A consensus on reporting variables for terrestrial helicopter search and rescue operations in South Africa through a Delphi study.

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B(EMC): EMC (NMU)

THNSIM003

This study is in partial fulfilment of the requirements for the degree Master of Philosophy in the Faculty of Health Sciences at the University of Cape Town

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March 2024

DECLARATION

I, Simone Stefanie Theunissen (student number THNSIM003), at this moment, declare that the work on which this thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university. I authorise the University to reproduce for the purpose of research either the whole or any portion of the contents in any manner whatsoever. I further declare the following:

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Abbreviations/Glossary

ALS:	Advanced Life Support
Dr:	Doctor
ELO:	External load operator
EMS:	Emergency Medical Services
HEMS:	Helicopter Emergency Medical Services
HIC:	High-Income Countries
ICAR MEDCOM:	International Commission for Mountain Emergency Medicine
LMIC:	Low to Middle Income Counties
MCSA:	Mountain Club of South Africa
SAAF:	South African Airforce
SANPARKS:	South African National Parks
SAPS:	South African Police Services
SAR:	Search and Rescue
SARC AMS:	SA Red Cross Air Mercy Service
SATS:	South Africa Triage Score
WSAR:	Wilderness Search and Rescue

PART A: LITERATURE REVIEW

Introduction

Search and rescue (SAR) operations are conducted by emergency services, often with the assistance of well-trained volunteers. (1–4) Their main goal is to locate individuals who are believed to be distressed, lost, ill, or injured in challenging and remote environments such as mountains, deserts, forests, or at sea. (1–6)

The history of helicopter SAR traces back to Jimmy Viner, a pilot who executed the first helicopter rescue in 1945 using a Sikorsky R-5 Helicopter to save two stranded men from an oil barge. (7) This rescue mission marked the first of numerous successful rescue missions that followed to establish helicopter rescue. Today, helicopters are pivotal in global military and civilian life-saving efforts at sea and on land. (7–11)

Helicopter SAR refers to utilising helicopters to carry out and facilitate SAR missions for aquatic and terrestrial operations globally. (1–4) Terrestrial helicopter SAR describes any SAR mission conducted by a helicopter on land. (12) This study is centred on terrestrial SAR operations within the context of South Africa.

The significance of terrestrial helicopter SAR operations becomes evident in their ability to swiftly and effectively respond to emergencies in challenging and remote landscapes, such as mountains. (3,5,8,13–18) Global demand for SAR missions has surged due to increased participation in outdoor recreational activities. (3,8,15,19–22) This rise in activity has also led to more individuals requiring assistance for reasons ranging from sports-related injuries to severe illnesses. (22) The effectiveness of helicopters in SAR operations lies in their ability to access remote or rural locations where accessibility by foot or vehicle is challenging. (3) They demonstrate exceptional time efficiency during rescue operations, enabling the swift transportation of equipment and specialised teams directly to patients and to appropriate hospital facilities for the continuum of care. (3,14,17,18)

In high-income countries (HIC) such as Switzerland, Sweden, Germany, Australia, the United States of America, Canada and Norway, helicopters are commonly used for terrestrial SAR operations, and there is a wealth of literature available on helicopter search and rescue (HEMS) SAR operations in these countries describing operational and patient benefit. (3,4,18,23–31,5,32–41,10,42–47,11,13–17) Numerous studies highlight the advantages of helicopters in rescue missions, emphasising improved response times and decreased morbidity and mortality, especially in alpine and terrestrial regions.

(14,23,32,48–50) While there is a wealth of literature on helicopter SAR operations in HIC, research in low- and middle-income countries (LMIC) is notably lacking, primarily due to limited resources, particularly in the availability of HEMS SAR in these countries. (8)

Reporting on helicopter SAR operations faces several challenges on a national and international scale. (8,14,51) These difficulties arise from various factors that hinder the systematic collection and analysis of data in this field. (14,51) The primary reasons contributing to these challenges are discrepancies in terminology, incomplete records, inadequate record keeping, and limitations posed by the predominantly military nature of many helicopter SAR operations. (8,32,51)

In the context of South Africa, a significant challenge lies in the need for more well-defined rules, standardisation, comprehensive guidelines, and governance within the SAR operations landscape. (22) The absence of nationally accepted norms and benchmarks exacerbates this issue, allowing practices to proceed without sufficient regulatory oversight. (22) This deficiency not only hampers effective coordination and execution of SAR missions but also gives rise to potential misinterpretations of protocols and conflicts among different SAR services. (22)

In a study by Park-Ross et al., a noteworthy finding highlighted poor data quality attributed to incomplete records, suggesting the need for future investigations into standardised reporting practices. (8) Standardising reporting and documenting could be the first step to overcoming some of these challenges of poor reporting practises.

Acknowledging the growing occurrence of SAR incidents and the vital imperative to safeguard the well-being of rescue personnel and individuals needing assistance, there is an evident and pressing need for a standardised reporting framework in terrestrial helicopter SAR operations. (8,50) The absence of a standardised document or report form underscores the necessity to create one, aiming to establish consistent reporting standards and terminology for helicopter SAR operations in South Africa. (8,22) The primary focus will be improving the quality of standardised report writing and documentation.

Standardising reporting is advantageous as adopting a standardised reporting framework significantly improves the accuracy and credibility of data. (52) It contributes to a unified literature base for reporting, facilitating more precise and effective communication among various SAR entities. Standardising reporting practices necessitates the development of standardised reporting mechanisms

and agreed-upon terminology to facilitate accurate data collection and meaningful analysis in the critical domain of terrestrial helicopter SAR operations in South Africa. This will create opportunities for future research endeavours in helicopter rescues, empowering researchers to draw upon consistent and comparable data for making informed decisions on training, education, and cost-effective resource utilisation of HEMS and HEMS SAR in resource-constrained areas of the country. (10,53,54) Additionally, it will help improve reporting practices, which, in turn, can enhance training and improve communication, quality assurance, and injury or incident prevention in terrestrial helicopter SAR operations. (8,50)

This literature review thoroughly explores the imperative need for standardised reporting in terrestrial helicopter SAR, underscoring the benefits of embracing a unified framework to enhance efficiency, mitigate risks, and optimise rescue outcomes. The focus of this review centres on the compilation and clarification of specific variables crucial for reporting on terrestrial helicopter SAR operations in South Africa. Of particular note, the emphasis will be placed on temporospatial, technical, operational, patient, and clinical variables, acknowledging their pivotal role in fostering comprehensive and standardised reporting practices.

Literature search and strategy

The search was conducted through two major databases: PubMed and Google Scholar. A comprehensive approach was taken, employing a snowball technique where references cited in the identified articles were also reviewed to include pertinent studies. The search strategy aimed to be inclusive, given the limited literature on helicopter rescue, with no restrictions on the publication date.

Search strings utilised but not limited to:

The search terms were combined using Boolean operators to refine the results. Each search string included combinations of terms to capture the breadth of the literature:

1. "Helicopter" OR "HEMS" in Title/Abstract AND "Rescue" in Title/Abstract
2. "Helicopter" OR "HEMS" in Title/Abstract AND "Hoist" OR "winch" in Title/Abstract
3. "Helicopter" OR "HEMS" in Title/Abstract AND "Longline" in Title/Abstract
4. "Helicopter" OR "HEMS" in Title/Abstract AND "slinging" OR "Short hauling" in Title/Abstract

5. "Helicopter" OR "HEMS" in Title/Abstract AND "Standardised reporting of helicopter rescue" in Title/Abstract
6. "Helicopter" OR "HEMS" in Title/Abstract AND "Variables to report on in helicopter rescues" in Title/Abstract
7. "Helicopter" OR "HEMS" in Title/Abstract AND "medical interventions required in a helicopter rescue" in Title/Abstract
8. "Helicopter" OR "HEMS" in Title/Abstract AND "terrestrial rescue" in Title/Abstract
9. "Helicopter" OR "HEMS" in Title/Abstract AND "wilderness SAR" in Title/Abstract
10. "Helicopter" OR "HEMS" in Title/Abstract AND "reporting standards" in Title/Abstract

Was There a Difference Between the Searches Conducted in PubMed and Google Scholar?

The search strategy was applied similarly across both PubMed and Google Scholar, using the same search terms and combinations. However, due to differences in indexing and search algorithms, the results and number of articles retrieved might have varied slightly between the two databases.

What Articles Were Included?

Articles meeting the following criteria were included in the literature review:

- Human studies involving patients of all ages.
- Language: English, including translated studies.

Who Extracted the Information?

The primary researcher extracted the information. The researcher independently reviewed the titles and abstracts to assess inclusion and relevance to the study objectives.

Exclusion Criteria:

- Non-English language papers.
- Articles lacking full-text availability.

Specific Exclusions:

- Language: A total of 5 articles were excluded due to being in non-English languages.

- Full-Text Availability: 3 articles were excluded due to lack of full-text availability.

Summary of Strategy:

The approach aimed to capture a comprehensive range of literature on helicopter rescue by employing inclusive search strings and considering a wide range of studies. References of identified articles were reviewed to ensure thorough coverage of pertinent research. The inclusion of studies without date restriction allowed for a complete overview of the available research on this topic.

The utilisation and benefit of helicopter SAR

Helicopters play a pivotal role in rescue operations, offering substantial benefits depending on the patient's condition and the circumstances at the accident site. (17) Grissom et al. conducted a detailed descriptive study on the utilisation of medical helicopters in wilderness search and rescue operations. (5) The study emphasised that safety is the foremost priority for any helicopter service involved in wilderness SAR. (5) It underscored the value of medical helicopters in terrestrial SAR operations, highlighting specific advantages when implemented with stringent screening procedures, effective crew resource management, and mission-specific planning. (5)

Helicopters' advantages include their ability to conduct air searches for lost victims, provide a swift means of transporting rescue personnel, equipment, or supplies to the victim, and deliver advanced medical care on-site. (3,5) This leads to significant time savings in mountain rescues, a reduction in the number of rescuers needed for ground evacuation, minimised exposure to hazards in hostile environments, and a decrease in patient transport time to a treatment centre. (5) A reduction in time to access and extract patients results in a substantial decrease in mortality rates for severely injured or ill patients. (1,2,4–7) Lastly, helicopters prove invaluable in conducting aerial searches and extracting victims from remote locations due to their capability to access challenging remote or rural areas where accessibility by foot or vehicle is difficult. (3,5,14) The validity and robustness of this study apply to any geographic location where HEMS are employed for SAR operations.

Helicopters have proven their value in numerous cases by enhancing emergency response and providing benefits to injured individuals. (3,32,37,50,55–57) Additionally, helicopters play a crucial role in meeting various demands in SAR operations, such as mass evacuations during natural disasters like floods and fires and ensuring the safety of workers stationed in unsafe or remote locations. (28)

Helicopter SAR demand worldwide

Terrestrial regions offer ample opportunities for outdoor and mountain activities, collectively known as "Mountain Tourism". (15) Mountains have evolved into hubs for diverse extreme sports and activities, including trail running, mountain biking, hiking, mountaineering, rock climbing, skiing, and paragliding. (25) However, data on the frequency of Wilderness Search and Rescue (WSAR) or terrestrial SAR incidents in South Africa is limited. (22) Addressing this gap, a recent study examined five years of

helicopter SAR operations in South Africa conducted by Park-Ross et al. The findings revealed that Table Mountain National Park, located within the Cape Town Metropole of the Western Cape Province, attracts an estimated four million local and international visitors annually, with one million summiting Table Mountain via cable car. (8) This aligns with a noticeable increase in rescue activities during these peak periods, with 451 terrestrial HEMS SAR missions conducted over the five years. (8) This demand for rescues during weekends and afternoons and over the summer period underscores the prevalence of recreational activities, such as hiking and running, that necessitate rescue efforts. (8)

The rise in mountain tourism, especially among less experienced participants, has resulted in an uptick in injuries. (15) These activities inherently carry risks of varying degrees of danger, and when injuries occur, locating and reaching the affected person becomes challenging. (8,22) Mountain rescue teams encounter unique challenges in these rugged environments. (22)

A retrospective review study by Glomseth et al. underscores the increased demand for helicopter SAR operations in Norway. (3) The study, which focuses on the contribution of ambulance helicopters to search and rescue in Northern Norway, reveals a significant surge in SAR missions over ten years, indicating heightened workload and demand for HEMS in SAR operations. (3) The findings indicate that there were 769 requests in 639 different SAR operations, with 600 missions completed. (3) The number of SAR missions conducted per annum doubled from the start to the end of the 10-year study period. (3) This substantial increase in demand for SAR operations in Norway underscores the anticipation of a rise in patients requiring HEMS SAR in the coming years, especially in connection with the increased popularity of mountain tourism. (3)

Rescue techniques.

