RESCUE ACTIVITY OF A CIVILIAN HELICOPTER EMERGENCY MEDICAL SERVICE IN THE WESTERN CAPE, SOUTH AFRICA: A FIVE-YEAR RETROSPECTIVE REVIEW

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## Abbreviations/Glossary

<table>
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<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ALS:</td>
<td>Advanced Life Support</td>
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<tr>
<td>ASR:</td>
<td>Aquatic Search and Rescue</td>
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<tr>
<td>Dr:</td>
<td>Doctor</td>
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<tr>
<td>ELO:</td>
<td>External load operator</td>
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<td>EMS:</td>
<td>Emergency Medical Services</td>
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<td>HEMS:</td>
<td>Helicopter Emergency Medical Services</td>
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<tr>
<td>HPCSA:</td>
<td>Health Professions Council of South Africa</td>
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<td>ICAR MEDCOM:</td>
<td>International Commission for Mountain Emergency Medicine</td>
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<td>ILS:</td>
<td>Intermediate Life Support</td>
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<tr>
<td>MCSA:</td>
<td>Mountain Club of South Africa</td>
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<tr>
<td>NSRI:</td>
<td>National Sea Rescue Institute</td>
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<tr>
<td>SAAF:</td>
<td>South African Airforce</td>
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<tr>
<td>SANPARKS:</td>
<td>South African National Parks</td>
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<tr>
<td>SAPS:</td>
<td>South African Police Services</td>
</tr>
<tr>
<td>SAR:</td>
<td>Search and Rescue</td>
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<tr>
<td>SARC AMS:</td>
<td>SA Red Cross Air Mercy Service</td>
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<tr>
<td>SATS:</td>
<td>South Africa Triage Score</td>
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<tr>
<td>TMNP:</td>
<td>Table Mountain National Park</td>
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<tr>
<td>UK:</td>
<td>United Kingdom</td>
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<tr>
<td>USA:</td>
<td>United States of America</td>
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<td>WSAR:</td>
<td>Wilderness Search and Rescue</td>
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PART A: LITERATURE REVIEW
Background
Helicopters provide benefit in the rescue of the critically ill and injured in remote or inaccessible terrain by decreasing time to first contact with medical personnel and delivery to definitive care. Furthermore, the ability to rapidly search expansive or challenging terrain reduces the potential for harm to the uninjured who are lost or stranded. (1, 2) However, helicopters are an expensive resource, and consequently, much of the aeromedical search and rescue literature stems from high-income countries, with few well-described services in low- and middle-income settings. Through an improved understanding of the epidemiological aspects of rescue, it is possible to best inform injury prevention strategies, reduce cost and improve safety conditions through public awareness.

This background will explain the current context of helicopter search and rescue in the Western Cape of South Africa, the resources available and the organizations involved, followed by a literature review examining international practice. The Western Cape is the southernmost of the nine South African provinces spanning 129 462 km². (3) The topography is diverse, with an arid, hilly interior and mountainous regions scattered throughout. The Cape Metropole has the highest population density, housing two-thirds of the province's 6.6 million inhabitants. (4) The Western Cape is a popular travel destination for local and international travellers with seasonal influxes of visitors over the summer months. Table Mountain forms the centre of the city of Cape Town in the Cape Metropole. It is one of the seven natural wonders of the natural world with one million visitors summiting the mountain by cable car per annum. (5) Table Mountain National Park is a largely open-access national park, spanning 212 km² from Table Mountain to Cape Point with an estimated 4 million visitors per annum. (5)

In South Africa, several aeromedical rescue programs exist. These multidisciplinary, multi-agency partnerships utilize pre-existing Provincial Department of Health or South African Airforce assets. In the Western Cape, a regionalized aeromedical system has demonstrated benefit in assisting a low resource emergency medical service. (6) The South African Air Force (SAAF) conducts search and rescue operations across South Africa when requested, having assisted in Mozambique (2000, 2019), Malawi (2019) and Mauritius (1989) during natural disasters, as well as occasional rescue across some of South Africa's provinces. (7, 8) Aircraft used include the Agusta Westland AW109 and Atlas Oryx. The South African Police Service (SAPS) Air Wing have rescue capabilities but do not routinely conduct search and rescue operations as part of their mandate. (9)

