen, A. S., Samdal,, M., Sollid,, S., & Rehn, M. (2020). Major incident management by helicopter emergency medical services in south-east Norway from 2000 to 2016: Retrospective cohort study. *Anaesthesiologica Scandinavica, 64*(7), 1014-1020. doi:https://doi.org/10.1111/aas.13583.

Kaya, M., Yildirim, H., Toprak, M., & Ulu, M. (2025). Comparison of Trauma Scoring Systems for Predicting Mortality in Emergency Department Patients with Traffic-Related Multiple Trauma. *Diagnostics*, *15*(12), 1–11. https://doi.org/10.3390/diagnostics15121563

Keeley, T., Williamson, P., Callery, P., Jones, L. L., Mathers, J., Jones, J., Young, B., & Calvert, M. (2016). The use of qualitative methods to inform Delphi surveys in core outcome set development. *Trials*, *17*(1), 1–9. https://doi.org/10.1186/s13063-016-1356-7

Khodarahmi, A., Hasan, Y. A., & Nair, R. (2025). *Outcomes in Rural vs Urban Centre Treated Adult Trauma Patients : A Systematic Review*. *8*(1), 100–105. https://doi.org/10.26502/jsr.10020424

King, J. C., Franklin, R. C., Robertson, A., Aitken, P. J., Elcock, M. S., Gibbs, C., Lawton, L., Mazur, S. M., Edwards, K. H., & Leggat, P. A. (2019). Review article: Primary aeromedical retrievals in Australia: An interrogation and search for context. *Emergency Medicine Australasia*, *31*(6), 916–929. https://doi.org/https://doi.org/10.1111/1742-6723.13405

Koome, G., Atela, M., Thuita, F., & Egondi, T. (2020). *Health system factors associated with post- - trauma mortality at the prehospital care level in Africa : a scoping review*. 1–8. https://doi.org/10.1136/tsaco-2020-000530

Kotwal MC USA (Ret), R. S., Staudt PhD MPH, A. M., Trevino MBA, J. D., Valdez-Delgado BSN RN, K. K., Le MD DrPH, T. D., Gurney MC USA, J. M., Sauer MC USA (Ret), S. W., Shackelford USAF MC, S. A., Stockinger MC USN, Z. T., & Mann-Salinas ANC USA (Ret), E. A. (2018). A Review of Casualties

Transported to Role 2 Medical Treatment Facilities in Afghanistan. *Military Medicine, Suppl. Supplement*, *183*(3/4), 134–145. https://doi.org/https://doi.org/10.1093/milmed/usx211

Kostiuk, M., & Burns , B. (2022). Trauma Assessment. *StatPearls Publishing*. Retrieved from https://pubmed.ncbi.nlm.nih.gov/32310373/.

Kulshrestha, A., & Singh, J. (2016). Inter-hospital and intra-hospital patient transfer:Recent Concepts. *Indian Journal of Anaesthesia, 60*(45), 1-7.

Laatz, D. (2018, April 04). *Developing Call-Out Criteria For South African Helicopter Emergency Medical Services: A Delphi.* Retrieved from OpenUCT: https://open.uct.ac.za/handle/11427/29354

Lagarde, E. (2007). Road traffic injury is an escalating burden in Africa and deserves proportionate research efforts. *PLoS Medicine*, *4*(6), 0967–0971. https://doi.org/10.1371/journal.pmed.0040170

Laverty, C., Tien, H., Beckett, A., Nathens, A., Rivest-Caissy, J. P., & Luz, L. T. da. (2020). Primary aeromedical retrieval crew composition: Do different teams impact clinical outcomes? A descriptive systematic review. *CJEM : Journal of the Canadian Association of Emergency Physicians*, *22*(S2), S89–S103. https://doi.org/https://doi.org/10.1017/cem.2020.404

Law, J., & Vanderploeg, J. (2011). Development of an Emergency Medical Services Plan for Commercial Spaceflight Events in Spaceport America [The University of Texas Medical Branch Graduate School of Biomedical Sciences]. In *ProQuest Dissertations and Theses*. https://www.proquest.com/dissertations-theses/development-emergency-medical-services-plan/docview/896959981/se-2?accountid=50177

Legal Assistance Centre. (2019, 12 12). *Age of Majority.* Retrieved from Legal Assistance Centre: http://www.lac.org.na/projects/grap/Pdf/3-Age_of_Majority.pdf

Legal Assistance Centre (2023). *Hospitals and Health Facilities Act 36 of 1994 Arrangement Of Sections Part I Preliminary Provisions 1. Definitions Part Ii Establishment And Management Of State Hospitals, State Health Facilities And Services*. *1994*(February 1995), 1–26. https://www.lac.org.na/laws/annoSTAT/Hospitals and Health Facilities Act 36 of 1994.pdf

Lentz, T., Groizard, C., Colomes, A., Ozguler, A., Baer, M., & Loeb, T. (2021). Collective Critical Care Ambulance: an innovative transportation of critical care patients by bus in COVID-19 pandemic response. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine.*, *29*(1).

https://doi.org/https://doi.org/10.1186/s13049-021-00896-0

Lopes, C., & Foresti, M. (2025, December 1). How the West is losing the visa war. *The Africa Report*. https://www.theafricareport.com/400620/how-the-west-is-losing-the-visa-war/

Lou, J., Xiang, Z., Zhu, X., Fan, Y., Song, J., Cui, S., Li, J., Jin, G., Huang, N., & Le, X. (2025). Trends and levels of the global, regional, and national burden of injuries from 1990 to 2021: findings from the global burden of disease study 2021. *Annals of Medicine*, *57*(1). https://doi.org/10.1080/07853890.2025.2537917

Loyd. (2024). Aeromedical Transport. *StatPearls*. https://www.ncbi.nlm.nih.gov/books/NBK518986

Luft, A., Corcostegui, S.-P., Millet, M., Gillard, J., Boissier, J., Rondy, P., Bancarel, J., Carfantan, C., Antoine, L., Simon-Pierre, C., Marianne, M., Jonathan, G., Jerome, B., Patrick, R., Jérôme, B., & Cyril, C. (2020). Aeromedical Evacuations Within the French Armed Forces: Analysis of 2,129 Patients. *Military Medicine*, *185*(3/4), 468–476. https://doi.org/10.1093/milmed/usz268

Lyng, J. W., Braithwaite, S., Abraham, H., Brent, C. M., Meurer, D. A., Torres, A.,Larrimore, A. (2021). Appropriate Air Medical Services Utilization and Recommendations for Integration of Air Medical Services Resources into the EMS System of Care: A Joint Position Statement and Resource Document of NAEMSP, ACEP, and AMPA. *Prehospital Emergency Care*, 854-873.

Maddry, J. K., Arana, A. A., Mora, A. G., Perez, C. A., Cutright, J. E., Kester, B. M., Ng, P. C., Schauer, S. G., & Bebarta, V. S. (2021). Advancing Prehospital Combat Casualty Evacuation: Patients Amenable to Aeromedical Evacuation via Unmanned Aerial Vehicles. *Military Medicine*, *186*(3/4), e366–e372. https://doi.org/10.1093/milmed/usaa438

Maddry, J. K., Mora, A. G., Perez, C. A., Reeves, L. K., Paciocco, J. A., Clemons, M. A., Sheean, A., Kester, N. M., & Bebarta, V. S. (2022). Characterization of Long-range Aeromedical Transport and Its Relationship to the Development of Traumatic Extremity Compartment Syndrome: A 7-year, Retrospective Study. *Military Medicine*, *187*(1/2), e224–e231. https://doi.org/10.1093/milmed/usaa462

Maher, P. D., Matarelli, S. A., & Pascarella, J. (2019). Florida Adult Trauma Scorecard Methodology and Scene Transportation Choice [Walden University]. In *ProQuest Dissertations and Theses*. https://www.proquest.com/dissertations-theses/florida-adult-trauma-scorecard-methodology-scene/docview/2309941879/se-2

Masterson, S., Deasy, C., Doyle, M., Hennelly, D., Knox, S., & Sorensen, J. (2020). What clinical crew competencies and qualifications are required for helicopter emergency medical services? A review of the literature. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine*, *28*(1), 1–9. https://doi.org/10.1186/s13049-020-00722-z

Mcgrath, R. E., Hall-simmonds, A., & Goldberg, L. R. (2020). *Are Measures of Character and Personality Distinct ? Evidence From Observed-Score and True-Score Analyses*. https://doi.org/10.1177/1073191117738047

McGrath, B. A., Brenner, M. J., Warrillow, S. J., Pandian, V., Arora, A., Cameron , T. S., & et al. (2020). Tracheostomy in the COVID-19 era: global and multidisciplinary guidance. *Lancet Respiratory Medicine, 8*(7), 717-725. doi:doi: 10.1016/S2213-2600(20)30230-7.

Meyer, G. D., Meyer, T. N., & Gaunt, C. B. (2018). African Journal of Emergency Medicine Validity of the South African Triage Scale in a rural district hospital. *African Journal of Emergency Medicine*, *8*(4), 145–149. https://doi.org/10.1016/j.afjem.2018.07.004

Michaels, D., Pham, H., Puckett, Y., & Dissanaike, S. (2019). *Helicopter versus ground ambulance : review of national database for outcomes in survival in transferred trauma patients in the USA*. 2018–2020. https://doi.org/10.1136/tsaco-2018-000211

Microsoft, C. (2021). Microsoft Excel for Windows,Version 365. *Redmond (WA)*.

Mitchell, R., Bue, O., Nou, G., Taumomoa, J., Vagoli, W., Jack, S., Banks, C., Reilly, G. O., Bornstein, S., Ham, T., Cole, T., Reynolds, T., Körver, S., & Cameron, P. (2021). The Lancet Regional Health - Western Pacific Validation of the Interagency Integrated Triage Tool in a resource-limited , urban emergency department in Papua New Guinea : a pilot study. *The Lancet Regional Health - Western Pacific*, *13*(June), 100194. https://doi.org/10.1016/j.lanwpc.2021.100194

MoHSS. (2015). *MINISTRY OF HEALTH AND SOCIAL SERVICES GUIDELINES FOR IMPLEMENTATING NATIONAL REFERRAL POLICY First Edition* (Issue March).