Search and rescue operations involve specialised helicopter rescue capabilities such as a hoist or sling, with the option of landing on the scene to extricate the patient. (8,18) The selection of helicopters for rescue depends on factors like cost, performance, legal requirements, and weather conditions. (18) Some services choose helicopters with hoisting and longline capabilities to align them with the international recommendations on helicopter SAR standards. (18)

Winching, also referred to as hoisting, entails the utilisation of a reeled cable positioned externally on the helicopter. It is operated by an external load operator to facilitate the movement of individuals in and out of the helicopter. (8,18) This method finds its primary application in terrestrial rescue operations. (8,18) Terms such as human external cargo, static line, static rope evacuations, short-hauling, and longline describe the approach of manipulating a fixed-length rope attached to the cargo sling hooks at the helicopter's bottom. This technique proves valuable when multiple individuals need simultaneous rescue efforts. (8,18)

Limitations of helicopters in rescue

Helicopter selection for rescue is influenced by factors such as cost, performance, legal requirements, weather, and night flying conditions. (8) In HIC and military settings, twin-engine helicopters are commonly used for HEMS SAR due to their superior standard and performance, especially in severe weather, wind or low visibility conditions. (8,58,59) However, in LMIC, single-engine helicopters are more prevalent due to cost-effectiveness despite their lower performance capabilities and redundancy in emergencies. (58,59) The helicopter type choice reflects each region's needs, available resources, and operational conditions.

Risks

HEMS operations, encompassing tasks like search and rescue, present significant risks throughout missions, especially when transporting patients and crew in, out, and to and from the aircraft, including using techniques like hoisting or longlining. (8,18) The paramount concern in any helicopter mission is to ensure the crew's safety and the overall operation. (50) Extensive literature delves into factors such as equipment failure, adverse weather conditions, human errors, and aircraft maintenance, all contributing to accidents, elevating the risks associated with helicopter operations. (8,60–66)

The following studies underscore the general safety concerns in helicopter operations and emphasise that the risk factors contributing to helicopter accidents should not be underestimated. A study by J. Homer Saleh et al. identified maintenance and inspection as risk factors in helicopter accidents. (63) Over ten years, from 2005 to 2015, flawed maintenance and inspection were identified as causal factors in 14% to 21% of helicopter accidents in the U.S. civil fleet over the study period. (63) Another study by Nævestad et al. highlighted human errors and technical failures as significant risk factors for helicopter accidents. (64) Additionally, a chapter by Mathavara et al. on the role of human factors in preventing aviation accidents stated that 75 per cent of civil and military aviation accidents globally were attributed to human errors at various stages, such as design, drawing, manufacturing, assembly, maintenance, and flight operations. (65)

Well-documented fatal helicopter accidents involving patients, pilots, and crew members serve as tangible evidence, underscoring the inherent risks associated with aviation and helicopter HEMS SAR operations. This emphasises the imperative need to prioritise safety. (8,60–62) It is crucial to acknowledge that helicopter and helicopter SAR missions are not without risks, and the perils of the mission must be balanced with the advantage of rescuing someone and safeguarding the lives of the aircrew. (8)

Various factors, including weather, human factors, terrain, and wind, can influence the mission's success, particularly in challenging terrains like mountains, where helicopter landings are not always possible and hoist or longline operations are employed. (8) This underscores the importance of having competent aircrew and conducting regular simulated training for HEMS SAR missions in terrestrial areas to reduce the risk of human errors during real-time missions. (50)

Crewing

Civilian HEMS SAR organisations generally adhere to the International Commission for Mountain Emergency Medicine (ICAR MEDCOM) consensus for helicopter staffing, typically involving a physician or advanced life support paramedic, a hoist operator/external load operator (ELO), and a pilot for crewing. (50) ICAR MEDCOM recommends deploying doctors for wilderness helicopter rescue in terrestrial settings, particularly in high-income or high-resource areas where it is common for doctors to be part of rescue helicopter teams in the EMS. (3,28,29,50,67) Crew configurations vary between systems, with literature extensively describing medical and non-medical personnel used for helicopter

rescue crews. (8) In South Africa, advanced life support paramedics often serve as the primary providers for critical care life-saving interventions instead of physicians. (8)

A well-trained aircrew is imperative for the success of HEMS SAR missions, playing a vital role in improving rescue efficiency, making informed care decisions, and mitigating safety risks during operations. (50) Studies focusing on helicopter hoist operations underscore the significance of adequately trained medical crew members, particularly in scenarios demanding complex and life-saving medical interventions. (13,15,28,48,50,68)

In a retrospective study conducted by Pietsch et al., which evaluated the incidence and challenges of HEMS rescue missions involving helicopter hoist operations (HHO) and other human external cargo (HEC) missions over nine years by a Swiss HEMS provider, it was found that nearly 20% of all patients requiring hoist evacuation were severely injured. (49) Complex and life-saving medical interventions were deemed necessary before the HHO procedure. (49) Consequently, the study recommended that only adequately trained and experienced medical crew members should accompany HHO missions. (49)

The study, focusing on 9,963 (88.7%) HEMS missions involving HHO and HEC, revealed that most were conducted during the day, with 1,265 (11.3%) occurring at night. (49) For victims with time-critical injuries (NACA severity score ≥ 4), 21.1% reached the hospital within 60 minutes during the day, compared to 9.1% at night. (49) Nighttime missions, trauma diagnoses, on-site intubation, and NACA Score ≥ 4 were independently and significantly associated with longer mission times ($p < 0.001$). (49) The data also indicated that the highest proportion of patients requiring hoist or HEC operations during daytime HEMS missions had sustained moderate injuries (37.5%) while engaging in recreational activities (55.1%). (49)

Reasons for rescues

Various factors contribute to the need for terrestrial rescues, often stemming from inadequate preparedness and unforeseen circumstances in outdoor environments. (22) Distress often arises from unfamiliarity with activities, the terrain, extreme weather conditions and pre-existing medical conditions. (8,22,69–74) The most common cause for rescue in the global SAR literature is trauma. (8,11,51,75–77)

Less commonly, incidents sometimes involve missing individuals, elderly persons with dementia, self-harm, crime-related situations, and overdue aircraft or vehicles in terrestrial environments, which also contribute to the multifaceted challenges of terrestrial rescue operations and necessitate SAR intervention. (22)

Benefits

The widespread implementation of helicopters for HEMS, encompassing rescue operations, has been thoroughly documented. (37,40,55–57,78) HEMS SAR offers a range of benefits, such as enhanced rescue times, expanded coverage areas, and improved survival rates, especially for trauma patients. (37,50,55–57)

The survival benefits associated with HEMS are attributed to factors such as rapid transport, enhanced on-scene management by experienced medical crews, and the ability to perform advanced interventions. (37,50,55–57) However, acknowledging HEMS as a valuable resource is tempered by its limited availability and high cost, necessitating strategic utilisation, especially in LMICs like South Africa. (8,79–81) Two notable studies exemplify these advantages.

Park-Ross et al. conducted a retrospective descriptive analysis in South Africa, shedding light on patient demographics and rescue activities. Their findings mirror those in high-income settings, with trauma emerging as the primary reason for terrestrial helicopter SAR operations. (8) A total of 581 search and rescue missions were conducted, with 451 terrestrial and 130 aquatic rescues. Most rescues occurred in the urban Cape Peninsula, totalling 644 patients, of which 79% were uninjured or had minor injuries. (8) Trauma, notably lower limb trauma, emerged as the predominant medical cause for rescue. (8) This study highlights a significant advancement in understanding SAR operations conducted by the civilian HEMS SAR Service. Establishing dispatch criteria for rescue proves instrumental in facilitating the prudent and equitable allocation of resources in HEMS SAR, particularly within the constraints of a resource-limited prehospital environment. (8)

In support of the benefit of HEMS overall for trauma patients, Andruszkow et al. focused on the impact of helicopter emergency medical service on traumatised patients in Germany. (82) Their retrospective analysis of 52,281 trauma patients revealed that prehospital trauma patients, in general, benefit from HEMS, with in-hospital survival being the primary outcome parameter. (82) Subgroup analysis highlighted that middle-aged and older patients, those with low-energy trauma and minor

severity injuries, experienced the highest survival benefit with HEMS rescue. (82) While HEMS patients were more severely injured, with a higher frequency of traumatic shock, the overall survival benefit compared to ground emergency medical services (GEMS) was evident. Specific subgroups, such as patients aged over 55 years and those with 'low falls' or minor trauma, particularly benefited from HEMS treatment. (82)

Addressing medical considerations for helicopter use in mountain rescue, Tomazin et al.'s non-systematic literature review emphasises the seamless integration of helicopters into existing emergency medical systems. (50) They advocate for appropriately trained personnel and efficient equipment deployment to minimise activation time. (50,83) Highlighting the critical role of helicopters in time-sensitive interventions for severe injuries or illnesses, the study underscores their significant impact on improving patient outcomes in mountain rescue scenarios. (50,83)

HEMS SAR in HIC

In high-income countries such as Switzerland, Sweden, Germany, the USA, Canada, Australia and Norway, extensive literature exists on helicopter SAR operations. (3,4,17,18,23–30,5,31–40,8,41–47,10,11,13–16) Numerous studies emphasise the benefits of helicopters in rescue operations, particularly in alpine and terrestrial areas, showcasing improved response times and enhanced morbidity and mortality rates. (14,23,48–50) The International Commission for Mountain Emergency Medicine (ICAR MEDCOM), a volunteer-based organisation, produces consensus and guidance documents on mountain rescue matters, including medical procedures, care, and helicopter usage. (8,50) These guidelines, while designed for high-income settings, are relevant for LMIC operations with adaptation to context.

Overview of HEMS SAR in a LMIC setting in South Africa

In contrast to the wealth of literature on helicopter SAR operations in HIC, there is a significant need for more research in LMIC. (8) The deficiency is particularly evident in LMICs, where helicopter SAR activities lack comprehensive exploration. Only one publication addresses HEMS SAR in Africa. (8)

Helicopter SAR operations in South Africa are limited. (8) The responsibility for such operations predominantly rests with the military, complemented by limited civilian aeromedical organisations operating within the country. (8) The South African Air Force (SAAF) plays a restricted role, doing only a

few calls compared to other services in the landscape of SAR in South Africa and neighbouring countries, responding to calls for assistance in maritime and terrestrial scenarios. Their involvement entails using twin-engine aircraft, including the Atlas Oryx, Augusta Westland 109, and BK 119 models, to carry out SAR missions effectively. (8) Furthermore, the South African Police Service (SAPS) has air rescue capabilities, although this is not their primary mandate. (5) The SA Red Cross Air Medical Service (SARC AMS) is the sole contracted civilian HEMS SAR entity actively participating in air ambulance, terrestrial, and sea rescue missions across the Western Cape and the broader South African region. (8,22) SARC AMS uses a single-engine Augusta Westland 119 helicopter to execute HEMS and rescue functions, with bases in both Cape Town and Oudtshoorn to ensure efficient response capabilities while servicing the Western Cape province. (8)

A retrospective descriptive analysis study conducted by Park-Ross et al. on terrestrial and aquatic helicopter rescue activities in the Western Cape, South Africa, from January 2012 to December 2016 sheds light on the rescue techniques employed and the population requiring rescue. (8) The findings were as follows: The patient demographics and rescue activity described are similar to those described in high-income settings. (8) A total of 581 search and rescue missions were conducted, of which 451 were terrestrial and 130 were aquatic rescues. (8) The highest volume of rescues was conducted within the urban Cape Peninsula. (8) Hoisting using a rescue harness was the most common rescue technique used. (8) Six hundred forty-four patients were rescued. (8) Uninjured or minorly injured persons represented 79% of the sample. (8) Trauma (33%) was the most common medical reason for rescue, with lower limb trauma predominant (15%). (8) The most common clinical interventions performed were intravenous access (24%), spinal immobilisation (21%), splinting (17%) and analgesia administration 13%). (8) However, the study is limited by selection bias, focusing solely on a single civilian-operated service within the Western Cape, raising concerns about the generalizability of findings.

Data limitations in the field of HEMS SAR and HEMS in the country further underscore the need for future studies in the field. (8) The limited literature on HEMS in South Africa mainly focuses on research priorities such as scene time, dispatch criteria, airway management practices, and mortality related to trauma patients. (8,46,57,80,84–86) A retrospective case-control study by Stassen et al. in the Gauteng province of South Africa aimed to determine whether HEMS contributed to a 30-day mortality improvement compared to ground emergency medical services (GEMS) for trauma cases. (86) Surprisingly, the study found no significant enhancement in mortality outcomes with HEMS over

GEMS and no overall influence on the mortality rate. (86) This finding may be attributed to the specific South African HEMS dispatch model. (86) HEMS is a scarce resource in the country, and the absence of evidence-based HEMS call-out criteria further complicates the efficient utilisation of this expensive resource. (79,85,86)

The scarcity of literature can be attributed to various factors in LMICs, including limited HEMS SAR operations, missing data, discrepancies between mission reports and medical records, and the predominantly military-based nature of HEMS SAR operations. (8)These challenges pose barriers to data publication in the country, hindering a comprehensive understanding of the landscape.