The Mountain Club of South Africa (MCSA) and Wilderness Search and Rescue (WSAR) are volunteer organizations integral to terrestrial rescue. Several other smaller local organizations are active, with MCSA acting as a larger governing body. For aquatic rescue, the National Sea Rescue Institute (NSRI) and Lifesaving South Africa are large national organizations with
a mixture of volunteers and full-time employees. Through land and water-based rescue and prevention activities conducted by these organizations, a growing awareness of water safety is evident in South Africa. (10)

The South African Red Cross Air Mercy Service (SARC AMS) is a non-profit organization subcontracted to the Western Cape Department of Health to deliver aeromedical services in the province, including aquatic and terrestrial rescue. There are two SARC AMS helicopter bases in the Western Cape – Cape Town and Oudtshoorn. The service utilizes single-engine Agusta Westland AW119 helicopters with hoisting and longline capabilities. To safely conduct operations, the pilot is assisted by an external load operator (ELO) or winchman who operates the hoist and assists the pilot with safe operations. Hoisting uses a reeled cable mounted above the helicopter door to move persons or objects up and down and is operated from inside the helicopter. (11, 12) The hoist can be used to move persons into and out of the cabin and extract stretcher patients. Short-haul or longlining techniques use static rope of varying lengths attached to a fixed external cargo attachment below the helicopter. This technique is used when multiple persons require simultaneous rescue, such as critical patients requiring ongoing medical intervention and monitoring, or to access locations exceeding the hoist's length, such as deep gorges. (13)

Rescues are conducted using multidisciplinary teams from various organizations, including volunteers and provincial emergency medical services (EMS) rescue teams, with provincial EMS acting as the coordinating body. Rescue training is held regularly with a minimum attendance set for proficiency to participate in rescue operations. Terrestrial rescue teams consist of an external load operator, medical rescuer and technical rescuer. The role of the medical rescuer is to provide emergency care as required. Medical rescuers are supplied by the SARC AMS and provincial EMS. Technical rescuers are drawn from provincial EMS or various volunteer organizations. The technical rescuer's role is to ensure technical aspects of the rescue are conducted safely and assist the medical rescuer with patient care and packaging where required. Aquatic rescue crew configurations include an external load operator, advanced life support paramedic and rescue swimmer. Rescue swimmers in the aquatic rescue programme are pooled from provincial EMS and volunteer organizations. Rescue swimmers from volunteer organizations are trained in first aid, while provincial EMS rescue swimmers have varying qualifications ranging from intermediate to advanced life support paramedics. (14)

Emergency medical services personnel in South Africa range in qualification from basic to advanced life support and are registered in different categories with the Health Professions Council of South Africa (HPCSA). (15) Practitioners registered with the HPCSA as Emergency
Care Practitioners can carry a range of analgesic and analgesic drugs and perform skills including endotracheal intubation, surgical airway intervention and intra-osseous access. (16)

The South African Triage Score (SATS) is the primary method of prehospital triage used in the Western Cape. Red patients are critical patients with life-threatening conditions requiring immediate intervention; orange patients require urgent care in under ten minutes from presentation; yellow patients and green patients are stable patients requiring non-urgent medical attention. (17)

**Literature search and strategy**

A semi-structured review of the literature was undertaken using PubMed and Google Scholar. A snowball strategy of including relevant articles cited in the articles meeting inclusion criteria was used. As the literature on helicopter rescue is relatively small, no limit was set for the publication date of articles included.

Search strings utilized:

1. "Helicopter" or "HEMS" in Title/Abstract AND "Rescue" in Title/Abstract
2. "Helicopter" or "HEMS" in Title/Abstract AND "Hoist" in Title/Abstract
3. "Helicopter" or "HEMS" in Title/Abstract AND "Longline" in Title/Abstract AND "Rescue" in Title/Abstract

The above search was last updated on 1st August 2020.

**Quality**

A low threshold for inclusion and open search strings were purposely employed due to the lack of standard terminology used in the literature. Titles and abstracts were read for assessment of inclusion and relevance to objectives. Articles meeting inclusion criteria were listed.