MoHSS. (2023). Sector brief Namibia: Health. *Business Scouts for Development*, 1–8. https://www.giz.de/en/downloads/giz2023-sector-brief-namibia-health.pdf

Mollazehi, M., El-Menyar, A., Mekkodathil, A., Consunji, R., & Al-Thani, H. (2020). Violence –related injuries in a rapidly developing Middle Eastern country: a retrospective study from a level 1 trauma center.

BMC Public Health, *20*(1), 1–9. https://doi.org/10.1186/s12889-020-09754-7

Mould-Millman, N., De Vries, S., Stein, C., Kafwamfwa, M., Dixon, J., Yancey, A.,Wallis, L. A. (2015). Developing emergency medical dispatch systems in Africa – Recommendations of the African Federation for Emergency Medicine. *African Journal of Emergency Medicine*, 141-147. doi:http://dx.doi.org/10.1016/j.afjem.2015.06.005.

Muhango, L., Khoza, S., Pretorius, R., & Pswarayi, R. (2025). The epidemiology of trauma patients presenting to a large urban public hospital trauma centre in South Africa. *Wits Journal of Clinical Medicine*, *7*(2), 71–76. https://doi.org/10.18772/26180197.2025.v7n2a5.

Mwandri M, S. B. H. T. C. H. J. R. A. M. G. R. L. P. J. C. O. D., & Metcalfe, D. (2025). Organised trauma systems and designated trauma centres for improving outcomes in injured patients. *Cochrane Database of Systematic Reviews*, *8*. https://doi.org/10.1002/14651858.CD012500.pub

Nasa, P., Jain, R., & Juneja, D. (2021). Delphi methodology in healthcare research: How to decide its appropriateness. *World Journal of Methodology*, 116-129.

National Highway Traffic Safety Administration. (2006). Guide For Interfacility Patient Transfer. *National Highway Traffic Safety Administration*. http://www.nhtsa.gov/people/injury/ems/interfacility/index.htm

Neill, R., Zia, N., Ashraf, L., Khan, Z., Pryor, W., & Bachani, A. M. (2023). Integration measurement and its applications in low- and middle-income country health systems: a scoping review. *BMC Public Health*, *23*(1), 1–15. https://doi.org/10.1186/s12889-023-16724-2

Newgard, C. D., Cheney, T. P., Chou, R., Fu, R., Daya, M. R., O'Neil, M. E., Wasson, N., Hart, E. L., & Totten, A. M. (2020). Out-of-hospital Circulatory Measures to Identify Patients With Serious Injury: A Systematic Review. *Academic Emergency Medicine : Official Journal of the Society for Academic Emergency Medicine*, *27*(12), 1323–1339. https://doi.org/10.1111/acem.14056

Newgard, C. D., Fischer, P. E., Gestring, M., Michaels, H. N., Jurkovich, G. J., Lerner, E. B., Fallat, M. E., Delbridge, T. R., Brown, J. B., Bulger, E. M., Goodloe, J. M., Armstrong, J. H., Gallagher, J. M., Wang, S. C., Eastridge, B. J., Mann, N. C., Lawler, R. R., Salomone, J. P., Chou, R., … Dodd, J. (2022). National guideline for the field triage of injured patients: Recommendations of the National Expert Panel on Field Triage, 2021. *Journal of Trauma and Acute Care Surgery*, *93*(2), E49–E60. https://doi.org/10.1097/TA.0000000000003627

Ngoie, K. D., Jenkins, L., & Schoevers, J. (2025). Evaluating referrals between rural district hospitals and a regional hospital in South Africa. *African Journal of Primary Health Care & Family Medicine*, *17*(1), e1–e11. https://doi.org/10.4102/phcfm.v17i1.4956

NSA. (2023). *Mortality and Causess of Deaths in Namibia (2018-2021)*.

Onwuegbuzie, A. J., & Dickinson, W. B. (2008). Mixed Methods Analysis and Information Visualization: Graphical Display for Effective Communication of Research Results. *The Qualitative Report, 13*(2), 204-225. doi: https://doi.org/10.46743/2160-3715/2008.1595.

Oyefeso, O. O., Madiba, S. E., & Hoque, M. E. (2011). Prevalence and profle of injuries in Khorixas District Hospital, Namibia. *Southern African Journal of Epidemiology and Infection*, *26*(2), 83–87. https://doi.org/10.1080/10158782.2011.11441430

Ouzzani, M., Hammady, H., Fedorowicz, Z., & Elmagarmid, A. (2016). Rayyan—a web and mobile app for systematic reviews. *Systematic Reviews, 5*(210). doi:https://doi.org/10.1186/s13643-016-0384-4.

Palm, K., & Hansson, J. (2018). Influencing project work: exploring the potentials of participatory research. *Journal of Work-Applied Management*, 63-73.

Paoli, A., Pascolini, M., Cipolloti, G., & Spagna, A. (2020). Is Helicopter Really Faster Than Ambulance? The Padua Helicopter Emergency Medical Services Station Experience. *Air Medical Journal*, 399-403.

Park, C. Y., Kim, O. H., Chang, S. W., Choi, K. K., Lee, K. H., Kim, S. Y., Kim, M., & Lee, G. J. (2020). Part 3. Clinical Practice Guideline for Airway Management and Emergency Thoracotomy for Trauma Patients from the Korean Society of Traumatology. *Journal of Trauma and Injury*, *33*(3), 195–203. https://doi.org/10.20408/jti.2020.0050

Prabowo, Y., & Reksoprodjo, A. Y. (2019). Modified total humeral replacement on unusual osteosarcoma of the humerus: A case report. *International Journal of Surgery Case Reports, 58*, 132-137. doi:https://doi.org/10.1016/j.ijscr.2019.04.027.

Pelletier, C. (2023). Inadequate Infrastructure and Resources of Rural Healthcare. *Journal of Family Medicine & Medical Science Research*, *12*(2), 1–2. https://doi.org/10.37532/2327-4972.23.12.149

Peters M.D.J.,Godfrey C.,McInerney P.,Munn Z.,Tricco A.C.,Khalil H. (2020). Scoping Reviews. *JBI Manual for Evidence Synthesis.* https://doi.org/10.46658/JBIMES-24-09

Petersen, L., & Gaylard, M. (2019). Strategies to strengthen referral from primary care to secondary care in low- and middle-income countries. In *World Health Organisation* (Vol. 1, Issue September).

Phillips, R. T., Conaway, C., Mullarkey, D., & Owen, J. L. (1999). One year's trauma mortality experience at Brooke Army Medical Center: Is aeromedical transportation of trauma patients necessary? *Military Medicine*, *164*(5), 361–365. https://doi.org/10.1093/milmed/164.5.361

Pollock, D., Peters, M. D. J., Khalil, H., McInerney, P., Alexander, L., Tricco, A. C., Evans, C., De Moraes, É. B., Godfrey, C. M., Pieper, D., Saran, A., Stern, C., & Munn, Z. (2022). Recommendations for the extraction, analysis, and presentation of results in scoping reviews. *JBI Evidence Synthesis*, *21*(3), 520–532. https://doi.org/10.11124/JBIES-22-00123

Prorok, J. C., Williamson, P. R., Shea, B., Rolfson, D., Mañas, L. R., Cesari, M., Kim, P., & Muscedere, J. (2022). An international Delphi consensus process to determine a common data element and core outcome set for frailty: FOCUS (The Frailty Outcomes Consensus Project). *BMC Geriatrics*, *22*(1), 1–9. https://doi.org/10.1186/s12877-022-02993-w

Pule, M. S., Hodkinson, P., & Hardcastle, T. (2022). A descriptive study of trauma patients transported by helicopter emergency medical services to a level one trauma centre. *African Journal of Emergency Medicine*, 183-190.

Puyeipawa Nakashole. (2025, June 3). Namibia: Health Ministry Unveils Vision for Smart Ambulances, Decentralised Care. *The Namibian*. https://www.namibian.com.na/health-ministry-unveils-vision-for-smart-ambulances-decentralised-care/

Quinlan, J. P. G. O. B. J. F. (2017). *Emergency aeromedical services in Ireland : a retrospective study for '" MEDEVAC112 ."'* 33–39. https://doi.org/10.1007/s11845-016-1403-0

Randomizer, R. (2024). *Research Randomizer 9.4.Pdf*. https://www.randomizer.org/

Ranjan, C. K., & Renjhen, P. (2017). Casualty Air Evacuation: Sine quo non of combat casualty. *Medical Journal Armed Forces India*, *73*(4), 394–399. https://doi.org/10.1016/j.mjafi.2017.08.007

Reno, J. (2010). Military aeromedical evacuation, with special emphasis on craniospinal trauma. *Neurosurgical Focus*, *28*(5), 1–5. https://doi.org/10.3171/2010.2.FOCUS1023Renz, B. M., Cava, R., Feliciano, D., & Rozycki, G. (2000). Transmediastinal Gunshot Wounds: A Prospective Study. *The Journal of Trauma: Injury, Infection, and Critical Care, 48*(3), 416-422. Retrieved from https://journals.lww.com/jtrauma/Abstract/2000/03000/Transmediastinal_Gunshot_Wounds__A_Prospective.8.aspx.

Robba, C., Pozzebon, S., Moro, B., Vincent, J.-L., Creteur, J., & Taccone, F. S. (2020). Multimodal non-invasive assessment of intracranial hypertension: an observational study. *Critical Care, 24*, 379. doi:https://doi.org/10.1186.

Roje, R. (2023). *Data Practices and Management*. 65–81. https://doi.org/10.1007/978-3-031-22412-6_5

Sekayi, D., & Kennedy, A. (2017). Qualitative Delphi Method: A Four Round Process with a Worked Example. *The Qualitative Report, 22*(10), 2755.

Sethi, D., & Subramanian, S. (2014). When place and time matter: How to conduct safe inter-hospital transfer of patients. *Saudi Journal of Anaesthesia*, 104-113.

Shimuafeni, A. (2020). Report on mortality and causes of deaths in namibia. Windhoek: Namibia Statistics Agency.

Silverman, D., & Gendreau, M. (2009). Medical issues associated with commercial flights. *The Lancet*, *373*(9680), 2067–2077. https://doi.org/10.1016/S0140-6736(09)60209-9

Silverman, M. (2015). In this issue: In this issue. *Asia-Pacific Journal of Clinical Oncology*, *11*(2), i–i.