Furthermore, more documented information is needed, specifically regarding terrestrial SAR operations, incident frequencies within South Africa, and HEMS SAR in the country. (8,23) Existing literature emphasises the importance of addressing this gap, especially with the anticipation of increased injuries, illnesses, or individuals getting lost in terrestrial areas. This surge is expected to coincide with the rise in seasonal wilderness activities driven by tourism. (8,23) The current state of knowledge underscores the urgency for further research and data dissemination in this critical field.

Overview of South Africa's landscape

South Africa is renowned for its abundant biodiversity, diverse landscapes, and thriving ecotourism, making it a favoured destination for outdoor enthusiasts. (22,87–89) South Africa has a population of approximately 62 million individuals and spans a total land area of 1,219,602 km². (90) The South African terrain encompasses eight terrestrial biomes: grassland, savanna, succulent karoo, Nama karoo, forest, fynbos, desert, and thicket. (91–94) While urban centres such as Durban, Johannesburg, and Cape Town house a significant portion of the population, substantial expanses of undeveloped and remote land still exist within the country's borders. (22,91–94)

South Africa's appeal lies in its expansive mountain ranges, drawing in tourists seeking outdoor adventure. (8,91–94) The Drakensberg Mountain Range is the country's tallest known mountain range. (91–94) Other prominent ranges like Table Mountain, Amatole Mountain Range, Magaliesberg Mountain, Cederberg Mountain, and Wilderness Areas contribute to the allure of outdoor activities. (91–94)

South Africa remains a popular tourist destination, with a notable emphasis on ecotourism. (95) The South African National Parks (SANParks) Annual Report for 2021/2022 reveals that 3,482,514 visitors explored the country's 19 national parks within 12 months. (96) Despite limited comprehensive data on the frequency of wilderness search and rescue (WSAR) incidents in South Africa, it is reasonable to expect that visitors to terrestrial areas may encounter occasional health issues, injuries, or navigation challenges. (22) These challenges are also anticipated to contribute to higher call-out rates for terrestrial helicopter SAR operations, given the demanding topography and inherent terrain challenges in these areas, compounded by the increasing number of tourists visiting these regions. (8)

Overview of South Africa's terrestrial rescue

Hartnady et al. conducted a cross-sectional study to thoroughly document, describe, and compare the present state of WSAR practices in the nine provinces of South Africa. (22) The primary finding underscored a significant disparity among agencies regarding capabilities and practices attributed to the absence of national WSAR guidelines, norms, standards, and regulations. (22) Notably, the study revealed a need for legislative clarity regarding entities mandated for wilderness SAR, resulting in predominantly unregulated practices without nationally accepted guidelines. (22) This situation challenges the standardisation and coordination of WSAR efforts across the country. (22)

It is crucial to acknowledge certain limitations within the study. The reliance on self-reported data during data collection introduces the potential for self-reporting bias, as respondents may provide information based on subjective perceptions. Concerns about respondent fatigue and potential selection bias arise from using a sizable response template. Additionally, response bias was identified, stemming from a binary "yes" or "no" format, excluding nuanced information about agencies playing supportive roles. This limitation proves there may have been a lack of awareness or recognition of these supporting entities, hindering a thorough understanding of the overall landscape of search and rescue operations. (22) While Hartnady et al.'s study sheds light on significant disparities in WSAR practices across South Africa, caution is necessary in interpreting findings due to noted limitations. To address some of these limitations, it might be beneficial to conduct a more inclusive and detailed analysis, ensuring that all relevant entities involved in supporting core WSAR agencies are acknowledged and considered. (22)

Rescue agencies in South Africa

In South Africa, a collaborative effort involving both governmental and non-governmental agencies is observed in terrestrial SAR operations, illustrating a multi-agency approach to emergency response. (22) This comprehensive undertaking entails the coordinated efforts of multidisciplinary teams drawn from various organisations, including volunteers, provincial emergency medical services (EMS) rescue teams, fire SAR units, law enforcement personnel, and military assets, with provincial EMS assuming the role of the coordinating authority. (8,22)

Numerous volunteer agencies play a crucial role in South Africa's SAR landscape. (8,22) Prominent among them are WSAR, Search and Rescue South Africa (SARZA), and the Mountain Club of South Africa (MCSA). (8) Additional entities include Delta Search and Rescue, Hamnet, Hikers Network, K9 Search and Rescue, Off-Road Rescue Unit (ORRU), and Overberg Fire Rescue. (6) In the Western Cape region of South Africa, WSAR operates as a collaborative effort between the provincial government of the Western Cape, represented by the Directorate of Emergency Medical Service, and various member organisations. (6) Together, they manage and execute search and rescue operations for individuals or patients whose health and safety are threatened or compromised in a wilderness or terrestrial environment. (6)

Despite their shared objective of locating, accessing, treating, extricating, and safely transporting victims, each agency operates under distinct legislation, procedures, equipment protocols, and personnel prerequisites. (22) This coexistence of diverse agencies highlights the existence of varying rescue techniques, all aligned with the same mission but influenced by geographical disparities across the country and resource availability. (22) Consequently, differences in terminology, standards, policies, and procedures emerge among these agencies, reflecting the unique challenges they face in their operational landscapes. (22) While united in their fundamental purpose, the complex interplay of different agencies underscores the dynamic nature of SAR operations in South Africa. (22)

Regulation of Rescue in South Africa

The oversight and regulation of terrestrial SAR operations in South Africa have raised significant concerns, necessitating the establishment of more transparent regulations, standardised protocols, comprehensive guidelines, and effective governance. (22)

In the realm of South African SAR operations, the need for formal regulatory oversight and structured auditing mechanisms is emphasised. (22) This gap is exacerbated by the absence of nationally accepted norms, benchmarks, or guidelines. (22)

The absence of standardised guidelines and procedures poses a significant challenge to the effective coordination and execution of SAR missions. This lack of regulatory structure and uniformity can lead to several issues, including misinterpretations of protocols, inaccuracies in practices, miscommunication and potential conflicts between various SAR services. (22) The existing apertures emphasise the importance of establishing appropriate regulatory measures to ensure effective, harmonised, and standardised SAR operations within the country.

Standardising reporting and documenting could be the first step to overcoming some of these challenges. Standardised reporting will necessitate the development of standardised reporting mechanisms and agreed-upon terminology to facilitate accurate data collection and meaningful analysis in this critical domain for terrestrial SAR operations in South Africa.

Standardised reporting

When done correctly and appropriately, implementing standardised reporting offers immense benefits by enhancing the accuracy and credibility of data for research and decision-making. (97) While the advantages of standardised reporting are clear, specific systems face challenges in ensuring consistent, comparable, and high-quality sustainability information. (97–102)

The establishment of a standardised reporting framework holds the potential to yield numerous benefits. Firstly, it would contribute to a unified literature base for reporting, facilitating more precise and effective communication among and comparison between various SAR entities. (10,53,54)This standardisation would also create opportunities for future research endeavours in helicopter rescues, enabling researchers to leverage consistent and comparable data. (53,103) This data can then inform planning and prevention initiatives, enabling data-driven decisions related to staffing, training, logistic coverage, and injury or loss prevention. (8)

Given that helicopters are scarce resources with significant expenses, it becomes crucial to prioritise the greater good when allocating resources within the health system, especially in systems where helicopters are employed for both medical missions and SAR operations. (8,79,80,82) This is the case in South Africa.

Consensus around reporting globally

The ICAR MEDCOM has established a consensus on standards for helicopter SAR operations in terrestrial areas globally. This collaborative effort has produced medical recommendations and standardised guidelines for organisations involved in helicopter SAR operations worldwide, particularly focusing on high-income countries with alpine landscapes and dedicated mountain rescue services. (13,50,68)

ICAR MEDCOMS's consensus revolves around critical variables impacting the effectiveness of helicopter SAR operations, encompassing dispatch procedures, time of day, response time, communication protocols, safety protocols, staff training, medical equipment, rescue equipment, duty shifts, and on-site and enroute medical treatment. (13,50,68,104)

In a non-systematic literature review study, Tomazin et al. aimed to establish medical recommendations for safe and effective HEMS in countries with dedicated mountain rescue services. (50) The study emphasised the crucial role helicopters play in mountain rescue operations, especially for severely injured or ill patients in challenging environments. Rapid response times (less than 20 minutes) and quality medical treatment were highlighted as crucial for survival in severely ill or injured patients. (50) The study also mentioned that with optimal organisation, modern helicopters can achieve activation times of less than 5 minutes and approach times of less than 20 minutes within a 50 km diameter. (50) ICAR MEDCOM's 'air rescue optimal crew' concept ensures flexibility and adaptability, recommending appropriate equipment and safety standards in mountain-related emergencies. (50)

Nevertheless, the study's methodological limitations give rise to concerns regarding the validity because the standards and recommendations were originally crafted for European countries, where helicopter rescue operations often involve dedicated helicopters specifically for rescues, and HEMS operate separately from the rescue helicopters in those HICs. In contrast, in many LMICs, helicopters are used for mixed purposes, including rescue and medical missions, where the HEMS systems may differ significantly in functionality.

Challenges in reporting

Common challenges linked to standardised reporting encompass a need for more flexibility, inadequate time for thorough documentation and reporting, insufficient recording materials or datasets, and a deficiency in clarity and organisation. (97–102)These factors can result in confusion and misinterpretation of the data. (97–102) Other challenges include insufficient detail, a lack of supporting evidence, and inconsistencies in formatting, terminology, or presentation, leading to potential confusion and misinterpretation. (97–102) Additionally, resistance to change poses another obstacle to effectively implementing standardised reporting processes. (97–102) This emphasises that reporting standards should be specifically developed and implemented from the start to overcome these reporting and documenting challenges.

Helicopter SAR operations encounter numerous global and domestic obstacles. (8) These challenges stem from diverse factors that impede the organised gathering and examination of data within this domain. (8,14,15,22,32,38,43,49,51,105,106) Numerous studies have highlighted the restricted data availability attributable to incomplete records in their publications. (8,14,15,22,32,38,43,49,51,105,106) Other key factors exacerbating these difficulties include inconsistencies in terminology, inadequate record-keeping, and constraints imposed by the predominantly military-based operations, which limit the accessibility to these records of many helicopter SAR operations. (8,15,22,32,38,43,49,51,105,106)

The existing gap in the literature is primarily attributed to the absence of a standardised reporting dataset and the use of differing terminology for standard rescue techniques and related activity. (51) An example of the lack of standard terminology is evident in the case of the term "short hauling," which refers to a rescue technique of using a rope secured to the cargo hook of a helicopter for transporting individuals suspended beneath a helicopter. (3,5,16,18,22,107) This technique is known by different names, such as short hauling, slinging, short line, and long line, all denoting the same method. (3,5,16,18,22) The interchangeable use of terms, such as "winch" and "hoisting," to describe the same rescue technique adds to the confusion, further underscoring the lack of standardised reporting in the field. (8)

Consequently, the absence of a uniform reporting framework poses a challenge when conducting comprehensive literature reviews in helicopter SAR operations. (13) Overcoming these challenges

necessitates the development of standardised reporting mechanisms and agreed-upon terminology to facilitate accurate data collection and meaningful analysis in this critical domain.

The scarcity of literature in LMIC presents a considerable challenge in reporting. (8) This issue is compounded by the absence of standardised rescue protocols and guidelines in these countries, as highlighted in the study conducted by Park-Ross et al.(8)

The contents of the current reporting consensus

Classification of Variables

ICAR MEDCOM has reached a consensus on various aspects of helicopter terrestrial SAR. (50,69) Their recommendations and guidelines have identified specific variables for incorporation into the reporting and documentation of terrestrial helicopter SAR operations. (50) They play a crucial role in evaluating performance, providing metrics for analysis, and supplying valuable material for future learning and case studies. Including these variables contributes to a comprehensive understanding of HEMS SAR operations and their outcomes.

The following paragraphs elaborate on the content of these variables and the rationale behind their inclusion, all of which have been sourced from international studies focused on terrestrial helicopter SAR operations. In this study, variables are classified into five distinct categories: temporospatial variables, technical variables, operational variables, patient variables, and clinical variables.

Temporospatial variables refer to data collection across space and time, providing context to events within a specific location. (108) These include date, time, and geographical location.

Date variables encompass reporting the exact date and time of day when the incident occurred. This temporal information is crucial for pinpointing the occurrence of the incident and understanding its context within a reviewer's perspective of the time of year. (36,38)

Time variables commonly encompass parameters such as take-off time, response time, on-scene time, dispatch time, and first medical contact time. (8,16,25,26,87–89,109,110) These time-related variables provide insights into the efficiency of the operation and its various stages.