**Inclusion**

All relevant articles which meet the below criteria will be included in the literature review:

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

**Exclusion**

- Non-English language papers
- No date exclusion was implemented
Introduction

Helicopter emergency medical services describe the application of helicopters to perform emergency medical services in the prehospital, inter-hospital transfer/retrieval and rescue setting. With origins in military operations, both helicopter rescue and aeromedical services are utilized in emergency medical services across the world in different configurations and operational models. (6) This is an expensive and scarce resource with the highest concentration of helicopter emergency medical services (HEMS) services found in the high-income setting. (18) The primary advantage of HEMS is in the rapid delivery of well-equipped medical personnel to the scene of an emergency, as well as the rapid extrication to appropriate definitive care. (19)

The challenges facing the health services in the South Africa context for which HEMS provides particular advantages include large rural populations; long transport distances to tertiary hospitals based in urban areas, and a shortage of prehospital staff. (20, 21)

The usage of helicopters in search and rescue operations presents a clear advantage over overland extraction or assisting a ground rescue team. Helicopter rescue activations can be grouped into two categories: patient condition and rescue complexity. The rescue's complexity can include a situation prohibiting ground access or egress, such as terrain or extraction distance. Search and rescue operations include specialized helicopter rescue capabilities such as a hoist or sling, but sometimes a helicopter can land on the scene of the emergency to extricate the patient. Helicopters used for rescue must carry appropriately trained medical and rescue personnel and equipment and have adequate load capacity and space. (2)

Literature describing HEMS in South Africa is limited, with no published literature regarding HEMS search and rescue in this setting. A description of current HEMS rescue operations are required to inform policy and practice regarding dispatch criteria, crewing and equipment standards and operation policies, as well as informing preventative measures. The focus of the current aeromedical HEMS literature in South Africa includes scene time (22), dispatch criteria (23), airway management practices (24) and mortality related to HEMS for trauma patients. (21)

While some high-income settings have described potential mortality benefit with the usage of private HEMS for patients who have sustained major trauma, there seems to be no 30-day mortality benefit in the South African setting. This has been possibly attributed to the dispatch model utilized, which differs between private and state services. (21) A case-mix description of private HEMS described a one-year sample, including 537 cases transporting predominately adult patients in two South African provinces. Adult male patients who had sustained trauma were the most common patients transported, with 75% alive and stable at
72-hour follow-up. Motor vehicle accidents were the most common reason for dispatch of HEMS. (25)

In a description of aeromedical inter-facility retrieval of pediatric patients undertaken by the SA Red Cross Air Mercy Service in the Western Cape, pediatric patients represented 25% of all missions undertaken. More than half of these were completed by helicopter, providing rapid transfer and improved patient safety compared to non-specialized ambulance transfers. This emphasizes the importance of the aeromedical platforms’ availability for timeous and safe retrieval of pediatric and neonatal patients. (20) In the mixed model utilized in the Western Cape, it is vital to understand how the dispatch of the HEMS services can be utilized justly to provide the most benefit.

In international HEMS search and rescue, continents best represented in the literature include Europe (13, 26-75), Australia (1, 11, 39, 76-80), United States of America (81-89) and Canada (90, 91). Asian countries, including Japan (92, 93), South Korea (94) and Taiwan (95) have active HEMS rescue services. HEMS services in each of these regions will be described in detail from the available literature.

The maturity and complexity of prehospital and rescue services vary across the African continent, with some countries operating comprehensive aeromedical services to compliment ground ambulance services. As the current focus of some low- and middle-income settings includes the development of basic systems such as community first responders and equitable access to basic emergency care, HEMS may be inappropriate in this context. The literature related to helicopter rescue, both terrestrial and aquatic, is especially limited in the low- and middle-income setting, with no HEMS search and rescue publications in Africa. Helicopter rescue in Nepal, initiated and funded in partnership with Swiss helicopter rescue organisations, has established HEMS in Nepal's high-volume mountaineering area through funding and training partnerships with high-resource setting services (67, 96-98).