South, E., & Rodgers, M. (2023). Data visualisation in scoping reviews and evidence maps on health topics: a cross-sectional analysis. *Systematic Reviews*, *12*(1), 1–11. https://doi.org/10.1186/s13643-023-02309-y

Shirazi, F., Wu, Y., Hajli, A., Zadeh, A. H., Hajli, N., & Lin, X. (2021). Value co-creation in online healthcare communities. *Technological Forecasting and Social Change, 167*, 120665. doi:https://doi.org/10.1016/j.techfore.2021.12066

Southern, A. P., & Celik, D. H. (2022, July 19). *EMS, Trauma Center Designation.* Retrieved from NCBI Bookshelf: https://www.ncbi.nlm.nih.gov/books/NBK560553/.

Steenhoff, T. C., Siddiqui, D. I., & Zohn, S. F. (2022). EMS Air Medical Transport. *StatsPearl Publishing*, https://www.ncbi.nlm.nih.gov/books/NBK482358/.

Stoll, C. R., Izadi, S., Fowler, S., Green, P., Suls, J., & Colditz, G. A. (2019). The value of a second reviewer for study selection in systematic reviews. *Research Synthesis Methods*, 539-545.

Sterner, R. C., & Brooks, N. P. (2024). *Interfacility Ambulance Versus Helicopter Transport of Traumatic Spinal Cord Injury Patients : Outcomes , Observations , and Utilization*.

Stewart, B., Hollis, S., Amato, S. S., Bulger, E., Mocka, C., & Reynolds, T. (2019). Trauma care and development assistance: Opportunities to reduce the burden of injury and strengthen health systems. *Bulletin of the World Health Organization*, *97*(5), 371–373. https://doi.org/10.2471/BLT.18.213074

Stuke, L., Duchesne, J., Hunt, J., Marr, A., Meade, P., & McSwain, N. (2013). Mechanism of Injury Is Not a Predictor of Trauma Center Admission. *The American Surgeon*, *79*, 1149–1153. https://doi.org/10.1177/000313481307901116

Sunde, G. A., Bjerkvig, C., Bekkevold, M., Kristoffersen, E. K., Strandenes, G., Bruserud, Ø., Apelseth, T. O., & Heltne, J. K. (2022). Implementation of a low-titre whole blood transfusion program in a civilian helicopter emergency medical service. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine*, *30*(1), 1–10. https://doi.org/10.1186/s13049-022-01051-z

The Namibian Newspaper. (2017, 10 06). *Ambulance needed at Rietoog - The Namibian*. Retrieved from The Namibian: https://www.namibian.com.na/170251/archive-read/Ambulance-needed-at-Rietoog

The Namibian. (2018). Windhoek health centres bursting at the seams. *The Namibian*. Windhoek health centres bursting at the seams

Thomas, S., Brown, K., Olivier, Z., Spaite, D., Lawner, B., Sahni, R., Weik, T. S., Falck-Ytter, Y., Wright, J. L., & Lang, E. S. (2013). An Evidence-based Guideline for the air medical transportation of prehospital trauma patients. *Prehosp Emerg Care*, 35-44.

Toner, S., Wiltens, D. H., Berg, J., Williams, H., Klein, S., Marshall, S., Copeland, R. (2017). Medical evacuations in the oil and gas industry: A retrospective review with implications for future evacuation and preventative strategies. *International Society of Travel Medicine*, 1-7.

Tsuchiya, A., Tsutsumi, Y., & Yasunaga, H. (2016). Outcomes after helicopter versus ground emergency medical services for major trauma--propensity score and instrumental variable analyses: a retrospective nationwide cohort study. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine, 24*, 140. doi:https://doi.org/10.1186/s13049-016-0335-z.

United Nations Population Fund . (2022, July 26). *Annual Report UNFPA Annual Report 2013*. Retrieved from United Nations Population Fund: https://www.unfpa.org/publications/unfpa-annual-report-2013.

Utter, G. H., Victorino, G. P., & Wisner, D. H. (2008). Correspondence: Interhospital Transfer of Acute Trauma Patients: How Long Does it Take and How is the Time Spent? *Clinical Medicine: Trauma and Intensive Medicine*, 1-11.

Valaitis, R., Martin-Misener, R., Wong, S. T., McDonald, M., Meagher-Stewart, D., Austin, P., O-Mara, L. (2012). Methods, strategies and technologies used to conduct a scoping literature review of collaboration between primary care and public health. *Primary Health Care Research & Development, 13*, 219-236. doi:10.1017/S1463423611000594.

Van Hoving, D. J., Smith, W. P., & Wallis, L. A. (2008). Comparison of mean on-scene times: Road versus air transportation of critically ill patients in the Western Cape of South Africa. *Emergency Medicine Journal*, *25*(3), 136–139. https://doi.org/10.1136/emj.2007.051540

Vines, C., Tesseneer, S. J., Cox, R. D., Darsey, D. A., Carbrey, K., & Puskarich, M. A. (2018). Air Ambulance Delivery and Administration of Four-factor Prothrombin Complex Concentrate Is Feasible and Decreases Time to Anticoagulation Reversal. *Academic Emergency Medicine*, *25*(1), 33–40. https://doi.org/https://doi.org/10.1111/acem.13338

Visser, M. (2011). *Air Ambulance Transport in Sub-Saharan Africa: Challenges Experienced By Health Care Professionals University of Pretoria*. *January*, 1–232.

Walrath, B. D., & Herbal, J. (2016). Navy En Route Care: A three-year review of 428 Navy air evacuations [The University of Texas School of Public Health]. In *ProQuest Dissertations and Theses*. https://www.proquest.com/dissertations-theses/navy-en-route-care-three-year-review-428-air/docview/1818548312/se-2?accountid=50177

Weaver, J., Topping, P., Chui, J., Su, J., Stevenage/UK, & London/UK. (2020). *Trauma unit MDCT in severely injured patients: an audit*. https://doi.org/https://dx.doi.org/10.26044/ecr2020/C-13680

Weaver, N. D., Bertolacci, G. J., Rosenblad, E., Ghoba, S., Cunningham, M., Ikuta, K. S., Moberg, M. E., Mougin, V., Han, C., Wool, E. E., Abate, Y. H., Adewuyi, H. O., Adnani, Q. E. S., Adzigbli, L. A., Afolabi, A. A., Agampodi, S. B., Ahinkorah, B. O., Ahmad, A., Ahmad, D., … Naghavi, M. (2025). Global, regional, and national burden of suicide, 1990-2021: a systematic analysis for the Global Burden of Disease Study 2021. *The Lancet Public Health*, *10*(3), e189–e202. https://doi.org/10.1016/S2468-

2667(25)00006-4

World Health Organization.,(2024). *Injuries and violence fact sheet*. World Health Organization. https://www.who.int/news-room/fact-sheets/detail/injuries-and-violence

World Health Organization.,(2021). *Injuries and violence*. https://www.who.int/news-room/fact-sheets/detail/injuries-and-violence

Whitaker, J., Denning, M., O'Donohoe, N., Poenaru, D., Guadagno, E., Leather, A., & Davies, J. (2019). Assessing trauma care health systems in low- and middle-income countries, a protocol for a systematic literature review and narrative synthesis. *Systematic Reviews*, *8*(1), 4–9. https://doi.org/10.1186/s13643-019-1075-8

Widener, M. J., Saxe, S., & Galloway, T. (2017). The Relationship between Airport Infrastructure and Flight Arrivals in Remote Northern Canadian Communities. *Arctic, 70*(3), 249-258. doi:https://doi.org/10.14430/arctic4663.

Williams, L., Harlock, J., Robert, G., Mannion, R., Brearley, S., & Hall, K. (2017). Decommissioning health care: identifying best practice through primary and secondary research – a prospective mixed-methods. *Health Services and Delivery Research*, 1-194. https://doi.org/10.3310/hsdr05220.

Wilson, D. J., Wong, G. Z., Tignanelli, C., Nix, M., Moreno, A. N., & Lagrone, L. N. (2025). TRAUMA: making trauma clinical guidance more implementable. *Trauma Surgery and Acute Care Open*, *10*(Suppl 5), 1–9. https://doi.org/10.1136/tsaco-2024-001610

Woodcock, T., Adeleke, Y., Goeschel, C., Pronovost, P., & Dixon-Woods, M. (2020). A modified Delphi study to identify the features of high quality measurement plans for healthcare improvement projects. *BMC Medical research Methodology, 20*, 8. https://doi.org/10.1186/s12874-019-0886-6

World Bank. (2022, July 20). *https://data.worldbank.org/indicator/EN.POP.DNST?locations=NA*. Retrieved from World Bank: https://data.worldbank.org/indicator/EN.POP.DNST?locations=NA

Yeates, E. O., Grigorian, A., Barrios, C., Schellenberg, M., Owattanapanich, N., Barmparas, G., & et, a. (2021). Changes in traumatic mechanisms of injury in Southern California. *Journal of Trauma Acute Care Surgery, 90*(4), 714-721. https://doi.org/10.1097/TA.0000000000003068.

Yorulmaz, Ş., & Gökçe, A. (2022). Transport of Trauma Patients by Airway: Turkish Experience. *Eurasian Journal of Emergency Medicine*, *21*(3), 211–214. https://doi.org/10.4274/eajem.galenos.2022.91069.

Youngquist, S. T., & Gee, C. A. (2011). Non-experimental studies in air medical research. *Air Medical Journal*, *30*(4), 168–172. https://doi.org/10.1016/j.amj.2011.04.019.

Zamani, H., Parvaresh, F., & Isfahani, M. N. (2025). Optimizing patient flow logistics: strategic challenges, tactical solutions, and future directions. *BMC Health Services Research*, *25*(1). https://doi.org/10.1186/s12913-025-13516-9.