Geographical location variables pertain to detailed incident information, including the specific location, terrain type, and prevailing weather conditions. (111) This information is usually provided as GPS coordinates, a physical address, or a location. The terrain description highlights the environment's unique challenges, such as mountains, steep slopes, forests, and more. (11,28,30–32) Weather conditions, including cloud cover, wind direction, and speed, contribute to understanding the operational conditions during the SAR mission. (38)

Clinical variables explain the treatment and interventions carried out as part of patient care. (112) This includes details about interventions undertaken to stabilise patients at the scene before transport, such as intravenous fluid administration, spinal immobilisation, splinting, and pain management, contributing to understanding the immediate medical care provided. (8,11,13–15,25,30,32,38,50,105)

Patient variables encompass demographic details such as age, gender, and nationality, which are crucial for understanding the profiles of individuals who are being rescued. (8,11,14,15,25,30,32,38,105,112) These variables also include the number of patients affected, the cause of the accident or incident, the chief complaint of the patients, and the types of injuries sustained. (113) Given that trauma is a primary reason for medical rescues, notably lower limb trauma, reporting on these aspects offers insights into the nature and severity of incidents. (8)

Technical variables describe rescue operations' techniques, procedures, and methods. (18) This includes variables referring to specific helicopter rescue techniques, such as hoisting, longlining or short hauling, trooping and others to extricate and rescue the patient. (18)

Operational variables describe the concrete operations, measures, and steps undertaken during rescues. (114) Examples of operational variables include the type of SAR mission, the type of aircraft used for the mission, the crewing details, the reasons for the rescue, and any adverse events during the mission. (18,49)

Incorporating these diverse variables in reporting ensures a comprehensive and detailed portrayal of terrestrial helicopter SAR operations. Their inclusion stems from their significance in evaluating mission effectiveness, measuring outcomes, and facilitating future improvements in SAR.

Study rationale

This study represents a continuation and expansion of the research conducted by Park-Ross et al., which highlighted poor data quality attributed to incomplete records, suggesting the need for future investigations into standard reporting practices. (8)

The motivation for conducting this research arises from establishing uniform reporting standards and consistent terminology within the realm of terrestrial helicopter SAR operations in South Africa, focusing on enhancing the quality of standardised report writing and documentation, particularly following rescue missions.

This improvement is proposed through the recommendation to establish a standardised dataset for documenting and reporting by identifying the key variables crucial for reporting through expert consensus in terrestrial helicopter SAR operations.

The creation of this standardised reporting framework holds the potential to bear several benefits. Firstly, it will contribute to a unified literature base for reporting, facilitating more precise and effective communication among various SAR entities. (52,53,103) This standardisation will also open avenues for future research endeavours within helicopter rescues, enabling researchers to draw upon consistent and comparable data. (52) This data can then inform planning and prevention initiatives, enabling data-driven decisions related to staffing, training, logistic coverage, and injury or loss prevention. (5)

This study's significance is particularly pronounced for the future of South African SAR operations. By establishing a standardised reporting approach, certain facets of helicopter rescue practices in South Africa can be harmonised, resulting in improved operational efficiency and a more cohesive approach to SAR missions. This study is poised to generate valuable recommendations for developing a standardised reporting form that encapsulates the crucial variables essential for terrestrial helicopter SAR operations reporting, thus contributing to the overall advancement of the SAR domain in South Africa.

The context of current SAR practices in South Africa underscores the need for such an undertaking. (8,22) SAR practices within the country need more standardised procedures and better delineation and description. (22) This absence of formal regulatory oversight and the need for more nationally

accepted guidelines, norms, and standards presents a notable challenge to the potential advancement and development of SAR operations and programs across South Africa. (22) As a result, it is imperative to address this issue for the overall growth and effectiveness of SAR efforts within the nation.

Central to the study's aim is the importance of standardised reporting for helicopter SAR missions. The existing challenges in reporting SAR operations are intrinsically tied to the need for clear guidelines. (8,22) One prominent challenge is the diverse terminology used to describe identical rescue techniques. (8)

Another significant challenge arises from the incompleteness of records used for reporting or documenting HEMS and SAR mission information, as well as the need for more research in LMIC on helicopter SAR operations, as evidenced by the literature. (8) This limitation in standardised reporting practices has been consistently identified as a constraint in studies focused on helicopter SAR. (8,22) Acknowledging and addressing these challenges is pivotal for improving the efficiency, accuracy, and comprehensiveness of documenting for reporting on SAR operations.

Conclusion

The literature review primarily includes articles from retrospective studies in HICs, such as those from Switzerland, Sweden, Germany, Australia, the United States of America, Canada, and Norway. Helicopters play a crucial role in terrestrial SAR operations in these regions, and there is a substantial body of literature on HEMS SAR operations and the effectiveness of helicopters in terrestrial SAR operations. In contrast, there is limited published literature on HEMS SAR in LMICs, with only one published study on HEMS SAR in Africa. (8)

Significant challenges arise in addressing the literature gap within South Africa from the absence of standardised reporting datasets and the use of diverse terminology for standard rescue techniques and related activities. Challenges in reporting helicopter SAR operations are multifaceted, stemming from discrepancies in terminology, incomplete records, inadequate record-keeping, and the military-based nature of helicopter SAR operations, which may impact record availability.

The first step in overcoming these challenges is the establishment of standardised reporting, creating a unified literature base. This study, guided by expert consensus, aims to define a list of variables for reporting terrestrial helicopter SAR operations, addressing issues related to insufficient regulation,

varied terminology, and incomplete records. The proposed list of variables serves as a foundational framework that could guide future studies in developing a standardised reporting form applicable to helicopter and general terrestrial SAR operations in the country. This initiative opens up opportunities for future research in helicopter rescues, enabling researchers to leverage consistent and comparable data. Such data can inform planning and prevention initiatives, facilitating data-driven decisions regarding staffing, training, logistic coverage, and injury or loss prevention.

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PART B: JOURNAL ARTICLE

A consensus on reporting variables for terrestrial helicopter SAR operations in South Africa through a Delphi study.

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ABSTRACT:

INTRODUCTION:

Search and rescue (SAR) endeavours to locate distressed individuals in remote, challenging environments. Terrestrial rescues take place on land, while aquatic rescues involve water operations. The global surge in outdoor activities has increased SAR demands, especially in challenging landscapes, prompting the need for efficient terrestrial helicopter SAR operations.

In South Africa, SAR practices face challenges due to a lack of standardisation, governance, and clear guidelines, leading to agency communication and coordination issues. To address this, a standardised reporting and documenting framework is essential to ensure uniform terminology and documentation in helicopter SAR missions.

This study focuses on the initial step of standardising reporting and documenting to overcome these challenges and improve the quality of standardised report writing and documentation, particularly following rescue missions.

METHODS:

A Modified Delphi survey was conducted over three rounds to obtain a sample criterion of variables for reporting and documenting terrestrial helicopter SAR operations. The first round of the Delphi study was informed by a literature review. Purposive snowball sampling was used to recruit experts in terrestrial rescue. An online survey tool offered both binary and free-text options to participants. Consensus was set at 75%.

RESULTS:

A panel of twenty-eight participants agreed to partake in the study, and 16 (57%) completed all three rounds. A total of 65 items were proposed to the panel for review and were grouped into five categories: temporospatial, technical, operational, patient, and clinical. A consensus of 96.9 % (63/65 items) was obtained during the first round, 77.5% consensus (31/40 items) in round two, and 33.3 % (3/9 items) at the end of round three. A total of seventy-five variables were included in the final list of items recommended to report on for terrestrial helicopter SAR operations.

CONCLUSION:

The study aimed to establish a standardised and universally accepted set of reporting variables for terrestrial helicopter SAR operations. This initiative addressed challenges from inconsistent practices, diverse terminology, and incomplete records, aiming to enhance the efficiency, communication, and effectiveness of terrestrial helicopter SAR missions in South Africa. As a result, the study successfully compiled a comprehensive list of essential variables for reporting on terrestrial helicopter SAR operations in South Africa.

Keywords: terrestrial helicopter rescue, hoist, longline, HEMS, rescue techniques, SAR

Introduction

Search and rescue (SAR) operations are conducted to locate individuals who are believed to be distressed, lost, ill, or injured in challenging and remote environments such as mountains, deserts, forests, or at sea. (1–6) These operations are conducted by emergency services, often with the assistance of well-trained volunteers. Helicopter SAR refers to utilising helicopters to carry out and facilitate SAR missions for aquatic and terrestrial operations. (1–4) Terrestrial helicopter SAR describes any SAR mission conducted by a helicopter on land. (7) This study is centred on terrestrial SAR operations within the context of South Africa.

In high-income countries (HIC), helicopters are commonly used for terrestrial SAR operations, and there is a wealth of literature available on helicopter search and rescue (HEMS) SAR operations in these countries explaining why helicopters are ideal. (3–5,8–39) Numerous studies highlight the advantages of helicopters in rescue missions, emphasising improved response times and enhanced morbidity and mortality rates, especially in alpine and terrestrial regions. (10,18,28,40–42) While there is a wealth of literature on helicopter SAR operations in HICs, research in low- and middle-income countries (LMIC) is notably lacking, primarily due to limited resources, particularly in the availability of HEMS SAR in these countries. (43)

The use of helicopters in terrestrial SAR offers significant benefits by decreasing the time to access and extraction of persons requiring assistance, especially in challenging terrain. (18,35,43) Global demand for SAR missions has surged due to increased participation in outdoor recreational activities. (3,12,43–46) This rise in activity has also led to more individuals requiring assistance for reasons ranging from sports-related injuries to severe illnesses. (46) The effectiveness of helicopters in SAR operations lies in their ability to access remote or rural locations where accessibility by foot or vehicle is challenging. (3) Helicopters demonstrate exceptional time efficiency during rescue operations, enabling the swift transportation of equipment and specialised teams directly to patients and to appropriate hospital facilities for the continuum of care. (3,15,18,24)

Reporting on helicopter SAR operations faces several challenges on a national and international scale. (18,43,47) These difficulties arise from various factors that hinder the systematic collection and analysis of data in this field. (18,47) The primary reasons contributing to these challenges are discrepancies in terminology, incomplete records, and inadequate record keeping. (10,43,47) Many

helicopter SAR rescue operations are conducted by military-based organisations, which limits the dissemination and sharing of operational data. (10,43,47)

Standardising reporting is advantageous as adopting a standardised reporting framework significantly improves the accuracy and credibility of data. (48) It contributes to a unified literature base for reporting, facilitating more precise and effective communication among various SAR entities.

Standardising reporting practices necessitates the development of standardised reporting mechanisms and agreed-upon terminology to facilitate accurate data collection and meaningful analysis in the critical domain of terrestrial helicopter SAR operations in South Africa. (48) This will create opportunities for future research endeavours in helicopter rescues, empowering researchers to draw upon consistent and comparable data for making informed decisions on training, education, and cost-effective resource utilisation of HEMS and HEMS SAR in resource-constrained areas of the country. (49–51) Additionally, it will help improve reporting practices, which, in turn, can enhance training and improve communication, quality assurance, and injury or incident prevention in terrestrial helicopter SAR operations. (42,43)

In South Africa, a significant challenge lies in the need for more well-defined rules, standardisation, comprehensive guidelines, and governance within the SAR operations landscape. (46) The absence of nationally accepted norms and benchmarks exacerbates this issue, allowing practices to proceed without sufficient regulatory oversight. (46) This deficiency not only hampers effective coordination and execution of SAR missions but also gives rise to potential misinterpretations of protocols and conflicts among different SAR services. (46) In a study of helicopter search and rescue of a civilian helicopter EMS service in South Africa, a noteworthy finding highlighted poor data quality attributed to incomplete records, suggesting the need for future investigations into standardised reporting practices. (43) Standardising reporting and documenting could be the first step to overcoming some of these challenges of poor reporting practises.

Acknowledging the growing occurrence of SAR incidents and the vital imperative to safeguard the well-being of rescue personnel and individuals needing assistance, there is an evident and pressing need for a standardised reporting framework in terrestrial helicopter SAR operations. (42,43) The absence of a standardised document or report form underscores the necessity to create one, aiming to establish consistent reporting standards and terminology for helicopter SAR operations in South

Africa. (43,46) The primary focus will be improving the quality of standardised report writing and documentation, with particular attention to post-rescue missions.

The study aims to address these reporting challenges by identifying necessary variables for reporting and documenting, forming a unified literature base for reporting, and facilitating future studies in helicopter rescues. This will be the first step to establishing a standardised and universally accepted reporting data set for terrestrial helicopter SAR operations in South Africa.