Differing funding models exist for HEMS rescue, such as state-funded or fee for service operations. Helicopter emergency medical services and rescue were traditionally performed by the military. Several models now exist, including civilian, military organizations and firefighter helicopter rescue services. There is little military search and rescue data published. The Austrian government cannot fund large-scale HEMS rescue due to national health insurance restrictions, requiring supplemental accident insurance to fund HEMS rescue. (99) In the South African context, for the most part, the cost of rescue is borne by governmental services. (14)

Cost reduction can be better achieved by understanding the epidemiology of search and rescue. (76) Much of the epidemiological literature on this subject is focused on specified
national parks and detailed areas of high rescue activity that can be targeted for injury prevention. (76) There appears to be consensus across the literature, revealing a surprising proportion of persons requiring rescue being uninjured and requiring situation assistance due to being ill-prepared, lost or inexperienced in activities undertaken. (100) This cohort of patients could be targeted as a cost reduction strategy. A regionalized approach to aeromedical resources such as rescue may have cost-benefit when utilized to support ground resources. (6)

The risk of HEMS operations, including in search and rescue, is significant, with several documented fatal helicopter accidents involving patients, pilots and crew members. (99) Helicopter rescue is high risk in all phases of the mission, especially during the phase when patients and crew are moved in and out of the aircraft, such as during hoisting or longlining procedures. Case reports of deaths related to HEMS rescue show that causes include equipment and human factors, including patients falling from harnesses after becoming unresponsive and persons falling from height due to technical errors. (101-103) Training for safe HEMS rescue is imperative, and in some countries, aviation regulatory bodies detail requirements by law which are extensive and expensive for operations to adhere to. (11)

Criteria for appropriate utilization of HEMS in search and rescue activities form part of good governance and beneficial, cost-effective service delivery. The use of HEMS search and rescue is warranted for time-critical patient conditions where ground evacuation may be prolonged or dangerous, and the operation can be conducted safely. (2) Decision-making before the dispatch of a helicopter requires gathering pre-flight information such as patient location, available and required resources and alternatives (such as ground crews on foot or with appropriate vehicles), time to access, condition of patient, weather and light constraints. (23, 88) The usage of a medically supervised standardized dispatch protocol utilized by experienced and knowledgeable persons improves decision making in HEMS rescue dispatch. (104)

The International Commission for Mountain Emergency Medicine (ICAR MEDCOM) is a volunteer-based organization with members from high- and low-middle income countries. Contributing members produce consensus and guidance documents on mountain rescue matters, including medical equipment standards, mountain emergency medicine, medical procedures and care, safe response to rescue scenarios, helicopter usage, and scenario-based guidelines such as advanced airway management and trauma. (2, 41) The focus of much of the ICAR-MEDCOM has been on developed world settings and alpine rescue such as avalanche response.
Description of regional HEMS services

Europe
The trend across European HEMS rescue follows that of international trends: most patients retrieved are male patients who have sustained trauma, mostly lower limb, with a large proportion of persons rescued being uninjured or sustaining minor injuries. (28, 44, 48) Alpine rescue requires extensive training and has unique challenges, including the rescue of the hypothermic patient, high altitude and extreme weather conditions. Severe polytrauma, hypothermia and asphyxia are the most prevalent causes of morbidity and mortality. (65, 66, 84) In some European countries, there may be a connection between tourism and temporal surges in rescue requirements in some areas, especially alpine areas. (48, 99) In many of these cases, the persons were in need of situational rescue rather than emergency medical assistance. (99)

Marinangeli et al. (105) performed a country-wide questionnaire-based survey of helicopter emergency medical services across Italy. Of 47 helicopter EMS bases, 28 conducted search and rescue operations using a twin-engine helicopter equipped with a hoist and a mountain rescue technician. The services are physician and nurse or technician based, with medical personnel trained as hoist operators. Training of medical persons as hoist operators follows the same model as some Australian systems and the SARC AMS model. (11) This study did not describe patients rescued, or technique used but focused on the wider integration and optimization of HEMS into the medical system.

Helicopter search and rescue in Norway is conducted by the National Air Ambulance Service of Norway and the Norwegian Air Force, coordinated by the police authorities and have experienced a national increased demand for helicopter search and rescue. (28) Terrestrial rescue is in greater demand than aquatic rescue, with most rescues performed in simple terrain to retrieve persons using hoist or longline techniques. This model highlights the importance of understanding the usage of HEMS for search and rescue activities as this limits the availability of the resource to the healthcare system for time-critical medical missions.