APPENDICES

Appendix 1: Pre-tested Data Extraction Form

Data Extraction Form
Study: Developing Clinical Criteria for aeromedical transfers of adult trauma patients
Review Year: 2023

Scoping Review Details:
Scoping Review Title:
Review Objective(s):
Review Question(s):
Inclusion/Exclusion Criteria: Adult Trauma Patients >18 years
Population:
Concept:
Context:
Types of evidence source:
Evidence source Details and Characteristics
Citation details (e.g., Author/s, date, title, journal, volume,issue,pages)
Country:
Context:
Participants:
Details/Results extracted from source of evidence

Appendix 2: Table of Evidence

Author(s) and Year of Publication	Study Setting	Aim and Methodology	Participants	Results
Andrew (1994)	United Kingdom	Aim: Outlines the history of aeromedical evacuation and examines American military ;md civil experience Methodology: Narrative Review	Wounded Soldiers	• Make doctors part of the flight team. Preferably, a trauma specialist. • Nurses & Paramedics should also be in the team with ATLS and ACLS certification. • Medevacs extend the reach of tertiary care. • Criteria for flights: Trauma Score (TS) between 5-10 • Conditions required/performed on flights: ○ Cricothyroidotomy ○ Tracheostomy ○ Endotracheal Intubation ○ Assisted Ventilation ○ Chest Drain ○ Fluid & Blood Replacement ○ MAST Trousers ○ CPR
Brown & Gestring (2013)	Michigan, United States	Aim: Review evidence on whether helicopter transfers improve outcomes for trauma patients. Methodology: Narrative Review	Trauma Patients	• TRISS • ISS (16-60) • Trauma Score (5-10) • Severe entrapment + abnormal vitals • Ground travel is greater than >20 minutes • Distance greater than 45-50 miles (72km-80km) • Hard-to-reach areas (Access) • Head Injuries • Brain Injuries • Regional, environmental, and situational factors (Access) • Conditions required/performed on flights: ○ RSI ○ Cricothyroidotomy ○ Blood Products ○ Thoracic Decompression
Butler et al. (2017)	San Antonio, United States	Aim: Examine the clinical practice and decision making of two theatre flight surgeons.	30-year-old median, soldiers, and civilians	• Pre-flight surgeon and an In-flight surgeon • Nonclinical aspects of the transport are validated as “good to go;” examples include the presence of passports, diplomatic clearances for territorial overflight, and destination resources.

		Methodology:
		Retrospective Descriptive Cohort Design
				• An urgent patient requires transport as soon as possible to preserve life, limb, or eyesight.
				• A priority patient requires transport within 24 hours to preserve life, limb, or eyesight.
				• Clinical Parameters to consider:
				  ○ HB levels
				  ○ Saturation levels
				  ○ PEEP
				  ○ Extremity issues made up 48% of transport found in the worksheet cohort followed by face–neck (18%), head (15%), chest (13%), abdomen (13%), spine (8%), and pelvis (6%). Six percent were burns, whereas 14% were cardiac.

Cannon et al. (2018)	San Antonio, United States	Aim: ARDS diagnosis and management in combat casualties Methodology: Narrative Review	U.S.A Military Patients	• Pulmonary contusion, inhalation injury, and fat emboli may lead to ARDS. • Timing of ARDS must occur within 1 week of a known clinical insult described above or must be in the context of new or worsening respiratory symptoms. • Early consultation with an intensivist is encouraged for all patients with moderate to severe ARDS. • Lung Protective Ventilatory Settings for ARDS • Considerations should include the severity of the patient's respiratory failure, the trajectory of that respiratory failure (improving or worsening), and the experience of the team. • Indications for requesting an Advanced Critical Care Evacuation Team (ACCET) for transport to the USA include the following: • PaO_2: FiO_2 0.7 or pH 15 cm H_2O with PPLAT >30 cm H_2O. • Severe brain injury w/$PaCO_2$ >40 mmHg on a transport ventilator. • Cardiogenic shock refractory to maximal medical therapy. • Anatomic derangement (e.g., bronchopleural fistula, pneumonectomy). • Use of advanced ventilator modes such as airway pressure release ventilation. • Acute pulmonary embolism post cardiac arrest or with persistent hypoxemia. • Multi-system organ failure (e.g., ARDS + renal failure).
Corbet & Nelson (1955)	Ottawa, Canada	Aim: Outlines the history and advantages of aeromedical evacuation, it emphasizes patient selection and restrictions for air transport Methodology: Narrative Review	Royal Canadian Air Force, Ottawa.	In brief the main factors for consideration are: • Temperature variations. • Anoxia. • Decompression. • Gravity effects. • Consideration for air travel: • The patient with pneumothorax (both spontaneous and traumatic) or hemithorax. Thoracentesis equipment should always be available. Lowered atmospheric pressure may in such cases cause serious pericardial displacement. In the Royal Canadian Air

				Force, aircrew following recovery from a spontaneous pneumothorax has been limited to an altitude of 10,000 feet and to not being in charge of the aircraft. This policy is presently under reconsideration in view of the experience of the Royal Air Force, in which rehabilitated cases are returned to full flying duties. • The patient with recent acute internal haemorrhage. Both the result (degree of anaemia) and the cause (in relation to potential recurrence) be carefully assessed. • The patient has had within 10 days surgery for intrathoracic or intra-abdominal wounds or illnesses. • The patient who has had a loss of cranial bone or disturbance in cerebrospinal circulation through skull fracture. • The patient with suspected major intracranial trauma or pathological injury.
Davis et al. (2005)	San Diego, USA	Aim: Explore the impact of aeromedical response in patients with moderate to severe traumatic brain injury. Methodology: Retrospective Analysis	Homogenous group with moderate to severe head injuries	• Helicopters are used in many systems to respond to major trauma victims, with 3 theoretical therapeutic advantages: • Rapid transport to a designated receiving facility when ground transport is unavailable or would lead to inordinate delays. • Response by advanced practitioners with an expanded scope of practice to optimize early care. • Response by crews with greater experience managing critically injured patients. • Aeromedical crews consist of a certified flight nurse, along with a flight paramedic, an emergency medicine resident physician, or a second certified flight nurse. Physicians and certified flight nurses can perform advanced procedures: • Rapid sequence intubation • Tube thoracostomy • Central venous catheterization • Pericardiocentesis • Paramedics can perform intubation without rapid sequence intubation (Location based) • Needle thoracostomy. • Paramedics are instructed to attempt endotracheal intubation in major trauma victims with a Glasgow Coma Scale score of 8 or less. • Most dispatch protocols rely on estimated ground transport time or distance in the decision to request aeromedical resources
DeGennaro et al. (2016)	Haiti	Aim: Implement a more robust pre-hospital system in Haiti over the next 12–24 months, including more scene call capabilities.	81 patients requiring air transfer.	• Haiti is a mountainous country with poor roads that make ground ambulance transport over long distances difficult and even dangerous. • There are only a few hospitals that offer high quality intensive care, and they are not evenly distributed geographically throughout the country, making the utility of the helicopter even greater in this setting than in many developed countries.

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<td>Methodology:
Retrospective Review</td>
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Haiti Air Ambulance is based entirely in the country that it serves and is publicly available, regardless of the patients' ability to pay.
Haiti Air Ambulance subcontracted the US-based HAA company Air Methods Corporation, the largest provider of medical helicopters in the world, to supply the Bell 407, single engine helicopters and provide pilots and mechanics.
Advanced Cardiac Life Support, Paediatric Advanced Life Support, Neonatal Advanced Life Support, Advanced Trauma Life Support, and critical care experience as their job description demands.
Medication Selection
Meticulous process involves a multidisciplinary team of doctors, nurses, paramedics, and pharmacists.
Medical utilization criteria

Trauma
Burns
Head trauma
Spinal trauma
Abdominal aorta aneurysm
Myocardial infarction
Stroke
Sepsis with shock
Acute congestive heart failure
Pulmonary embolism
Status epilepticus
Obstetric emergencies
Gastrointestinal haemorrhage
Urgent congenital anomalies

Trauma was the leading indication for transfer, which was mostly comprised of motor vehicle accidents. Nineteen of the patients transferred fell outside of the utilization criteria for urgent transfer. They included paraplegic and quadriplegic patients travelling to one of the three rehabilitation centres in Haiti, malnourished children, and those requiring specialty care not available where they were.
Transfer requests by medical category.

<table>
<tr><th>Medical problem</th><th>Number of patients (%)</th></tr>
<tr><td>Traumatic injury</td><td>37 (35)</td></tr>
<tr><td>Non-emergency interfacility transfer</td><td>19 (18)</td></tr>
<tr><td>Burns</td><td>6 (6)</td></tr>
<tr><td>Cardiac arrest/chest pain</td><td>5 (6)</td></tr>
<tr><td>Stab/gunshot wound</td><td>4 (4)</td></tr>
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<tr><td>Pregnancy/childbirth</td><td>3 (3)</td></tr>
<tr><td>Seizure</td><td>3 (3)</td></tr>
<tr><td>Surgical</td><td>3 (3)</td></tr>
<tr><td>Abdominal pain</td><td>2 (2)</td></tr>
<tr><td>Fall victim</td><td>1 (1)</td></tr>
<tr><td>Drowning</td><td>1 (1)</td></tr>
<tr><td>Altered mental status</td><td>1 (1)</td></tr>
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<tr>
<td>Dhawan et al. (2021)</td>
<td>India</td>
<td>Aim:
Formulate a protocol for activation of CCATT for aeromedical evacuation that best suits our setup keeping in view the availability of electromedical equipment, manpower and aircrafts.

Methodology:
Cross-sectional Study</td>
<td>CCATT air evacuated patients between January 2010 and February 2017</td>
<td>

Elective vs urgent vs emergent evacuation of patients
Scoring system for evaluating the severity of casualties for activation of CCATT
Scoring system based on modified early warning score for activation of CCATT.

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<td>Duchateau et al. (2009)</td>
<td>Paris, France</td>
<td>Aim:
Characterize international aeromedical evacuations in order to identify predictive factors that indicate urgent evacuation.