METHODS:

Design

A Modified Delphi study was conducted to obtain a set of consensus-based variables for reporting on terrestrial helicopter SAR operations in South Africa.

Setting

Terrestrial helicopter SAR operations in South Africa are conducted by the military-based South African Air Force (SAAF) and civilian HEMS services with rescue capability, such as the SA Red Cross Air Mercy Service (SARC AMS).

Different role players or agencies within Wilderness SAR (WSAR) and the Mountain Club of South Africa (both volunteer organisations) working closely with HEMS SAR services and the SAAF were approached to participate in this study. These role players include the Department of Health (DOH) Western Cape aviation rescue team in Cape Town and Eden district of the Western Cape Province, helicopter rescue teams, paramedics and pilots working as HEMS for SRC AMS, and pilots in SAAF.

Sample and Sampling

Experts are defined as individuals engaged in helicopter wilderness/terrestrial SAR training and operations from role players, including volunteer agencies, government EMS and rescue services, and civilian and military helicopter rescue services from around South Africa. Respondents' roles include responders, emergency medical services, technical crew members, service managers, oversight/management committees, and helicopter SAR pilots. Emergency physicians from selected hospitals regularly receiving patients rescued by helicopter SAR operations were included. Due to the limited number of participants available, no minimum years of experience was defined.

Role-player organisations involved with terrestrial helicopter SAR operations, hospitals, and the DOH Western Cape aviation rescue team management committee were approached and asked to distribute an email invite to field experts to participate in the study. Snowball sampling followed the initial email invite. The sampling strategy for the Delphi study consisted of participants (experts in helicopter SAR) who were invited to participate. A heterogeneous sample ensured that the entire spectrum of opinions was represented.

To those who received the email and wished to participate, all the necessary information was given about the study and what it entailed to participate in it. The interested participants ticked a consent question box when they agreed to partake in the study. Blinding was used to reduce bias during participant feedback and responses. A unique identifier was allocated to each participant to track their progress and feedback throughout the study, ensuring pseudonymisation participation and limiting bias. No other participant-related information was recorded. The data were collected using a multi-stage survey using an online survey tool, REDCap. The research team could only access this platform using a password created for this study by the researcher.

Procedure

The survey was conducted over three rounds to obtain a sample criterion of potential variables for reporting and documenting terrestrial helicopter SAR operations post-mission. The first round was developed through information gathered from the literature review. Participants were asked to select a binary response ("YES or NO") to each question and provide comments to support answers or introduce additional variables at the end of each section. A consensus threshold of 75% agreement was set. Variables not meeting this consensus were carried to the second round, along with newly identified variables from the participants' comments. All free-text comments were collated and collapsed, and feedback was provided after each round. Variables that did not reach consensus in a former round were also adjusted based on these comments and presented in a subsequent round. Consensus obtained on a particular item resulted in its inclusion in the final list.

Figure 1 depicts the research process. This study was approved by the Human Research Ethics Committee (HREC) of the University of Cape Town (Cape Town, South Africa; HREC Ref 435/2022). The results were presented per the proposed Conducting and Reporting Delphi Studies (CREDES) checklist. (52)

RESULTS:

Eighty potential participants, of whom twenty-eight agreed, were invited via email to participate in the study using the snowball sampling technique. The panel was comprised of experts in helicopter SAR who represented different agencies where they worked or volunteered. Table 1 shows the demographic details of the participants. This included the organisation they represented and their experience level, which ranged from two years to more than 20 years.

An attrition rate of 30% was seen between rounds one and two, leaving twenty responses eligible for analysis at the end of round two, and an attrition rate of 30% between rounds 2 and 3, leaving 16 responses eligible for analysis at the end of round three.

Table 2 provides a summary of the levels of consensus achieved through each round of the survey. A total of sixty-five items were proposed to the panel for review and were grouped into five categories: Temporospatial, Technical, Operational, Patient, and Clinical. Consensus was achieved in round one of 96.9% (n=63/65) variables. Round one also yielded newly identified variable items (n = 38) as proposed by the expert panel. These items and the remaining two from round one were presented to the participants again in round two.

Round two of the survey achieved a 77.5% (n = 31/40) consensus on the variables presented. The free text was analysed for the remaining items in round two, which resulted in (n = 9) questions being clarified, which were then posed to the panel in round three. The final round achieved a 33.3% (n = 3/9) consensus on all variables. The total level of consensus gained was 94.17% (n= 97) after the three rounds. The study was terminated after three rounds.

Out of the ninety-seven items identified to report, twenty-two items were merged with other items with similar wording and meaning that were previously identified in round one. A total of seventy-five variables were included in the final list. Appendix 1 presented the items included in the final list of variables that met consensus in the Delphi survey's conclusion and provided the final criteria of variables recommended to be reported on in terrestrial helicopter SAR operations.

DISCUSSION:

In South Africa, diverse government and non-government agencies collaborate to conduct terrestrial SAR operations involving multidisciplinary teams of volunteers, EMS rescue teams, fire SAR units, law enforcement, and military assets. (46) Despite their shared objective of locating, accessing, treating, extricating, and safely transporting victims, each agency operates under distinct legislation, procedures, equipment protocols, and personnel prerequisites. (46) Differences in terminology, standards, policies, and procedures emerge among these agencies, reflecting their unique operational landscape challenges. (46) While united in their fundamental purpose, the complex interplay of different agencies underscores the dynamic nature of SAR operations in South Africa. (46)

Through expert consensus, this study aimed to establish the variables for uniform reporting standards and consistent terminology within the terrestrial helicopter SAR operations in South Africa. After three rounds, a total of seventy-five variables were included in the final list of items recommended. These items were grouped into five categories: temporospatial, technical, operational, patient, and clinical variables. The meaningfulness of the agreed-upon variables will help us understand the results better through the following aspects.

Comprehensive Coverage: The final list of variables was compiled through an exhaustive process of expert review and consensus, ensuring that all aspects of SAR operations are covered.

Standardisation Benefits: The literature review and expert feedback underscore the imperative need for standardised reporting. Standardised variables enhance efficiency, mitigate risks, and optimise rescue outcomes by ensuring consistent and complete documentation of SAR missions.

Addressing Inconsistencies: The study addressed challenges from inconsistent practices, diverse terminology, and incomplete records. By establishing a standardised set of reporting variables, the study will help ensure that all SAR operations are documented consistently and comprehensively, improving communication and operational efficiency.

Facilitating Future Research: A standardised dataset is a foundational framework for future studies and initiatives. It allows for better data comparison, analysis, and planning and facilitates ongoing improvements in SAR practices.

Consensus was rapidly achieved in the initial Delphi survey round, which could be interpreted in two ways. Firstly, it may indicate that the industry is well-coordinated, with minimal controversy. Alternatively, it could suggest that our sample was too homogeneous, implying that individuals share similar perspectives due to their uniformity. However, the sample's heterogeneity is demonstrated by the representation of all agencies involved in terrestrial rescue across the country. This suggests alignment within the industry on topics related to helicopter SAR operations, potentially explaining the swift consensus. Another strength of this study is that, in the first round, every item on the list was derived from the literature, demonstrating the incorporation of international standards and alignment.

Limited literature is available on SAR in LMICs, with limited data available to inform operational and reporting standards. (43,46) Clinical variables, such as the required level of care identified as significant in this study through consensus, are crucial for comprehending patient needs and outcomes. (40–43,53) Helicopters can be seamlessly integrated into existing EMS systems, where well-trained staff and efficient equipment deployment minimise activation time and support successful helicopter terrestrial SAR missions. (42,43,54) In mountain rescue scenarios, swift rescue and medical care facilitated by helicopters significantly improve patient care outcomes, highlighting the critical role of helicopters in time-sensitive interventions for severe injuries or illnesses. (42,53)

Operational variables, such as crewing configurations, also identified as necessary in this study through consensus, play a crucial role in training requirements to ensure staff competence and proper training for HEMS and HEMS SAR operations. Data availability on these variables has the potential to indicate training needs and identify areas where training improvement should be prioritised for the crew.

Civilian HEMS SAR organisations generally adhere to the International Commission for Mountain Emergency Medicine (ICAR MEDCOM) consensus for helicopter staffing, typically involving a physician or advanced life support paramedic, a hoist operator, and a pilot for crewing. (42) ICAR MEDCOM recommends deploying physicians for wilderness helicopter rescue in terrestrial settings, particularly in high-income or high-resource areas where doctors are commonly part of rescue helicopter teams in the EMS. (3,38,39,42,55) Crew configurations vary between systems, with literature extensively describing medical and non-medical personnel used for helicopter rescue crews. (43) Advanced life support paramedics in South Africa often serve as the primary providers for critical care life-saving interventions instead of physicians. (43) Appropriate staffing levels and the competency of the aircrew enhance mission efficiency, enabling informed medical care decisions, mitigating safety risks during

operations, and ensuring the success and safety of helicopter rescue missions in terrestrial areas. (22,29,32,42,43,54)

Data limitations in SAR are a major challenge. (43) There is a recognised gap in current research on terrestrial HEMS SAR and terrestrial SAR. (43,46) The deficiency is particularly evident in LMICs, where helicopter SAR activities lack comprehensive exploration and address HEMS SAR in Africa. (43)This absence of information is striking in South Africa, where limited HEMS SAR services exist. The scarcity of literature can be attributed to various factors, including missing data, discrepancies between mission reports and medical records, and the predominantly military-based nature of HEMS SAR operations. (43) These challenges pose barriers to data publication, hindering a comprehensive understanding of the SAR landscape. One notable discovery from the research conducted by Park-Ross et al. underscores the issue of poor data quality attributed to incomplete records, indicating the necessity for further investigations into standard reporting practices, data dissemination, and further research in this field. (43)

There is a significant gap and lack of published research in South Africa regarding the burden of rescue operations on the health system. The only published study of helicopter SAR operations in South Africa focuses solely on the Western Cape and excludes SAR operations conducted by the South African Air Force (SAAF). (43) The study by Park-Ross found that between January 1, 2012, and December 31, 2016, SARC AMS conducted 4,998 HEMS missions in the Western Cape, of which 581 (12%) were rescue missions, either aquatic or terrestrial. (43)

The lack of comprehensive data and consistent data reporting hinders the ability to make informed decisions about the importance of implementing prevention planning and strategies to reduce unnecessary rescues in terrestrial areas. Prevention strategies are vital to reducing the burden of rescues on the health system.(43) Without accurate and complete data, developing effective prevention plans is challenging. This can lead to unnecessary rescues where the HEMS team's resources could be better utilised.

This study represents a crucial initial step in addressing the challenge of inadequate reporting and data limitations by advocating for standardised reporting practices.

This study aimed to generate a standardised dataset for documenting and reporting by identifying key variables essential for reporting through expert consensus in terrestrial helicopter SAR operations. The

development of this standardised reporting framework holds the potential for several benefits. Firstly, it will contribute to a unified literature base for reporting, fostering more precise and effective communication among various SAR entities. (48) Secondly, this standardisation and uniformity in reporting opens avenues for future research endeavours within helicopter rescues, enabling researchers to leverage consistent and comparable data and enhancing communication within the research field. (48) Thirdly, this initiative establishes the groundwork for a unified database for rescue agencies, facilitating future research, case studies, and discussions. Standardised data collection and reporting are essential for making informed decisions, developing effective prevention strategies, and ultimately reducing the burden on the health system. This, in turn, supports data-driven decisions related to training requirements, staffing, logistic coverage, budget expenditure, and other aspects to enhance the safety and efficiency of HEMS and terrestrial rescue operations in the country.

Strengths and Limitations:

The adapted Delphi technique employed in this study offered several advantages, including cost and time efficiency, participant anonymity, and reduced potential for biased responses. (56) It facilitated expert panel members in expressing their opinions openly and reaching a consensus on specific variables. (56)

However, Delphi research has several limitations, including participant attrition, limited opportunities for open discussions, and a reliance on the expertise of respondents in interpreting results. The specialised nature of helicopter SAR operations posed a significant challenge in recruiting adequate participants for the study, given the limited number of practitioners in this field. Participant attrition can become a concern, as the loss of participants may skew the results, potentially leading to an overestimation of consensus. A larger sample size typically increases the reliability and validity of the findings by ensuring a more diverse range of perspectives and reducing the margin of error. Not achieving the intended sample size may limit the generalizability of the results and increase the risk of bias.

This study's results and recommendations are based on expert opinion, representing a low level of evidence-based medicine. (57) Nevertheless, it is commonly utilised in studies focused on developing practice guidelines or recommendations for protocols in the medical field. (57) For this reason, further development of these criteria and future research to refine and test these results are recommended.

Another limitation was the absence of a pilot study round before the initial round, which could have helped identify potential issues such as survey design flaws, respondent issues, and survey accessibility, which could impact participant numbers. Participants for this study were all from South Africa and worked or volunteered in terrestrial rescue services; this ensured that items were contextual to the country's setting. This might limit the study's external validity and results should the study be applied to other settings.