Across the United Kingdom (UK), helicopter rescue is conducted by regionalized HEMS, the Royal Airforce, Royal Navy and Coastguard using hoisting for rescue and with a paramedical crewing model. (75) In the first description of mountain rescue in Scotland, Hearns (32) presented that 78% of all persons requiring rescue had trauma while only 3.8% has sustained major trauma. Of the fifty-seven fatalities described in the two-year sample, four died during rescue from hypothermia or trauma, as well as all major trauma patients were evacuated by helicopter. A decade later, helicopters were being used for between 40-56.9% of mountain rescue across the UK. (75) The description of casualties rescued in the UK, including Scotland
and Wales, aligns with those described in other high-resource settings: predominately male patients sustaining trauma to a single lower limb, as well as a half of all persons requiring rescue being classified as uninjured persons. A small proportion of casualties sustained serious trauma and required multiple interventions, and were more likely to be evacuated by helicopter than stretcher carry by ground rescue teams. Helicopters were used more often in Scotland than in the rest of the UK – this is attributed to the expansive remote areas in Scotland.

Literature describing the usage of helicopters for aquatic search and rescue is limited. The Norwegian civilian HEMS model, including aquatic and terrestrial rescue, is comparable to the SARC AMS model, where missions were limited from 10 – 24 per annum with no analysis of rescue techniques or patient factors described. (28)

**The United States of America**

Carpenter et al. conducted a ten-year retrospective description of a civilian helicopter rescue service in a rural area using a twin-engine, night flight capable helicopter. (85) There were 171 rescue missions with 214 persons rescued, with trauma and situational assistance being the predominate cause for rescue. Most persons hoisted were male with an average age of 35 years. Temporal rescue peaks were noted on weekends, early afternoon and in summer. Most patients were extracted by seat harness, followed by stretcher extraction. While 32% of persons rescued required no further care, 44% were transported via helicopter and 24% via ambulance to hospital. Difficulty was experienced in obtaining patient data as not all patients were transported to definitive care by helicopter, limiting the availability of patient data for analysis.

A 10-year retrospective review of all search and rescue activity in the Yosemite National Park from January 1990 – December 1999 was well described by Hung et al. (87), with an objective to reduce the need for search and rescue activities. Almost one-third of persons requiring rescue in the park were rescued by helicopter, but rescue techniques and patients were not detailed. The predominant population requiring rescue was hikers, with lower limb trauma the most common presentation. As described in other North American literature, dehydration was a common reason for rescue. The sample size was larger than most literature with similar time frames, with 2327 persons assisted during 1912 missions. The rescue of multiple persons per mission is not uncommon in the literature, as is described in Yosemite. Most persons rescued were male, and the mean age was 32 years old. The fatality rate was lower than in many other areas of the United States of America.

Heggie et al. (97) described the search and rescue trends in National Parks in Utah from 2001-2005 in a retrospective review of 4762 emergency medicals services incidents, of which 553
were transported by helicopter. Helicopter rescue techniques and crewing were not described. Male patients, hikers and persons aged 20-29 were most prevalent in the sample, as is well described in search and rescue literature. Most persons suffered trauma, but interestingly, medical emergencies were near equivalent to the trauma burden. Increased rescue activity was reported over weekends, correlating with increased visitors. The authors postulated that the usage of cellular phones was a logical cause of the high demand for search and rescue as cellular phones improved communication availability. While there is a definite increase in the global search and rescue activity, the study found that radio and in-person contact were the most common communication methods utilized for contacting emergency assistance.

In the United States of America, temporal data has shown that rescues are most likely to occur in the summer months, early afternoon and over weekends. Most persons rescued are male patients who have sustained trauma. Most patients requiring rescue require transport to hospital for further care.

**Canada**

In a descriptive analysis of the epidemiology of all search and rescue across Canada, Curran-Sills et al. (91) conducted a 35-year retrospective review including 1088 incidents with 1377 patients. A helicopter was used for 37.4% of rescues conducted, with ground support for all helicopter rescues. Fatalities consisted of 31% of the study population, which is notably higher than other literature. Male patients sustaining trauma were the highest proportion of patients requiring rescue, with lower limb trauma described as the most common injury. Medical conditions such as dehydration, exhaustion and hypothermia accounted for approximately one-third of patients. Hiking and mountaineering were the activities most likely to require rescue. Bimodal temporal peaks were noted in the winter and summer months and attributed to popular sporting activities during these periods. No severity scoring was included, and the patients rescued by helicopter were not differentiated nor described in this study.