Methodology:
Retrospective Review</td>
<td>Mondial Assistance France between August 2006 and July 2007 was reviewed for this study by a single investigator, who is a physician of the coordination centre.</td>
<td>

Emergency physicians, nurses, and nurse anaesthetists form the staff complement.
The most common condition necessitating transport was trauma (40%).
Mostly surgical interventions (27%) are required.
Monitoring devices (ECG, blood pressure, pulse oximetry, capnography), defibrillators, pacing devices, ventilators, aeronautical oxygen systems, infusion devices, mattresses, medications including resuscitation drugs must be available 24 hours a day.
Equipment must be certified for aeronautical use.
Characteristics of patients requiring aeromedical evacuations (August 2006-July 2007)

<table>
<tr><th></th><th>Immediate aeromedical evacuation N = 35</th><th>Nonurgent repatriation N = 367</th><th>p</th><th>Total N = 402</th></tr>
<tr><td>Age (yrs)</td><td>47±4</td><td>57±1</td><td>0.02</td><td></td></tr>
<tr><td>Location:</td><td></td><td></td><td></td><td></td></tr>
<tr><td>North Africa</td><td>13 (37%)</td><td>85 (23%)</td><td></td><td>98</td></tr>
<tr><td>Sub-Saharan Africa</td><td>15 (43%)</td><td>34 (9%)</td><td></td><td>49</td></tr>
<tr><td>Asia</td><td>2 (6%)</td><td>41 (11%)</td><td><0.0001</td><td>43</td></tr>
<tr><td>America</td><td>2 (6%)</td><td>25 (7%)</td><td></td><td>27</td></tr>
<tr><td>Europe</td><td>3 (8%)</td><td>182 (50%)</td><td></td><td>185</td></tr>
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Western countries' standards	2 (%6)	143 (39%)	<0.0001	145
High standard of structure in the country	21 (60%)	328 (89%)	<0.0001	349
Direct medical contact	31 (89%)	215 (59%)	0.17	246
Urgent treatment required	34 (97%)	123 (34%)	<0.0001	157

Data are expressed as *N* (%) unless otherwise indicated

				• A specific standardized scoring system could be a helpful tool. Our study showed that criteria associated with the need for immediate aeromedical evacuation can be summarized as age, local resources, and locations. The medical needs of our injured or ill clients can easily exceed local resources; this disparity is especially true for paediatrics care.
Eveson et al. (2020)	South Sudan	Aim: Assess capability to enable movement of patients in the fastest, safest and least stressful way that meets or exceeds the level of care an injured or ill person may expect to receive in the UK. Methodology: Retrospective Analysis	All patients aeromedical evacuated from the UK military level 2 hospital in Bentiu, South Sudan over 17 months.	• Categorisation of aeromedical patients
Fang et al. (2010)	Iraq, Afghanistan, and USA	Aim: Proper patient selection and thorough mission preparation are crucial to the safe and successful intercontinental aeromedical evacuation of critical brain-injured patients during Operations Iraqi Freedom	Air evacuated TBI patient during Op Iraqi Freedom and enduring freedom	• Physiological effects of flight on TBI

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<td>and Enduring Freedom.

Methodology:
Narrative Review</td>
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<tr>
<td>Farzan et al. (2023)</td>
<td>Iran</td>
<td>Aim:
Investigate the reasons and consequences of transferring patients by HEMS in Shahid Beheshti Hospital in Qom.

Methodology:
Cross-sectional Study</td>
<td>A cross-sectional study was done from March 2021 to March 2022 at Shahid Beheshti hospital complex in Qom, Iran.</td>
<td>

Medical contraindications such as active labor, untreated and severe pneumothorax, the aggressiveness of the patient, and even the high weight of the patient should be considered in addition to bad weather conditions.
Frequency of patients based on final diagnosis at the hospital alter evaluations.

<table>
<tr><th>Diagnosis</th><th>Frequency (Number)</th><th>Percentage</th></tr>
<tr><td>Trauma with normal imaging findings</td><td>51</td><td>41.1</td></tr>
<tr><td>left the hospital against medical advice by their own responsibility (before me final diagnosis)</td><td>9</td><td>7.3</td></tr>
<tr><td>Myocardial infection</td><td>1</td><td>0.8</td></tr>
<tr><td>Patient died before admission</td><td>3</td><td>2.4</td></tr>
<tr><td>Extensive lesion of the nasal area</td><td>1</td><td>0.8</td></tr>
<tr><td>Head trauma requiring emergent surgery</td><td>3</td><td>2.4</td></tr>
<tr><td>Upper Limb trauma requiring non-emergent surgery</td><td>4</td><td>3.2</td></tr>
<tr><td>Lower limb trauma requiring non-emergent surgery</td><td>1</td><td>0.8</td></tr>
<tr><td>Chest trauma requiring non-emergent surgery</td><td>3</td><td>2.4</td></tr>
<tr><td>Multi-organ trauma requiring emergent surgery</td><td>9</td><td>7.3</td></tr>
<tr><td>Multi-organ trauma requiring non-emergent surgery</td><td>4</td><td>3.2</td></tr>
<tr><td>Non- non-emergent surgical facial trauma</td><td>2</td><td>1.6</td></tr>
<tr><td>Vertebral trauma requiring non-emergent surgery</td><td>3</td><td>2.4</td></tr>
<tr><td>Head trauma without surgery</td><td>11</td><td>8.9</td></tr>
<tr><td>Non-surgical multiple organ trauma</td><td>3</td><td>2.4</td></tr>
<tr><td>Non-surgical limb trauma</td><td>12</td><td>9.7</td></tr>
<tr><td>Corbon monoxide poisoning</td><td>3</td><td>2.4</td></tr>
<tr><td>Pregnant woman with trauma</td><td>1</td><td>0.8</td></tr>
</table>

The most common cause of the HEMS transfer of patients was accidents and trauma.
According to a study, patients transferred by air ambulance had more critical situations compared to patients transferred by land emergency.
Based on their data, most of these patients had severe injuries to the neck, chest, abdomen, and back. The outcomes of these patients were not determined.
The factors related to 7-day mortality were age, GCS, and haematocrit levels. The age, GCS, haematocrit level, hemodynamic instability, and tracheal intubation were related to 30-day mortality.

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Galvagno et al. (2014)	Iraq	Aim:
		Highlight the importance of obtaining robust epidemiological data regarding patients transported by CCATTs.
		
		Methodology:
		Epidemiological Analysis
			1,418 patients from Operation Iraqi Freedom/ Operation Enduring Freedom (OIF/OEF).	• Teams are composed of three specially trained critical care providers:
				  ○ Acritical care physician
				  ○ A critical care nurse
				  ○ A respiratory therapist
				• Multisystem trauma, burns, shock, respiratory failure, and other serious illnesses and injuries.
				• The 15 Most Common ICD-9-CM Diagnoses (*N* = 290)
				ICD-9-CM Code — **Diagnosis** — **Total**
				897.6 — Bilateral Lower Extremity Amputation — 40
				E991.3 — Injury From Bomb Fragments — 29
				410.9 — Myocardial Infarction/Acute Coronary Syndrome — 19
				878.0-8 — Open Wound to Groin/Testes/Penis — 17
				805.4 — Lumbar Fracture — 16
				896 — Foot Amputation (Unilateral) — 14
				897 — Lower Extremity Amputation — 13
				887 — Hand Amputation — 10
				821 — Femur Fracture — 9
				805 — Cervical Fracture — 7
				860 — Pneumothorax — 7
				864 — Liver Injury — 5
				896.2 — Foot Amputation (Bilateral) — 5
				821.1 — Femur Fracture (Open) — 5
				860.1 — Pneumothorax (Open) — 4

Gibbons et al. (2017)	Ireland	Aim: Evaluate the new service to Tallaght Hospital in terms of: the criteria used for dispatch, an estimate of baseline efficiency of time critical management of patients, the cross catchment transfer of patients. Methodology: Retrospective Analysis	52 cases which were reported.	• Algorithm for activation of EAS **Activation criteria in order to task "MEDEVACII2" joint military-NAS helicopter.** **A. Expected "leaving scene" to "at hospital" time >45 min and advanced paramedic or paramedic on scene, and cos of the following apply.** 1. Patient meets criteria for Trauma appropriate hospital access (NAS procedure--NASCG009) **B. Expected "leaving scene" to "at hospital" time >45 min and paramedic on scene with no advanced paramedic availability and one of the following apply.** 2. Shock from blood loss adult or paediatrics (CPG 5/6,6.2 and CPG 5/6.7.13) 3. Burns >10% total body surface area (excluding 1st degree burns) **C. Expected "leaving scene" to "at hospital" time >45 min and advanced paramedic and/or paramedic discretion.** The practitioner scene may request EAS activation if the patient's clinical status does not precisely fit any of the criteria, but he/she believes tome critical treatment or transport is required and unachievable by ground transport. **EAS activation protocol**

				Subject to criteria above, request ambulance control to request EAS activation via National Aero Medical Coordination Centre (NACC) NACC will check activation criteria price to passing to aircraft commander for final acceptance **Appropriate Hospital Access criteria outlined in NASGC009** • Penetrating trauma to the head, neck, trunk, and extremities proximal to elbow and knee (gunshot wounds. • Flail chest • Suspected pelvic failure • ≥ proximal long bone fractures • Crush, degloved or mangled extremity • Paralysis • Amputation proximal to the wrist or ankle • Open of depressed skull fracture • Physiological • Systolic BP <90 mmHg % or absence of radial pulse • GCS ≤ 13 • Unassisted respiratory rate <10 or >29 breaths per min (<20 in infant under 1 year) • Immediately life-threatening injuries • Airway compromise (actual not potential) • Tension pneumothorax (no air entry on affected side, hypotension, respiratory compromise, and trachea deviated away from side of injury) • Life threatening haemorrhage-hypotension with absence of radial pulse • Practitioner discretion: in addition to the above criteria, if the treating practitioner has a high index of clinical suspicion of significant occult injury, the patient may be transported to the appropriate trauma receiving Emergency Department at an acute hospital even if they do not precisely it the criteria for trauma access
Hooker et al. (2008)	USA	Aim: Determine reasons for multiple-patient transports using a helicopter emergency medical services (HEMS) and to observe for any negative impact on patient care caused by the presence of the second patient. Methodology:	Trauma patients in two-patient HEMS transports.	• Comparison of double patient transport and single patient transport