The research team significantly impacted the final list of items, especially since the final step of merging items was not tested in an additional Delphi round. The study was terminated after three rounds. Out of the ninety-seven items identified to report, twenty-two were merged with other items with similar wording and meaning previously identified in round one. A total of seventy-five variables were included in the final list. The research team influenced the merging of the items on the final list of variables identified to be reported, potentially introducing selection bias. This influence might affect the objectivity of the final list as the decisions on merging were made by the research team rather than through additional consensus from the experts.

Recommendations for the Future:

Considering the scarcity of literature in this field, the study highlights the need for further research on helicopter SAR operations in South Africa and other LMICs. Future research should prioritise the implementation of established standardised reporting standards and terminology in helicopter SAR operations, thereby enhancing the quality of future studies in this domain.

In summary, this study successfully identifies essential variables for reporting in terrestrial helicopter SAR operations in South Africa, marking a crucial step toward standardising reporting practices in SAR operations within the country.

CONCLUSIONS:

The outcomes of this study have yielded a cohesive, standardised, and mutually agreed-upon set of variables recommended for reporting in terrestrial helicopter SAR operations. This compilation of variables represents an initial stride towards standardising reporting practices in South African post-rescue missions. By addressing challenges such as inconsistent practices, diverse terminology, potential miscommunication, human errors, and incomplete records, the aim is to improve the efficiency,

communication, and overall effectiveness of terrestrial helicopter SAR services in South Africa. This list of variables serves as a foundational framework that may pave the way for future studies to develop a standardised reporting form applicable to helicopter and general terrestrial SAR operations in the country. Such a standardised reporting form would prove valuable in future research efforts related to planning and intervention initiatives, with the ultimate goal of mitigating or reducing unnecessary rescues in terrestrial areas, thereby alleviating the burden of helicopter rescues on South Africa's health system.

Acknowledgement:

The authors express their gratitude to the participants for their valuable input and insights.

Financial/Material Support:

None

Disclosures:

During the preparation of this work, the author used ChatGPT (OpenAI, 2023) to improve the grammar, clarity, and readability of the writing. The primary author (SST) is a second-language English speaker. After using this tool, the authors reviewed and edited the content as needed and took full responsibility for the content.

Table 1: Demographics of participants

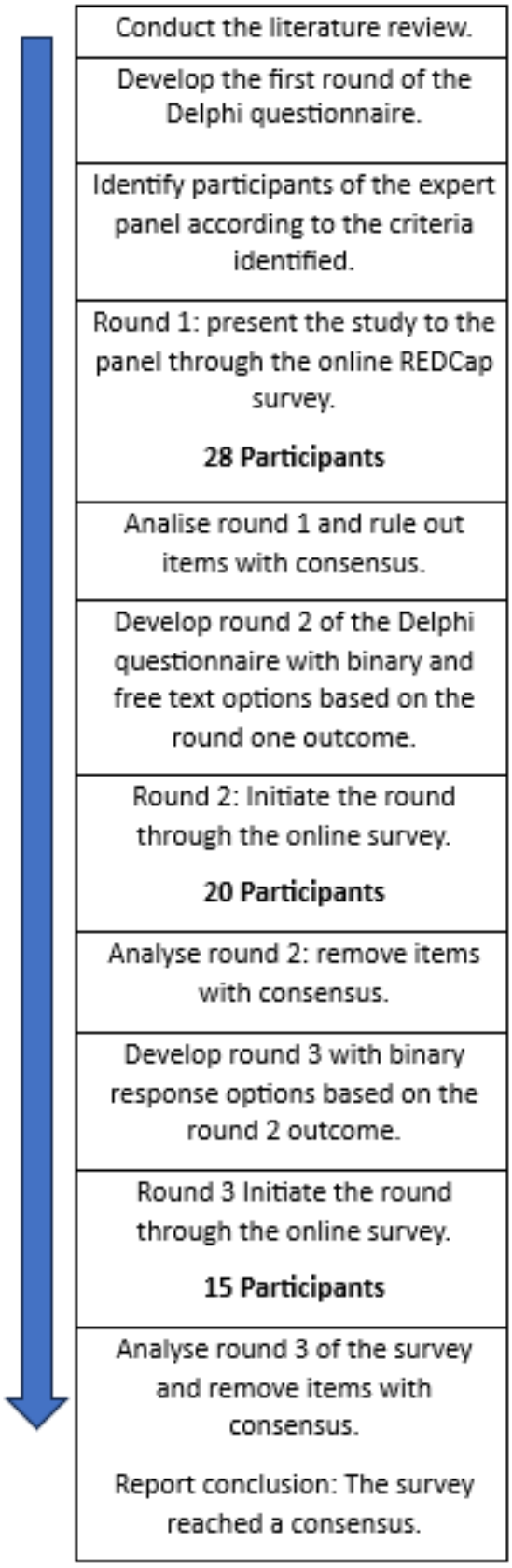
Organisation *	**n**	%
Volunteer agency	21	75%
Government EMS and rescue	2	7.1%
Civilian helicopter rescue service	4	14.3%
Military helicopter rescue service	5	17.9%
Other	7	25.0%
EXPERIENCE	**n**	%
Less than 1 year	0	0%
2-5 years	4	14.3%
5 - 10 years	6	21.4%
10 – 20 years	7	25.0%
More than 20 years	12	42.9%
Other	1	3.6%

* 7 participants recorded multiple affiliations (1 participant affiliated with a civilian helicopter rescue service and Other, 3 participants affiliated with a volunteer agency and Other, 2 participants affiliated with a volunteer agency and military helicopter rescue service, and lastly, 1 participant affiliated with a civilian helicopter rescue service, government EMS and rescue, a military helicopter rescue service and a volunteer agency).

Table 2: Summary of consensus

Round 1	**n**	**%**
Consensus on variables	63/65	96.9%
Round 2	**n**	**%**
Consensus on variables	31/40	77.5%
Round 3	**n**	**%**
Consensus on variables	3/9	33.3%
Non-Consensus on Questions / Exclusion	6/9	66.6%
The total level of consensus after the three rounds.	**97/103**	**94.17%**

Figure 1. Process flow of Delphi process.



Appendix 1: Final list of variables that met the consensus.

Temporospatial variables	**Date:** 1. The date the incident took place **Dispatch information:** 2. The number of patients involved / the number of patients requiring rescue 3. Reason why the helicopter was called or requested 4. The rescue agencies on the scene 5. The agencies involved in the incident **Times variables:** 6. Time of day: Night or day mission 7. Take-off time 8. Response time 9. On-scene time 10. First medical contact time 11. Insertion time 12. Extrication time 13. Hand-over time 14. Incident time 15. Notification time 16. Time of activation/deployment of all SAR teams 17. The time of authorisation was granted or declined 18. Time taken to mobilise the helicopter 19. Time spent on the scene before extraction **Geographical location:** 20. Incident location/ address 21. GPS coordinates 22. Description of the terrain 23. Weather conditions 24. The elevation where the SAR mission took place

	25. Area-specific or routine hazards 26. The presence of a landing zone
Technical variables	**Insertion:** 27. Method of insertion: Method used to deploy rescuers to the rescue site 28. The number of crew inserted 29. Equipment was inserted **Extrication:** 30. Method of extrication 31. Type of extrication device used 32. The number of crew extricated 33. Reason for extrication device or extraction method used **General technical information:** 34. The total number of hoists performed 35. The total number of people hoisted 36. The number of short-haul rotations performed 37. The total number of people short hauled 38. Specialized techniques used 39. Standard/specialised equipment used
Operational variables	**The flight details and agency:** 40. Type of rotor wing aircraft 41. Aircraft operator type 42. Flight authorisation number 43. Authorized by whom 44. Reason for declining helicopter authorisation **Crewing details:**

	45. The name and surname of the members on board the aircraft 46. The agency the crew on board represents 47. The crews on board medical qualification 48. The role of the members on board of the aircraft 49. Currency of crew members on board **Communication:** 50. Forms of communication used during the rescue 51. Effectiveness of communication strategies on scene **The rescue operation:** 52. The type of SAR mission 53. The person or agency coordinating onboard operations, if different from the Incident Commander 54. The rescue plan/action plan to conduct the rescue 55. Recommendations or debrief points 56. Any delay in the call-out process 57. Adverse events during the operation 58. The cause of the accident/incident 59. Routine, operational activities that may have occurred during a mission 60. Skill sets were represented by the agencies on the scene 61. Recreational activities that led to a rescue mission 62. The reason for each patient being rescued
Patient variables	**Demographic details of the patient:** 63. Age 64. Sex 65. Nationality of the patient

	General patient info: 66. AVPU score: The level of responsiveness of the patient 67. Patient triage code: Green, Yellow, Orange, Red, Blue 68. The chief complaint of the patient 69. Mechanism of injury 70. Patient activity before the rescue
Clinical variables	**Treatment:** 71. Medical interventions/treatment performed by SAR staff **Treatment time points:** 72. Time of first patient contact 73. Treatment time points: Times of medical interventions 74. Level of care required **General** 75. The disposition of the patient: Documentation of the patient's disposition after rescue

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PART C: ADDENDA

Appendix A: Relevant journal Instructions to Authors

Instructions to authors from the selected journal: Air Medical Journal

https://www.sciencedirect.com/journal/air-medical-journal/publish/guide-for-authors

Appendix B: Acknowledgements

Thank you to my supervisors, Willem Stassen and Jocelyn Frances Park-Ross, for their support while finishing this dissertation.

Appendix C: Research Protocol

A consensus on reporting variables for terrestrial helicopter search and rescue operations in South Africa through a Delphi study.

By

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BEMC:EMC (NMU)

THNSIM003

This proposal is submitted in partial fulfilment of the requirements for the degree Master of Philosophy in the Faculty of Health Sciences at the University of Cape Town.

Supervisor(s):

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12 July 2022

Declaration

I, Simone Stefanie Theunissen (THNSIM003), at this moment, declare that the work on which this thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university. I authorise the University to reproduce for the purpose of research either the whole or any portion of the contents in any manner whatsoever. I further declare the following:

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Signature: Simone Stefanie Theunissen **Date: 12 July 2022**

Signed by candidate

Background

Search and Rescue (SAR) "is an operation mounted by emergency services, often well-trained volunteers, to find someone believed to be in distress, lost, sick or injured either in a remote or difficult-to-access area, such as mountains, desert, forest, or sea."(115) SAR on land is referred to as terrestrial rescue, while SAR related to any water or at sea is referred to as aquatic rescue. (34,116)

Helicopter SAR, in general, can be categorised into military and civilian operations. (18) Military operations may be conducted in conflict areas, with some military organisations conducting search and rescue operations for civilian rescue. (18) Examples of this are the Coast Guard, which mainly does aquatic rescue internationally (5) and the South African Air Force (SAAF), which assists with aquatic and terrestrial rescues in and around South Africa. (117,118) Civilian operations include all non-military operations. This can be non-profit organisations or governmental or private rescue programs. (119) An example of such a Helicopter Emergency Medical Service (HEMS) operation is the South African Red Cross Air Mercery Service (AMS), which makes use of a helicopter to provide emergency medical services to victims in urgent need of transport or rescue in difficulty-accessed areas where no ground transport can reach them. (120,121)

International helicopter SAR / civilian HEMS services are mainly conducted in first-world or high-income countries such as Norway, Switzerland, Australia, the United States of America, Canada, Japan, South Korea, and Taiwan. (3,122–127) An example of these larger global agencies doing SAR work is Bristow Helicopters, providing SAR services in Guyana, Norway, Trinidad, the United States, and Canada, as well as SAR Coastguard helicopter services in and around the United Kingdom. (128)

According to studies on helicopter SAR/ HEMS, most victims needing helicopter SAR were male patients sustaining trauma to the lower extremities and uninjured persons. (127) A small proportion of casualties sustained severe trauma, required medical interventions, and were evacuated by helicopter rather than stretcher carry. (127) Further literature on helicopter SAR and HEMS is limited in low/middle-income countries, and there are few to no publications in and around Africa. (127)

Today, there is an increase in the number of rescues globally due to increased outdoor recreational activities. (3,19,126,129) Unfortunately, with the increased activity, there is also an increase in ill and injured persons requiring assistance. Injuries range from sports injuries such as falls and lower limb trauma to fatal injuries or illness. There has also been an increase in incidences where people get lost or drown, where boats get capsized, and many more. (129) This is when the demand comes for search

and rescue operations on terrestrial and aquatic terrain. There is no standardisation of reporting on rescue operations in South Africa.