Prior to this larger study, a smaller retrospective review described rescue activity in specific areas of Canada. Finlay et al. (87) described the epidemiology of mountain search and rescue operations in three of Canada's largest national parks in a three-year retrospective review documenting 317 rescues of 406 persons, of which most were rescued by helicopter. The use of the helicopter was attributed to harsh mountainous terrain. The helicopter was only equipped with longline or "heli-sling" capabilities, which were only used for one-third of helicopter rescue activity. Patients rescued were predominately male, had a mean age of 35 years old and had sustained trauma. Medical emergencies included dizziness, exhaustion and hypothermia, similar to the data presented by Curran-Sills et al. (91) Almost half of persons rescued were uninjured, as is common in helicopter search and rescue literature. One-quarter of persons rescued were not local to Canada. Temporal peaks were described in summer
months, with hiking as the most common patient activity. "Heli-sling" is not a term used elsewhere in the literature to describe the technique of using a static rope for helicopter rescue, and this non-standard nomenclature creates challenges when searching the literature.

Within the Canadian search and rescue literature, helicopter search and rescue crewing, rescue techniques and patient epidemiology were not well described, but there is clear involvement of helicopters in mountain search and rescue. Within the general search and rescue activity, trauma cases were predominant, but, as with other continents, patients experience an array of serious medical conditions such as cardiac and respiratory emergencies. Multi patient scenarios are described as is seen in other rescue systems. A proportion of persons requiring rescue were uninjured and required no further care. The availability of data and lack of standard quality reporting limits the patient-related data available for analysis.

**Australia**

In a retrospective analysis of a four year period with 125 HEMS rescue missions, Meadley et al. describe a paramedic-staffed 24-hour HEMS rescue operation utilizing twin-engine helicopters in Victoria, Australia. (11) This operation is similar to that of the SARC AMS with respect to crewing, paramedical scope of practice, patient presentation and topography. Patients were predominately male with a mean age of 38 years. Trauma was the most prevalent condition, with most patients sustaining mild to moderate trauma injuries, with lower limb trauma the most frequent injury. A decrease in rescue activity over the winter months was evident. Over 90% of patients had minor or no injuries, with 3.2% fatalities. While a small cohort, medical emergencies were similar to those described in the USA and Canada, with cardiac emergencies and drug overdoses most prevalent. The most common rescue technique used was a stretcher extraction by hoist (50.4%), with the use of a harness-style extraction by hoist in 40.8%. Of note, there were no advanced medical procedures performed during extraction, with intravenous fluid administration, analgesia and oxygen administration the most common medical interventions. Aligned with other international data, no medical intervention was performed in 39.2% of patients and the trauma prevalence and injury severity is consistent with those reported in the Canadian and North American systems. The proportion of critically injured patients was lower than that reported in alpine settings, which may result from different study criteria in literature or differing dispatch criteria. (43)

Contrasting to Meadley et al. (11), a retrospective review of 255 HEMS search and rescue cases in the greater Sydney area by Sherren et al. (1) argues that physicians are required for HEMS search and rescue mission to optimize patient care and outcome. Within the 120 cases described where a physician was hoisted, 63 patients required skills outside of the scope of paramedical practice in the state, with a median scene time of 45 minutes. Of the cases
described requiring physician attendance, skills performed outside the scope of paramedics registered under the Victoria state in Australia included the relocation of joints under procedural sedation, local nerve blocks and blood transfusion. The incidence of advanced airway management before extraction was 7.9%, including a surgical airway, which is far greater than that described by Meadley et al. (11) The service operates 24 hours using twin-engine helicopters. In Victoria and the Greater Sydney area, 78 - 85% of patients were male with median ages of 38 and 37 years and had sustained trauma.

Asia

Wang et al. (92) described 186 mountain rescues, including 14 involving HEMS rescue, in a retrospective review in Yu-Shan National Park, Taiwan, from 1985-2007. Temporal peaks in rescue activity in autumn are presented. Trauma was the most common reason for medical rescue and cause of mortality, with other medical reasons for rescue commonly including altitude-related illness. Crewing consisted of a technician and one prehospital care provider. No rescue techniques were described.

Examining the collaborative efforts of a firefighter rescue helicopter for patient rescue with a physician-staffed HEMS aircraft for medical care after rescue, Ohsaka et al. (92) described the rescue of 9 patients in Japan. The use of non-medical rescuers extracting patients to hand over to medical personnel for emergency care and transport was described, with seven of the nine patients having sustained traumatic injuries with one fatality. Rescue techniques are not described.