		Prospective Observational Study		
Joshi & Sharma (2010)	Bagdad & Talil Kuwait	Aim: Develop a highly efficient casualty air evacuation (CASAEVAC) system that can exceed the standards of care available at field medical units and even transport unstable patients with one or more organ dysfunction. Methodology: Narrative Review	Casualty evacuations of patients from Gaum to Brooke Army Medical Centre	• **Relative contraindications of CASAEVAC** ○ Pneumothorax, unless reduced by chest tube ○ Bowel obstruction from any source (commonly postoperative) ○ Laparotomy or thoracotomy within previous one week ○ Eye surgery within previous 7-14 days ○ Haemorrhagic cerebrovascular accident within previous week ○ Severe uncorrected anaemia (haemoglobin <7.0 g/di) ○ Acute blood loss with haematocrit below 30% ○ Uncontrolled dysrhythmia ○ Irreversible myocardial infarction ○ Congestive heart failure with acute pulmonary oedema ○ Acute psychosis ○ Spinal injury unless immobilized
Kotwal et al. (2018)	Afghanistan	Aim: Characterize battlefield casualties who underwent TACEVAC from a Role 1 entity to a Role 2 medical treatment facility as evaluated through data available for type and mode of transport Methodology: Retrospective Review and Descriptive Analysis	Patients transported from role one to role two facility via ambulance or flight	• Combat mortality index and physiological indicators • Average age of patients is 25 years • Male patients represent 97.4% of patients part of those evacuated by air for medical purposes. • Patients evacuated by air averaged 72 minutes to definitive care and 87 minutes by ground transport
Luft et al. (2018)	France	Aim: Describe the last piece, the evacuation process of the French Strategic-AE. Methodology:	Participants: French service members who needed an air evacuation from overseas to an R4	• Comparison of Management Between Battle injury (BI) and Non-Battle Injury and Diseases (NBID) Patients (Exclusion: Psychiatric Diseases) BI (*n* = 63) NBID (*n* = 1624) **Priority** P1 21 (33.356) 45(2.8%) P2 14 (22.2%) 82 (5%) P3 28 (44.5%) 1.497 (92.2%)

		Retrospective Cohort Analysis	or a medical unit in France	**Crew composition**		
				Flight surgeon	40 (63.5%)	190 (11.7%)
				Flight nurse	14 (22.25)	487 (30%)
				Nonmedicalised	9 (14.3%)	947 (58.3%)
				Plane		
				Falcon	38 (60.3%)	140 (8.6%)
				Regular flight	25 (39.7%)	1,484 (91.4%)
				Receiving service		
				Burns centre	0	14 (0.996)
				Surgery	46 (73%)	1.097 (67.6%)
				Medicine	0	413 (25.4%)
				Intensive care service	17 (275)	35 (2.1%)
				Primary care unit	0	65 (4%)
Maddry et al. (2022)	Germany	Aim: Characterize the temporal features of lower extremity compartment syndrome relative to the timing of transcontinental AE. Methodology: Retrospective Study	Compartment syndrome patients who were transferred via aeromedical transport from Iraq or Afghanistan to Landstuhl Regional Medical Centre (LRMC) from January 2007 to May 2014.	• Incidence of traumatic compartment syndrome of the extremities from time of injury in AE patients		
Madiraju et al. (2017)	Palm Beach, Florida USA	Aim: Show that a complex trauma algorithm leads to significant aeromedical over triage at substantial cost. Methodology: Retrospective Analysis	4 retrospective registry study from an urban Level I trauma centre in Palm Beach County, Florida	• Accurate vs inaccurate triage criteria • Trauma transport criteria (used for helicopter dispatch) • Predictors of over triage and under triage		
Maher et al. (2019)	USA	Aim: Explores if the	Trauma alert patients transported via	• Florida adult trauma scorecard		

		physiological criteria of the trauma scorecard have any relationship with the use of HEMS as a transportation method outside of paramedic discretion. Methodology: Retrospective Quantitative	GT or HEMS to Florida TC in 2015	
Mize et al. (2019)	Bhutan	Aim: Indicates that a low-income country such as Bhutan can organize and deploy a critical care HEMS team to meet the needs of severely injured patients who are located far from reliable emergency or critical care. Methodology: Case Series	Trauma who required aeromedical evacuation as determined by the national triage system of Bhutan during the 4-month period	• Bhutan Trauma retrieval triage criteria
Oner & Hakan (2006)	Turkey	Aim: Discuss medical aspects of flights and the capabilities of the aeromedical environment to help evacuate patients. Methodology: Narrative Review	NA	• Mode of transport selection criteria • Advantages and disadvantages of HEMS and GT • Considerations for specific patient populations and pathologies
Owen (1999)	USA	Aim: Review whether air ambulance transportation of trauma patients to the Brooke Army Medical	Trauma patients brought to BAMC by one air ambulance (San Antonio AirLife) and one	• Probability of survival rates of trauma patients transported by ground or aeromedical ambulances • TRISS method to triage patients for AE

		Centre (BAMC) level I trauma centre contributed to maintaining national mortality standards in the trauma care of these patients. Methodology: Retrospective Review	ground ambulance (San Antonio EMS).	
(Park et al., 2020)	Korea	Aim: Review the benefit of HAT for neurosurgical patients in Korea. Methodology: Retrospective Study	Benefit of HT in neurosurgery patients	• All neurosurgery patients were transported by helicopter to a single medical emergency centre between March 2011 and February 2013
Ranjan & Renjhen (2017)	India	Aim: Discuss the casualty evacuation capabilities of the aircrafts in the Indian Air Force (IAF) . Methodology: Narrative Review	Indian Air Force (IAF) casualty air evacuation capabilities	• Contraindications of air evacuation (untreated pneumothorax which can progress to a tension pneumothorax, abdominal surgery which can result in gas expansion with rise in altitude causing pain and dehiscence of wound and acute blood loss leading to low haematocrit). • Aeromedical considerations of air evacuation
Reno (2010)	USA	Aim: Educate civilian neurosurgeons on the structure and function of the US military aeromedical evacuation (AE) system, with special focus on the role of the military neurosurgeon. Methodology:	Aeromedical Emergency travels from a field hospital to one of the main theatres hospitals (Balad base, Iraq, or Bagram base, Afghanistan	• Stressors of flight and general clinical considerations

		Review		
Renz et al. (2008)	USA	Aim: Characterize the military burn casualties transported by each team and reports associated outcomes. Methodology: Retrospective Review	US military burn casualties injured in Iraq or Afghanistan who were transported from LRMC to our burn centre between March 2003 and February 2007 via air	• US Transportation Command policy guidelines on the transport of burn patients • Guidelines on the composition of transport team
Shatney et al. (2002)	USA	Aim: Assessing the value of scene helicopter evacuation of urban trauma victims. Methodology: Retrospective Review	Trauma registry extracted patients, transported by HEMS	• Injury severity score as a criterion for determining transport method • Time-distance benefit of HEMS vs GT
Taylor et al. (2018)	USA	Aim: Analysing the value of calling a helicopter for trauma patients within a moderate distance/<45 minutes, of a trauma centre. Methodology: Retrospective Analysis	Adult patients transported from scene to a level 1 TC for blunt injuries	• Survival difference in unstable patients transported via ground vs HEMS
Turkan (2006)	Turkey	Aim: Emphasizes the factors to consider in arriving at the decision to transport as well as the accurate assessment of available equipment and personnel resources.	Case study of an aero medically evacuated blast patient	• Considerations in the decision for an aeromedical evacuation

		Methodology: Case Review		
Zhang et al. (2022)	Canada	Aim: Determine causes for air ambulance trauma response cancellations and secondarily to identify patients who underwent secondary transfer to a trauma centre after a cancelled air ambulance dispatch. Methodology: Prospective Cohort Study	Cancelled Air Ambulance Trauma Scene Calls	• Trauma bypass criteria/ Ontario field trauma triage standard • Reasons for HEMS request cancellations
Zonies et al. (2018)	Germany	Aim: Systematically study the timing of chest drain removal after traumatic pneumothorax and risk of recurrence in relation to air travel. Methodology: Retrospective Cohort Study	Patients who sustained thoracic trauma requiring chest tube and aeromedical evacuation	• Safety of flight of patients post chest tube removal • Military flight doctrine (Pre-flight guidance)

Appendix 3: Invitation Letter to Steering Committee

Invitation Letter Steering Committee:

PARTICIPATION IN DELPHI STUDY ON THE VIEWS AND OPINIONS REGARDING DEVELOPING CLINICAL CRITERIA FOR AEROMEDICAL INTERFACILITY TRANSFERS OF ADULT TRAUMA PATIENTS IN NAMIBIA

Dear ,

I am enrolled as a student at the Namibia University of Science and Technology, and I am currently completing my second year in the Masters of Health Sciences (MOHS) programme. I am required to complete a research project as part of this qualification.

The research aims to develop clinical criteria for aeromedical interfacility transfers (IFTs) of adult trauma patients. The criteria should apply to Namibia, to be used when requesting aeromedical IFTs of adult trauma patients within this setting. I would like to investigate this topic, as there is a lack of uniformity amongst health care providers both in-hospital and prehospital and in the public and private sectors respectively. The lack of consensus often leads to the wrong patients being flown or patients being flown without adequate clinical consideration, correcting this will lead to overall improved utilization of the aeromedical services to improve patient treatment/transport delivery.

I would like to invite you to participate in this Delphi study, and to form part of a steering committee (SC). By accepting this invitation, you will be required to use your own personal experiences, available data and literature, or any other resources to guide the researcher to develop a framework for clinical criteria for aeromedical IFTs in adult trauma patients in Namibia. This framework is what the expert panellists who will participate in the Delphi rounds of this study will vote on to reach 75% consensus.

All communications will be kept confidential and as a member of the SC, you will have the opportunity to review your statements made during the development of the framework.

Yours sincerely,

S. Veldskoen
E-mail: sveldskoen@nust.na
Cell: 26481 283 6119

Appendix 4: Information Leaflet (Delphi Round One)

Dear Expert Panellist,

I am Salome Veldskoen, a Master of Health Sciences student at the Namibia University of Science and Technology (NUST). I am conducting a study aiming to utilize the perceptions of an expert panel critically and systematically to develop a standard clinical criterion for aeromedical IFTs of adult (≥18 years) trauma patients in Namibia. Given your expertise and pivotal role in the Namibian prehospital and/or in-hospital field, I invite you to participate in my research employing an online Delphi method. Your insights and contributions will be invaluable.

A **Delphi Study** is fitting as the design promotes policy making, organizational decision-making and informs direct practices. A key feature of the design is the structured approach to achieving consensus among experts, which serves as the foundation for creating the clinical criteria. The process will involve multiple rounds of online questionnaires completed by expert panelists. Each round builds on the feedback from the previous one, intending to refine and narrow the range of responses until consensus is achieved.