Currently, in South Africa (SA), rescue practises remain unregulated, non-standardised, and poorly outlined and described, resulting in conflict and confusion regarding which agencies are responsible for serving as the rescue service in operations. (22) The South African SAR practises are not subject to formal regulatory or auditing processes, and nationally accepted guidelines, norms, and standards are absent. (22) This creates a problem for SAR operations and programs' future growth and development in SA. (22) Standardisation is very important. It is “the process of developing, agreeing upon and implementing uniform technical specifications, criteria, methods, processes, designs or practices that can increase evidence-based results, compatibility, interoperability, safety, repeatability and quality.” (130,131)

Standardising techniques, methods, equipment, documentation, and operations in the workplace or services will help promote the following: Standardisation will lower costs, ensuring reliable, high-quality results and the best evidence-based practice. *It* will make the quality of care more measurable and reproducible for providers, patients, and payers, supporting more consistent, reliable treatment decisions. It will allow evidence-based standards and guidelines to provide complex decision-making and help avoid errors and omissions to ensure that all patients get consistently high-quality treatment. Standardisation represents efficiency and decreases variation, which increases quality and safety while reducing costs. It minimises the risk of errors, increases patient safety, and can improve the patient’s experience. Standards control the risks associated with rescue operations, ensuring a more efficient rescue operation. It allows for consistency, which is key to success. It empowers shared learning, facilitates teamwork, and improves efficiency in personnel interactions by establishing optimum conditions. It will enable the policy, decision-makers, and healthcare workers to compare outcomes from standardised process implementation within or among healthcare organisations. Lastly, it analyses and reduces the risk of human error in techniques, equipment, or terminology. (130–133)

It is important to standardise reporting for helicopter SAR missions, as some of the current challenges with reporting are due to a lack of clear guidelines. (127) One of the challenges is the different terminology used to describe the same rescue techniques. (127) A common example in helicopter search and rescue is “hoisting” or “winching”. (127) Both words are used interchangeably in helicopter SAR and describe the same technique. This shows the importance of using correct and standardised terminology for helicopter SAR operations to prevent miscommunication and human error in rescue missions. Another challenge is an incompleteness in records used for reporting or documenting HEMS and SAR mission information reported in the international literature. (127) This lack of standardised reporting practises was flagged as a limitation in studies done on helicopter SAR. (35,123,127,134–136)

This study will focus on terrestrial helicopter SAR operations in South Africa. Due to a lack of a standardised document or report form that outlines the variables essential to report on for helicopter SAR operations internationally, there is a need to develop such a form to create homogeneous reporting standards and terminology in helicopter search and rescue operations in South Africa. (127) This will assist in improving the standardised report writing and documenting helicopter SAR operations following a rescue mission by creating a unified literature base for reporting and an opportunity for future studies in helicopter rescues. (127) This study is significant for future South African search and rescue operations because it will be the first step to standardising some helicopter rescue practices in SA. This study will recommend creating a standard form to report the critical variables needed for helicopter SAR operations.

Research Question

What is the expert consensus on the variables needed for reporting terrestrial helicopter search and rescue operations?

Aim and Objectives

To determine, through expert consensus, the critical variables to be reported on for terrestrial helicopter search and rescue.

Methodology

Methods

This study will be conducted over two phases. Phase one focuses on a literature review to obtain a

sample criterion for potential variables for reporting during terrestrial helicopter SAR operations. Phase two will identify and invite helicopter rescue experts to partake in an online Delphi study where consensus is met on the variables needed for terrestrial helicopter SAR reporting.

Study setting.

This study will be focused only on terrestrial rescue in South Africa. Helicopter SAR operations in South Africa are conducted mainly by the South African Air Force (SAAF), military-based, and civilian HEMS services with rescue capability, such as the SA Red Cross Air Mercy Service (AMS). Different role players and agencies within Wilderness Search and Rescue (WSAR) working closely with HEMS/ SAR services and the SAAF across South Africa will be approached to participate in this study. Examples of role players include the Department of Health (DOH) Western Cape aviation rescue team in Cape Town and Eden district, Mountain Club South Africa (MCSA), helicopter rescue teams and pilots SAAF and civilian organisations.

Phase 1- Literature search

A literature Search will be conducted via a database on Science Direct, Research Gate PubMed, and Google Scholar. Literature on helicopter SAR is relatively limited, and all articles on helicopter rescue will be included with no limitation on published dates.

The literature review will collate and explain some variables that must be reported for terrestrial helicopter SAR operations in South Africa.

The type of variables that will be focused on are:

- Temporospatial variables
- Technical variables
- Operational variables
- Patient variables
- Clinical variables

The following strings will be used in multiple combinations with Boolean operators to search these databases.

(“Helicopter Search and Rescue”, “Rescue Work"[MeSH], “HEMS rescue”, “hoist or winch rescue “, “ long line, slinging or short hauling”, “standardised reporting of helicopter rescue “, “Variables to report on in

helicopter rescues", and " medical interventions required in helicopter rescue", "terrestrial rescue", "wilderness search and rescue", "reporting standards")

Inclusion criteria:

- All articles meet the search string for helicopter SAR/ HEMS operations.

Exclusion criteria:

- Non-English language papers
- Full-text not available

Duplicate studies will be manually eliminated. One reviewer will independently assess the studies for eligibility by reviewing the title, abstract, and, hereafter, full text. The reference lists of the included full-text articles will be interrogated similarly (duplicate and independent review of titles, abstracts, and full text). An independent reviewer will handle any discrepancies.

Data analysis:

All the information included in the full-text article will be extracted onto an Excel spreadsheet using a priori data extrication matrix. After the data extraction, the selected articles will be used to develop a descriptive summary of the literature's central themes by doing descriptive analysis.

Phase 2- Research Design

Study design.

In this study, a modified online Delphi study will be conducted amongst helicopter SAR experts to obtain expert consensus. This design is a multi-survey process, usually consisting of three to four rounds of surveys, requiring a series of questionnaires, each following up on the outcomes of the previous round. (137) The questions will be structured by the use of binary responses with answers of "yes" or "no" and a comment to motivate their answer and to add additional variables they think should be included in the study. A consensus level of the agreement will be set at 75%. Each variable that does not achieve the 75% consensus will be moved to the second round with the additional variables identified from the previous round and the summarised comments from the participants. Feedback will be given to the participant after each round, allowing them to change their answer on those variables that did not receive consensus in the next round.

The results of each round will be assembled on an Excel spreadsheet and interpreted. A list of variables for reporting on terrestrial helicopter search and rescue operations will be generated after the final round, where consensus is met. This list will be the first step towards standardising helicopter rescue reporting practices during rescue operations in South Africa. Possible candidates for the study will be invited via email through the management committee of the different organisation role players to those identified as experts in the field. This email will include documents with information on the study design and the method of conducting it, as well as an informed consent form explaining what is expected from the participants and why this study will be conducted.

This email will inform prospective participants that privacy and anonymity will be maintained throughout the Delphi study. Given that data is collected pseudonymously, we won't be able to exclude their data from the survey when they withdraw, as it will not be linkable to them.

Sample

The sampling strategy for the Delphi study will consist of a sample size of 60 - 80 participants (experts in helicopter search and rescue) who will be invited to participate in the study, aiming for a minimum of 25 participants in the last round. A heterogeneous sample will ensure that the entire spectrum of opinions is specified. (137) These experts include volunteers, healthcare professionals working in helicopter SAR environments, pilots, and other SAR organisations familiar and experienced with helicopter rescue operations. The experts will then give their consensus view about what variables must be reported during terrestrial helicopter Search and Rescue operations in South Africa. Many identified experts are likely to be operational within the Western Cape of South Africa, as this is the country's only operational civilian helicopter SAR program.

Inclusion criteria

Helicopter rescue experts are defined as:

- Participants involved in helicopter Wilderness Search and Rescue training and operations as responders, technical crew members, managers of services, or oversight/management committee members.

- Pilots flying for helicopter SAR services.
- Emergency physicians who receive patients who have been rescued by helicopter SAR.

Exclusion criteria

- Participants not involved in helicopter search and rescue practises.
- Identified participants not responding to an electronic invite to the study after 2 invites were sent one week apart from each other.

Recruitment and enrolment

Different role-player organisations involved with terrestrial helicopter search and rescue operations will be approached and asked to distribute an email invite to individuals/ experts in the field to participate in the study. After that, snowball sampling will be used.

Organisations will include helicopter SAR operations in South Africa include, but are not limited to:

- The South African Air Force (SAAF)
- Civilian HEMS services with rescue capability (SA Red Cross Air Mercy Service)
- Different role players/ agencies involved with and including Wilderness Search and Rescue (WSAR) and Mountain Club South Africa (MCSA)
- Department of Health (DOH) Western Cape Metro (EMS)

To those who received the email and wish to participate, all the necessary information about the research and what it entails will be given. When they agree to participate in the study, the interested participants will tick a consent question box. A unique identifier will be allocated to each participant to track their progress and feedback throughout the study, ensure pseudonymisation participation, and limit bias in the study. No other participant-related information will be recorded.

The rounds

Round one

A draft criterion of variables needed for reporting on helicopter SAR will be sent to the experts using the REDCap Survey online tool. The participants will be asked to respond to each variable in a binary response, meaning “Yes” or “No. " Their response will determine whether the variable will be included

or excluded in the criteria. There will also be a section where the participants can motivate their answers and add variables they feel should be included in the draft list.

A consensus of 75% or more should be achieved to be included in the final list of variables. Variables that don't reach the 75% consensus will be moved to the second round with the additional variables and the summarised comments from the participants.

Round two

The second-round criteria of variables will be modified from the findings of the first round. The new variables included in this round will also be binary answers, as in the first round, with a consensus rate of 75%. The exclusion variables will be carried over to the third round. Inclusion criteria variables will be added to the final list of variables. The participants will receive the opportunity in this round to rethink their previous round's answers on specific variables that were excluded from the first round by being able to change their answer to either agree or disagree on the previously excluded variables and motivate why they should now be included or remain excluded.

Round three

This is the final round. Participants will agree or disagree on the added variables and carry over from the second round. From here, it will be excluded if consensus is not met on the variable. The included variables where consensus is met will be added to the final criteria list of variables that are identified to be reported on for terrestrial helicopter SAR operations.

Research procedures and data analysis.

The data will be collected in a multi-stage survey process. It will be an internet survey questionnaire and an online tool called REDCap Survey. The research team can only access this platform using a password created for this study by the researcher. After agreeing to participate in the study, each participant will be given a number. This will allow the researcher to track how many participants participate and adhere to anonymity in the survey.

After the data collection is completed, the results will be analysed. This will determine what variables have been agreed upon for reporting terrestrial helicopter SAR operations. Those variables will then be documented and included when recommendations are made for further studies on developing a standardised reporting form for helicopter SAR operations.

DATA MANAGEMENT

All data/information will be captured onto a Microsoft Excel worksheet, and a login password will be protected to ensure the integrity of the data. Only the research team will have access to this password and data. This data will be stored and backed up on a secured cloud-based Microsoft OneDrive of UCT. The data will be kept for five years after an article is published.

ETHICAL CONSIDERATIONS

Ethical approval will be sought from the University of Cape Town Human Research Ethics Committee (HREC). The survey or questionnaires will be conducted via an internet-based survey software and questionnaire tool called REDCap Survey. The participants will be informed that participation in the study is voluntary. Informed consent will be received before participation in the study.

Anonymity and confidentiality will be prioritised throughout the study, and only the primary researcher and supervisors will have access to the participant list. Other principles that will be adhered to during the survey are respect for a person, beneficence, and justice. (138)

For the study, the questionnaires given to the participants will remain pseudonymised; those that have names or any identifiable information on them will be excluded from the study. Data will be secured in an online database; only the researcher and supervisors can access it. This database will be secured with a password. This will ensure that confidentiality will be maintained and that the risks are minimal to the participants.

The study will be conducted with permission from the management of the various departments. The questionnaires will be pseudonymised to maintain confidentiality. The contact numbers of researchers will be placed on the consent form for participants to express any concerns or rights violations.

Access to confidential information - Description of risks and benefits

Risk of taking part in the study:

The participant consents to avail their time to participate in the study. The Delphi study is a multi-survey process; if the participant agrees to participate, the participant is expected to join until the end. This will mean a long period of including emails and feedback and might be time-consuming to some degree.

There will be no risk involved because it's an online survey and will be pseudonymisation, where no trace can be made back to the participant. Only the primary researcher and supervisors will have access to the list of participants. Given that data is collected pseudonymously, we won't be able to exclude data from the study when a participant withdraws, as it will not be linkable to the participant.

Benefits of taking part in the study:

There will be no direct benefit from participating in the study. This study will identify the variables that need to be reported on for terrestrial helicopter search and rescue operations in South Africa. It will be the first step in standardising reporting rescue practices in SA, which will help with future helicopter rescue practices and potential growth in the field. This study will then open opportunities for future research in the field.