You are **eligible to partake** if you are a relevant Specialist or Surgeon (e.g., Emergency Medicine, Anaesthesiologists, Neurologist or Neurosurgeon, Orthopedic Surgeon, Cardiothoracic Surgeon, General Surgeon and Maxillo-Facial Surgeon), Senior Medical Officer or Advanced Life Support (ALS) Paramedic with 10 or more years of experience and currently working or recently worked (last 5 years) in the Namibian context. Your participation is **entirely voluntary,** and you are free to decline to participate or to stop completing the questionnaire at any time, even if you agreed to take part initially. However, once you submit your completed questionnaire online, you will no longer be able to withdraw your responses as there will be no way of linking your responses back to you. All information gathered will be securely stored and protected.

This research does not pose any risks or direct personal benefits to participants. However, the study findings have the potential to significantly benefit patients by improving clinical decision-making and enhancing the effectiveness of aeromedical interfacility transfers for adult trauma patients in Namibia.

Expert Panelists agree to:
1. Keep their responses isolated from other panelists allowing each individual freedom of expression without outside pressure or influence **(Anonymity).**
2. Each of the Expert Panelists agrees to consider and give feedback on all questions presented in the Delphi rounds until a consensus has been reached. The desired consensus for each criterion in this study is 75% **(Feedback).**

The survey should take you approximately **15 minutes** to complete.

This study received approval from the Ministry of Health and Social Services (MoHSS) and the Faculty Research Ethics Committee at NUST. The study will be conducted per international ethical

Appendix 5: Informed Consent

Informed Consent

Please read the below and make your selection:

- I read the information sheet provided above and understand the purpose of this study and my role.
- I understand that my participation in the study is entirely voluntary, and I can choose to leave at any time without any repercussions.
- All responses you provide for this study will be completely confidential. When the results of the study are reported, you will not be identified by name or any other information that could be used to infer your identity.
- I understand that the information will be anonymized on submission, thus when I have submitted the completed questionnaire online, I will no longer be able to withdraw my responses because there will be no way to trace them back to me.

Appendix 6: Questionnaire (Delphi Round One)

A. DEMOGRAPHICS

Please complete the below demographic questions. The demographic section helps us understand the diversity of participants. All information you provide is strictly confidential and will only be used for research purposes. Your responses will remain anonymous and unlinked to your identity.

4. Indicate your gender

- Male
- Female

5. Which of the following best describes your professional role?

- Emergency Medicine Specialist
- Senior Medical Officer/General Practitioner
- General Surgeon
- Cardiothoracic Surgeon
- Neurosurgeon
- Maxillo-Facial Surgeon
- Orthopaedic Surgeon
- Neurologist
- Anaesthesiologist
- Advanced Life Support/Paramedic with >10 years' experience
- Other

6. **Indicate in which sector you are currently employed.**

- Public
- Private
- Other

7. Indicate your years of professional experience.

- Less than 1 year
- 1-5 years
- 6-10 years
- More than 10 years

8. Indicate your years of experience and involvement in clinical decision-making for patients requiring aeromedical interfacility transfers.

- Less than 1 year
- 1-5
- 6-10 years
- More than 10 years

B. SCORING SYSTEMS AND PHYSIOLOGY

Please complete the following questions relating to trauma and triage scoring systems, patient clinical status, and physiological parameters. All information you prov ide is strictly confidential and will only be used for research purposes. Your responses will remain anonymous and unlinked to your identity.

9. Which of the following is the main trauma or triage scoring tools used in your department?

- o South African Triage Scale (SATS)
- o Revised Trauma Score (RTS)
- o Injury Severity Score (ISS)
- o Other

10.Rank the following trauma and triage scoring systems in order of suitability, starting with the most suitable and ending with the least suitable, for use in decision-making regarding the aeromedical interfacility transfer of an adult trauma patient (use the arrows on the right to indicate your choice of ranking)

SOUTH AFRICAN TRIAGE SCALE (SATS)	TRAUMA RELATED INJURY SEVERITY SCORE (TRISS)	REVISED TRAUMA SCORE (RTS)
Mobility RR SBP Temp AVPU Trauma	R – RTS I – Injury Severity Score S – Seen Age S – Specific Mechanism (Blunt or Penetrating)	R – Respiratory Rate T – The Blood Pressure S – Scale (GCS)

Trauma Related Injury Severity Score (TRISS)

Revised Trauma Score (RTS)

South African Triage Scale (SATS)

11. Please provide any additional comments or insights related to your responses to Question 10. Your input is valuable in enhancing our understanding.

12.To what extent do you agree or disagree with the inclusion of the following physiological parameters and clinical status when deciding whether to support or recommend aeromedical interfacility transfers of adult trauma patients?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The patient's ability to maintain and protect airway patency	○	○	○	○	○
The patient's ability to maintain oxygenation and ventilation.	○	○	○	○	○
Anticipated deterioration, requiring definitive airway management.	○	○	○	○	○
Vital trends (BP, Sats, RR, HR, HGT, ECG and GCS) of the patient.	○	○	○	○	○

13.Please provide any additional comments or insights related to your responses to Question 12. Your input is valuable in enhancing our understanding.

C. DISTANCE, TIME, CAPABILITIES AND RESOURCES

Please answer the following questions to determine the appropriate distance, time, capabilities, and resource parameters to considered for requesting an aeromedical interfacility transfer of adult trauma patients in Namibia. All information you provide is strictly confidential and will only be used for research purposes. Your responses will remain anonymous and unlinked to your identity.

14. To what extent do you agree or disagree with the inclusion of the following factors - distance, time, capabilities, and resources - when deciding whether to support or recommend aeromedical interfacility transfers of adult trauma patients?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
A distance of greater, than 250km by road.	○	○	○	○	○
A lack of appropriate local EMS resource (ambulance/ staff/ equipment) availability.	○	○	○	○	○
A lack of night landing capacity for flights.	○	○	○	○	○
Extended out of hospital time.	○	○	○	○	○

15. Please provide any additional comments or insights related to your responses for Question 14. Your input is valuable in enhancing our understanding.

D. CLINICAL PROCEDURES/INTERVENTIONS

Please answer the following questions to determine what procedures/interventions should be considered to activate an aeromedical interfacility transfer request for adult trauma patients in Namibia. All information you provide is strictly confidential and will only be used for research purposes. Your responses will remain anonymous and unlinked to your identity.

16.To what extent do you agree or disagree that, in situations where patients have received or are anticipated to require the clinical procedures or interventions outlined below, it is advisable to consider requesting an aeromedical interfacility transfer?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Endotracheal Intubation or Supraglottic Device placement	○	○	○	○	○
Mechanical Ventilation	○	○	○	○	○
Chest Drain or Needle Decompression	○	○	○	○	○
IV Fluid and/or Blood Transfers	○	○	○	○	○
CPR with ROSC	○	○	○	○	○
Continuous Drug Infusions	○	○	○	○	○

17.Please provide any additional comments or insights related to your responses to Question 16. Your input is valuable in enhancing our understanding.

E. SPECIFIC TYPES OF INJURIES AND SPECIAL POPULATIONS

Please answer the following questions to determine which specific types of injuries in adult trauma patients or special populations should be considered for aeromedical interfacility transfer in Namibia. All information provided will be kept confidential and used solely for research purposes. Your responses will remain anonymous and unlinked to your identity.

18.To what extent do you agree or disagree that, in an adult trauma patient, the request for an aeromedical interfacility transfer should be considered if the patient presents with the following injuries or criteria?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Moderate (GCS 9-12) or severe (GCS 8 or below) Traumatic Brain Injury (TBI) or signs of increased intracranial pressure.	○	○	○	○	○
Spinal injuries including subluxation of the cervical vertebra with neurological deficits.	○	○	○	○	○
Chest injuries from high impact mechanisms e.g., gunshots, blasts, crush injuries which can lead to various sequelae.	○	○	○	○	○
Hemoperitoneum requires urgent surgical intervention.	○	○	○	○	○
Object protruding from the abdomen and hemodynamic instability.	○	○	○	○	○

Pelvic fracture with hemodynamic instability.	○	○	○	○	○
Threatened extreme injuries.	○	○	○	○	○
Polytrauma	○	○	○	○	○
Severe Burns (>15% any full-thickness burns, circumferential burns, high-voltage burns including lightning and inhalation burns)	○	○	○	○	○

19.Please provide any additional comments or insights related to your responses for Question 18. Your input is valuable in enhancing our understanding.

20.To what extent do you agree or disagree that an aeromedical interfacility transfer should be considered for the following special populations in adult trauma patients?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Obstetric patients with a gestational age of 26 weeks or more.	○	○	○	○	○
Geriatric patients (60 years older)	○	○	○	○	○

21.Please provide any additional comments or insights related to your responses to Question 20. Your input is valuable in enhancing our understanding.

F. RELATIVE CONTRAINDICATIONS

Please answer the following questions to identify relative contraindications for requiring aeromedical interfacility transfers in adult trauma patients in Namibia. All in formation you provide is strictly confidential and will only be used for research purposes. Your responses will remain anonymous and unlinked to your identity.

22. In adult trauma patients, to what extent do you agree that the relative contraindications outlined below should be considered when determining whether to request an aeromedical interfacility transfer?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Untreated and severe pneumothorax.	○	○	○	○	○
Unrelated eye surgery (7-14 days).	○	○	○	○	○
ROSC with poor prognosis.	○	○	○	○	○
Spinal injury with inadequate immobilization.	○	○	○	○	○
Acute blood loss with haematocrit <30%.	○	○	○	○	○
Recent abdominal surgery/ untreated abdominal injury with confirmed entrapped gas in the peritoneum/GI tract.	○	○	○	○	○

23. Please provide any additional comments or insights related to your responses for Question 22. Your input is valuable in enhancing our understanding.

NB: DELPHI ROUNDS

Thank you for participating in the first round of the Delphi survey. To ensure we can send you the second-round survey and any subsequent rounds if consensus is not reached - while maintaining the anonymity of your responses - please follow the link to securely share your email address - https://forms.office.com/r/rTA6t5Fhdr This will allow us to send you the next survey when it becomes available.

Please remember to submit your response after sharing your email address.

Survey Completion

I am very appreciative of the time you have taken to assist in completing this survey. Your input will aid in the research to develop clinical criteria for aeromedical interfacility transfers of adult trauma patients in Namibia.

Please remember to share this survey with other individuals who meet the inclusion criteria.