Reimbursement for participation

No compensation will be given to the participants. It will be stated in the informed consent form that there will be no cost involved in taking part in the study. The study is voluntary, and the time spent to complete the questionnaires will be at least 10 minutes. Feedback will be given to the participants after each round.

Strengths and limitations
Strengths:

- Consensus is achieved in uncertainty or a situation lacking causation through a group of experts on a specific topic. (139)
- The Delphi method is straightforward to design and flexible in how the designs are put together. (139)
- The Delphi method is a way of knowledge-sharing and stimulating new ideas that apply to the panel's purpose. (139) This broadens the knowledge and scope of the panel of experts. (139)
- Delphi's design is highly cost-effective. (139) There is little expense unique to the study.
- Freedom of expression due to the anonymity requirement in all Delphi studies. (139) It gives panel members the freedom to present their opinions and potentially offers different perspectives to others without fear of criticism. (139)

- Electronic communications have virtually eliminated geographical boundaries and limits in Delphi studies when it's done online. (139)

Limitations:

This is a Delphi study, and with this type of methodology, there might be the following limitations that are encountered:

1. The Delphi study is based on expert opinion only. (140)
2. It helps identify areas one group of participants or experts consider important concerning that topic. (140,141)
3. There are only a few experts in the field. Thus, there is only a small data set and response rate. (140)
4. Anonymity prevents individualised feedback from being given to all involved in the initial sample. (141)
5. It does not allow participants to discuss or elaborate on their views with others. (140)
6. Consensus might not be met after the three or four rounds of surveys. (141)
7. Lastly, continued commitment from the participants is required throughout the multistage survey process for their questionnaires to be included in the study.

Dissemination of findings

The study and its results will be submitted to the University of Cape Town database and the participants. The findings will be disseminated to policymakers for recommendations on Helicopter SAR practices and publication in a peer-reviewed scientific journal with due consideration for open access.

Timeline

Project timeline in months:			
EMDRC: July 2022	HREC: July 2022	WCH health application: August 2022	Data collection: Aug-Oct 2022
Analysis: Nov 2022	Write up: Dec 2022- March 2023	Other timeline variables:	Other timeline variables:

Budget

The study will use internet-based surveys and questionnaires. Survey software and a questionnaire tool will be developed online and emailed to the participants. The cost of the research project will be self-funded.

The table below indicates the estimated budget for the study:

Estimated breakdown of costs

Item	**Price Estimates**
Editor cost	R5000.00
Other cost (printing etc.)	R500.00
Total	**+-R5500.00**

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Addendums

Addendum A: Participant information and consent form

Date being sent.

Dear Participant (Name inserted here)

PARTICIPATION IN A DELPHI SURVEY FOR THE DEVELOPMENT OF CONSENSUS CRITERIA OF VARIABLES REPORTED ON TERRESTRIAL HELICOPTER SEARCH AND RESCUE OPERATIONS IN SOUTH AFRICA.

I am enrolled at the University of Cape Town and completing my final year in the MPhil: Disaster Medicine program. As part of this qualification, I am required to complete a research project.

Through expert consensus, this study aims to determine the critical variables to be reported on for terrestrial helicopter search and rescue operations. This study will focus on terrestrial helicopter SAR operations in South Africa, which lack a standardised document or report form that outlines the variables that are important to report on for helicopter SAR operations. There is a need to develop such a form to create homogenous reporting standards and terminology in helicopter search and rescue operations in South Africa. This will assist in improving the standardised report writing and documentation of helicopter SAR operations following a rescue mission.

This study is essential for future South African search and rescue operations because it will be the first step to standardising some helicopter rescue practices in SA. This study will provide

recommendations for creating a standard form to report on the critical variables needed for helicopter SAR operations.

I invite you to participate in this Delphi survey and form part of a panel of experts to help reach a consensus on the variables that need to be reported for terrestrial helicopter search and rescue operations. Once you have accepted this invitation and consented to be part of this panel of experts, I will send you the first questionnaire via e-mail, connecting you to a REDCap Survey® questionnaire. While participating in the survey, you must use your personal experiences, available data and literature, or any other resources to provide your expert opinion.

To see if you are eligible to take part in this study, please make sure you review the inclusion and exclusion criteria below:

Inclusion Criteria

Helicopter SAR operations in South Africa include, but are not limited to:

- The South African Air Force (SAAF)
- Civilian HEMS services with rescue capability (SA Red Cross Air Mercy Service)
- Different role players/ agencies involved with and including Wilderness Search and Rescue (WSAR) and Mountain Club South Africa (MCSA)
- Department of Health (DOH) Western Cape Metro (EMS)

Exclusion criteria

- Participants not actively involved in helicopter search and rescue practises.
- Identified participants not responding to an electronic invite to the study after 2 invites were sent one week apart from each other.
- Individuals not currently part of any helicopter voluntary SAR agencies

Once you have completed the questionnaire, your valued views, opinions, and all your received answers will be collated, and relevant new themes will be formulated. A specific questionnaire will then be constructed and distributed to the panel of experts again.This will be repeated to three rounds per the Delphi method until a consensus is achieved.

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

Participation in this study is risk-free, and you will not receive any specific benefits σr compensation.

You can withdraw consent and participation from the study at any point by closing your browser or not participating in a subsequent round. Given that data is collected pseudonymously, we won't be able to exclude your data from the study when you withdraw, as it will not be linkable to you.

This proposal has been reviewed and approved by the Human Research Ethics Committee of

the University of Cape Town. The UCT's Faculty of Health Sciences Human Research Ethics

The committee can be contacted on 021 406 6338 if you have any ethical concerns or questions about your rights or welfare as a participant in this research study.

If you agree to take part in this study, please click on the checkbox below:

☐ I have read all the information above and consent to participate in this study.

Thank you for your time and for considering participating in this study.
If you have any questions or would like to get a hold of me:

Simone Theunissen

thnsim003@myuct.ac.z

a

Cell: 0769267698

Addendum B: Organisational approval letter

University of Cape Town Rondebosch

Cape Town 7700

(DATE)

Ms S. Theunissen

45 Erica Street

George

6530

Research Permission Letter Dear

My name is Simone Theunissen. I am an Emergency Care Practitioner working in Oudtshoorn. I am registered in the Master of Philosophy in Emergency Medicine programme at the University of Cape Town's Division of Disaster Medicine. Part of my master's program requires me to complete a research project.

The research title is A Consensus on Reporting Variables for Terrestrial Helicopter Search and Rescue Operations in South Africa through a Delphi Study. Through expert consensus, this study aims to determine the essential variables to be reported on for terrestrial helicopter search and rescue operations to help standardise reporting in rescue operations.

The study proposal is attached so you can review additional information and processes for the research project. The University of Cape has approved the proposal.

Town's Emergency Medicine Divisions' research subcommittee (EMDRC Ref:) has obtained ethical clearance from the facility's ethics committee. (HREC REF:)

In the first part of this research project, the researchers will collate the current criteria of variables that are used for reporting on search and rescue operations. In the second part of the study, these collated criteria will be presented to experts in helicopter search and rescue operations to reach a consensus on what variables are most appropriate and acceptable to them for standardised reporting of rescue missions.

The participants and their rescue entities will be anonymised, and there will be no means of identifying the specific criteria utilised by each rescue entity. These services will not be mentioned should the paper be published in a peer-reviewed journal. The final study report will be sent to you after it has been marked.

If you have any further queries or concerns, please contact me or one of my research supervisors, whose details are below.

Thank you for your time, and I hope to hear from you soonest.

Kind Regards

Simone Theunissen (Principal Investigator) UCT MPhil Student

Email: thnsim003@myuct.ac.za

Cell: +27 769267698

Willem Stassen (Supervisor)

Programme Coordinator: PhD Emergency Medicine Division of Emergency Medicine

Department of Surgery

Email: willem.stassen@uct.ac.za

Cell: +27 076 502 2187

Jo Park-Ross (Co-Supervisor)

Email: jocelyn.park-ross@uct.ac.za

Cell: +27 769501280

Appendix D: HREC approval letter

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

Room 45 E-52-E-Floor- Old Main Building
Groote Schuur Hospital
Observatory 7925
Telephone [021] 406 6492
Email: hrec-submissions@uct.ac.za
Website: www.health.uct.ac.za/fhs/research/humanethics/forms

28 July 2022

HREC REF: 435/2022

Miss J Park-Ross
Department of Anaesthesia
Email: Jocelyn.park-ross@uct.ac.za
Student: Thnsim003@myuct.ac.za

Dear Miss Park-Ross

PROJECT TITLE: A CONSENSUS ON REPORTING VARIABLES FOR TERRESTRIAL HELICOPTER SEARCH AND RESCUE OPERATIONS IN SOUTH AFRICA: A DELPHI STUDY- (MPHIL CANDIDATE-MISS SIMONE THEUNISSEN)

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

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

Approval is granted for one year until the 30 July 2023.

Please submit a progress form, using the standardised Annual Report Form (FHS016) if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.
(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

The HREC acknowledge that the student: - Miss Simone Theunissen will also be involved in this study.

Please quote the HREC REF 435/2022 in all your correspondence.

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

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

Yours sincerely

Signed by candidate

PROFESSOR M BLOCKMAN
CHAIRPERSON, FACULTY OF HEALTH SCIENCES HUMAN RESEARCH ETHICS COMMITTEE
Federal Wide Assurance Number: FWA00001637. Institutional Review Board (IRB) number: IRB00001938 NHREC-registration number: REC-210208-007

HUMAN RESEARCH ETHICS COMMITTEE
- 5 JUN 2023
HEALTH SCIENCES FACULTY
UNIVERSITY OF CAPE TOWN

UNIVERSITY OF CAPE TOWN
IYUNIVESITHI YASEKAPA • UNIVERSITEIT VAN KAAPSTAD

FACULTY OF HEALTH SCIENCES
Human Research Ethics Committee

FHS016: Annual Progress Report / Renewal

HREC office use only (FWA00001637; IRB00001938) This serves as notification of annual approval, including any documentation described below.			
☑ Approved	Annual progress report	Approved until/next renewal date	30/7/2024
☐ Not approved	See attached comments		
Signature Chairperson of the HREC/ Designee	Signed by candidate	Date Signed	5/6/2023

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

Comments to PI from the HREC

Principal Investigator to complete the following:

1. Protocol information

Date (when submitting this form)	1 June 2023		
HREC REF Number	435/2022	Current Ethics Approval was granted until	30 July 2023
Protocol title	A consensus on reporting variables for terrestrial Helicopter Search and Rescue operations in South Africa: a Delphi study.		
Protocol number (if applicable)	N/A		
Are there any sub-studies linked to this study?		☐ Yes	☑ No
If yes, could you please provide the HREC Reference number for all sub-studies? **Note:** A separate FHS016 must be submitted for each sub-study.			
Principal Investigator	Jocelyn Park-Ross		

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

Appendix E: AMS letter

AMS
S.A. RED CROSS AIR MERCY SERVICE

09 November 2022

Dear Simone Theunissen

Re: Approval & Access to AMS personnel and records for research purposes

The AMS Research Committee has received your research protocol and supports you in this study.

Your request for access to the SA Red Cross Air Mercy Service (AMS) personnel and records has been approved and granted.

The resources you require will be made available to you from our regional office located at the General Aviation Area - Cape Town International Airport.

Guidance to the use and maintenance of the record files will be advised on site by local management – Garth Moys.

Standard Ethical Rules together with the organisation's restriction on removal of confidential information offsite and the patients' right to confidentiality, apply.

We wish you well with this endeavour and request that where possible, the AMS be updated on the outcomes of the study.

Thank You

Best reards

Signed by candidate

Gary Mc Cormick
Safety, Quality & Technical Manager

Fax: (+27) 86 554 6313
E-mail: gary@ams.org.za

Appendix F: DOH letter

Western Cape Government

Department of Health and Wellness
Mr Craig Wylie
Emergency Medical Services
Craig.Wylie@westerncape.gov.za | Tel: 0788005644

TO: MS SS THEUNISSEN

A CONSENSUS ON REPORTING VARIABLES FOR TERRESTRIAL HELICOPTER SEARCH AND RESCUE OPERATIONS IN SOUTH AFRICA THROUGH A DELPHI STUDY. (WC_202209_031)

Dear, Ms SS Theunissen

Your request on the above matter refers.

Thank you for the request to conduct research within the Western Cape Government Emergency Medical Services. Your proposal has been evaluated and has been recommended for approval by this office.

I am therefore pleased to inform you that such approval is hereby granted.

I wish you well in your endeavour and trust that you will keep this office and its department informed of your findings when these become available. I look forward to the insights that your research will afford us.

Yours sincerely

Signed by candidate

Mr Craig Wylie

Director: Emergency Medical Services

DATE: 10 October 2022