If you have any further questions, please feel free to contact me directly, Best regards,

Salome Veldskoen

Mobile:+264812836119

Email:ellerize93@gmail.com

Appendix 7: Adjusted Information Leaflet (Delphi Round Two)

CLINICAL CRITERIA FOR AEROMEDICAL INTERFACILITY TRANSFERS OF ADULT TRAUMA PATIENTS NAMIBIA

Dear Expert Panelist,

I am Salome Veldskoen, a Master of Health Sciences student at the Namibia University of Science and Technology (NUST). I am conducting a study aiming to utilize the perceptions of an expert panel critically and systematically to develop a standard clinical criterion for aeromedical IFTs of adult (≥18 years) trauma patients in Namibia. Given your expertise and pivotal role in the Namibian prehospital and/or in-hospital field, I invite you to participate in my research employing an online Delphi method. Your insights and contributions will be invaluable.

A **Delphi Study** is fitting as the design promotes policy making, organizational decision-making and informs direct practices. A key feature of the design is the structured approach to achieving consensus among experts, which serves as the foundation for creating the clinical criteria. The process will involve multiple rounds of online questionnaires completed by expert panelists. Each round builds on the feedback from the previous one, intending to refine and narrow the range of responses until consensus is achieved.

You are **eligible to partake** if you are a relevant Specialist or Surgeon (e.g., Emergency Medicine, Anaesthesiologists, Neurologist or Neurosurgeon, Orthopedic Surgeon, Cardiothoracic Surgeon, General Surgeon and Maxillo-Facial Surgeon), Senior Medical Officer or Advanced Life Support (ALS) Paramedic with 10 or more years of experience and currently working or recently worked (last 5 years) in the Namibian context. Your participation is **entirely voluntary,** and you are free to decline to participate or to stop completing the questionnaire at any time, even if you agreed to take part initially. However, once you submit your completed questionnaire online, you will no longer be able to withdraw your responses as there will be no way of linking your responses back to you. All information gathered will be securely stored and protected.

This research does not pose any risks or direct personal benefits to participants. However, the study findings have the potential to significantly benefit patients by improving clinical decision-making and enhancing the effectiveness of aeromedical interfacility transfers for adult trauma patients in Namibia.

Expert Panelists agree to:
1. Keep their responses isolated from other panelists allowing each individual freedom of expression without outside pressure or influence **(Anonymity).**
2. Each of the Expert Panelists agrees to consider and give feedback on all questions presented in the Delphi rounds until a consensus has been reached. The desired consensus for each criterion in this study is 75% **(Feedback).**

This study received approval from the Ministry of Health and Social Services (MoHSS) and the Faculty Research Ethics Committee at NUST. The study will be conducted per international ethical guidelines and principles.

Upon completion, the researcher would like to publish the study results in reputable journals. Most journals require us to share anonymous data with them before publishing the results. The researcher would like to obtain your permission to have your anonymous data shared with reputable journals.

If you have any further questions, please feel free to contact me directly, at +264 81 283 6119 or ellerize93@gmail.com

Appendix 8: NUST Ethical Clearance

NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

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Windhoek
NAMIBIA

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FACULTY OF HEALTH AND APPLIED SCIENCES

DECISION/FEEDBACK ON RESEARCH PROPOSAL ETHICAL CLEARANCE

Dear ~~Prof/Dr/Mr~~/Ms/~~Other(s)~~: S. Veldskoen

Student No (if applicable):

Research Topic:	Developing clinical criteria for aeromedical inter-facility transfers of adult trauma patients in Namibia
Supervisor (if applicable):	Dr. Andrit Lourens
Co-supervisor(s): if applicable	Ms. Johanna Botha
Qualification registered for (if applicable):	Master of Health Sciences

Re: Ethical screening application No: FHAS:24/2022

The Research Ethics Screening Committee has reviewed your application for the above-mentioned research project. Based on the recommendation of the expert reviewer, the research as set out in the application is hereby:

(Indicate with an X)

Approved: i.e. may proceed with the project	X	
Approved provisionally: i.e. may proceed but subject to compliance with recommendation(s) listed below		
Not approved: Not to proceed with the project until compliance with recommendation(s) listed below and resubmit ethics application for consideration		
IS MINISTRY OF HEALTH & SOCIAL SERVICES (MoHSS) APPROVAL REQUIRED?	YES: X	NO:

It is important to note that as a researcher, you are expected to maintain ethical integrity of your research, strictly adhere to the ethical policy of NUST, and remain within the scope of your research proposal and supporting evidence as submitted to the REC. Should any aspect of your research change from the information as presented, which could have an impact or effect on any research participants/subjects/environment, you are to report this immediately to your supervisor or REC as applicable in writing. Failure to do so may result in withdrawal of approval. Kindly consult your supervisor or HoD if you need further clarification.

We wish you success in your research endeavour and are of the belief that it will have positive impact on your career as well as the development of NUST and the society in general.

Ethical issues that require compliance/ must be addressed: None		
No.	Ethical issues	Comment/recommendation
1.		
2.		

NB: May attach additional page as required

Reviewrs name:………………………………………… Signature: Date:

Full Name: Dr Larai Aku-Akai Signature: Date: **09 December 2022**

Chair: Ethics Screening Committee

Appendix 9: MoHSS Research Committee Ethical Clearance

REPUBLIC OF NAMIBIA

MINISTRY OF HEALTH AND SOCIAL SERVICES

Ministerial Building
Harvey Street
Private Bag 13198, Windhoek

OFFICE OF THE EXECUTIVE DIRECTOR

Tel: No: 061 -203 2507
Fax No: 061-222 558
Andreas.Shipanga@mhss.gov.na

Ref: Ref: 22/3/1/1
Enquiries: Mr. A. Shipanga

Date: 20 December 2022

Ms. Simone Ellerize Veldskoen
PO Box 32239
Windhoek

Dear Ms. Veldskoen

Re: Developing clinical criteria for aeromedical inter-facility transfers of adult trauma patients in Namibia

1. Reference is made to your application to conduct the above-mentioned study.
2. The proposal has been evaluated and found to have merit.
3. **Kindly be informed that permission to conduct the study has been granted under the following conditions:**
   3.1 The data to be collected must only be used for academic purpose;
   3.2 No other data should be collected other than the data stated in the proposal;
   3.3 Stipulated ethical considerations in the protocol related to the protection of Human Subjects should be observed and adhered to, any violation thereof will lead to termination of the study at any stage;
   3.4 A quarterly report to be submitted to the Ministry's Research Unit;
   3.5 Preliminary findings to be submitted upon completion of the study;
   3.6 Final report to be submitted upon completion of the study;
   3.7 Separate permission should be sought from the Ministry for the publication of the findings.
4. All the cost implications that will result from this study will be the responsibility of the applicant and **not** of the MoHSS.

Yours sincerely,

EXECUTIVE DIRECTOR
MINISTRY OF HEALTH AND SOCIAL SERVICES

BEN NANGOMBE
EXECUTIVE DIRECTOR

All official correspondence must be addressed to the Executive Director.

My NAMIBIA
MY COUNTRY. MY PRIDE

Appendix 10: Feedback Report (Delphi Round One)

Dear Expert Panellist,

Thank you for your participation in Round 1 of this Delphi study, ***"Developing Clinical Criteria for Aeromedical Inter-Facility Transfers of Adult Trauma Patients in Namibia".*** You are receiving this email as an expert panellist who consented to participate in this Delphi Study and receive additional communication and feedback.

If you would like to review the detailed information sheet or informed consent for this study, please see the attached.

Your contribution to Round 1 was instrumental in helping us reach consensus (≥75% agreement) on 22 of the 31 criteria. All criteria related to physiological parameters and clinical status (4/4), distance, time, capabilities and resources (4/4) and specific injuries (9/9) reached consensus. While some criteria related to clinical procedures/interventions (3/6), special populations (1/2) and relative contraindications (5/6) did not reach consensus. For a more detailed look at the consensus statements, please see the attached.

For **Round 2**, we have rephrased and restructured the criteria statements that did not reach ≥75% agreement in Round 1 for your consideration, as well as new statements derived from expert comments.

We would appreciate your continued input to finalise this second round of the Delphi study. Your participation in the second round is voluntary, and you have already provided consent to participate in this Delphi study. **The second round consists of nine questions**, which are mostly rating questions and are estimated to take less than 10 minutes to complete.

If you wish to proceed to the **second Round** of this Delphi study, please click on the link: Survey Link (Delphi Round 2)

I would like to ask that you kindly complete it by the **18th of August 2025**.

A gentle reminder of the survey will be sent out after 7 days.

If you have any further questions, please feel free to contact me directly at +264 81 283 6119 or ellerize93@gmail.com.

Your expert input and participation in this Delphi study are highly appreciated.

Regards,

Ms. Salome Veldskoen

Master of Health Sciences Student, Namibia University of Science and Technology (NUST)

Appendix 11: Language Editing Letter

NAMIBIA UNIVERSITY
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Faculty of Commerce, Human Sciences and Education – Department of Communication and Languages

Email: mmhene@nust.na

Tel: 61 207-2095 Cell: 0812954690

11 December 2025

TO WHOM IT MAY CONCERN.

I am writing to certify that a thesis titled***: "DEVELOPING CLINICAL CRITERIA FOR AEROMEDICAL INTER-FACILITY TRANSFERS OF ADULT TRAUMA PATIENTS IN NAMIBIA''*** presented in fulfilment of the requirements for the degree of Master of Health Sciences at the Namibia University of Science and Technology (NUST) was presented to me by **Salome Veldskoen** student number **212112724** for **LANGUAGE EDITING**.

Neither the thesis content nor the author's intentions were altered. The content guarantees the quality of English Language in this thesis. The editor's track changes were accepted and further changes made by the author were checked and a final version of the thesis was sent to the author for submission, examination and repository.

Do not hesitate to contact me if you have any queries. Thank you.

Yours sincerely

Prof Max Mhene

(Associate Professor: Linguistics, Literature and Communication)

Appendix 12: Turnitin Similarity Report

Dr Andrit Lourens

Final Thesis_S Veldskoen_212112724 (12 Dec 2025)

Veldskoen (Final Thesis)

Document Details

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17% Overall Similarity

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Exclusions

- 2 Excluded Matches

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0 Missing Citation 0%
Matches that have quotation marks, but no in-text citation

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Matches with in-text citation present, but no quotation marks

Top Sources

12% Internet sources
10% Publications
8% Submitted works (Student Papers)

Integrity Flags

0 Integrity Flags for Review

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