Nepal is categorized as a lower middle-income country and boasts the world's highest mountain peaks, attracting travellers who purchase trekking permits to visit or attempt to summit. Rescue in the region is done in extreme altitude and weather conditions, with the remoteness of the area adding to the medical challenges. In partnership with the ICAR MEDCOM, a unique partnership of developing a HEMS rescue service in a low resource setting was undertaken with extensive training and ongoing development of a support network. (96, 97) Helicopter rescue has been undertaken in the region for several decades, with an estimated required helicopter rescue of 75 persons per 100 000 trekking permits issued with trauma as the most prevalent reason for rescue, followed by altitude-related illness. (98)

There is limited data published on HEMS search and rescue activity in Asia, with data available indicating trauma as the most common presentation requiring rescue in line with international trends. (92, 95, 97, 98)
Technical aspects of HEMS rescue

Medical interventions
Consensus statements from the ICAR MEDCOM concerning standards for medical rescue helicopters and advanced airway management in helicopter rescue include a stated concern of skill attrition amongst clinicians practising wilderness rescue due to the low incidence of critical skills performance, such as endotracheal intubation. (2, 38) The recommendation is that clinicians work in a rotational fashion to diminish skills attrition for critical medical interventions. Intravenous access, oxygen administration and analgesia are the most common medical interventions performed in rescue. (1, 11, 26)

Patient care in the rescue environment presents rescuers with a multitude of challenges, including limited equipment and personnel. There is some suggestion that the usage of helicopters for terrestrial rescue decreases the requirement for analgesia provision through more rapid extraction to definitive care. (75) The provision of analgesia to patients can be challenging, with winchmen in Ireland reporting a perceived limited success in improving pain scores while practising within their scope of practice. (106) Some paramedical scopes of practice, such as in South Africa and Australia, allow advanced life support paramedics to administer analgesics such as ketamine, fentanyl, nitrous oxide and methoxyflurane, which are well suited to analgesia in the prehospital environment. (1, 11, 16, 75, 107) Much of the debate around physician staffing of HEMS rescue includes concern over the provision of analgesia and advanced techniques such as regional nerve blocks, with consideration of prolonged pain due to time to hospital. (1, 2)

Advanced airway management and assisted ventilation in the wilderness setting have a low incidence of 2-13% (38) and yet have been the subject of several studies with small sample sizes. A guidance document published by the ICAR MEDCOM presents practical considerations due to the lack of data for evidence-based recommendations. (38, 78) While endotracheal intubation is the gold standard for advanced airway management in the prehospital setting, it is an especially challenging skill to perform in the wilderness environment. Management of advanced airways and assisted ventilation is especially challenging during helicopter extrication. Challenges in manual ventilation include inaccuracies in ventilation and equipment failure under downwash, while mechanical ventilators risk disconnection from the patient and are heavy and difficult to secure a monitor. (38, 39, 78, 80) Hollot (79) proposed that mechanical ventilation was operationally safer and more reliable than manual ventilation in a manikin study. An important aspect of Hollot's argument is improved situational awareness during extraction using a mechanical ventilator which is vital for safe operations. (39)
Fatality rates in alpine HEMS have been reported between 10-20%, and globally between 0.2 – 30%. (32, 66) Cause of death or cardiac arrest is not well described, which can be attributed to most persons being found deceased, with few dying during rescue operations. (1, 11) Advanced modalities of care for these patients include mechanical CPR devices for prehospital extraction and transport and extracorporeal membrane oxygenation-assisted support. (64, 66)

Crewing

In a consensus for the usage of medical helicopters in terrestrial rescue, ICAR MEDCOM recommended the deployment of doctors for wilderness helicopter rescue. (2) In high-resource settings, it is commonplace for doctors to form part of rescue helicopter teams. Helicopter crewing configurations differ between systems. The usage of doctor (1, 11, 26, 33, 40, 41, 43, 44, 47, 51, 54, 55, 61, 62, 75, 92, 105, 108-111), paramedic (11, 28, 92) and firefighter or non-medical (92) centred helicopter rescue crewing is extensively described in the literature. The weight of physician centred crewing literature stems from high-resource settings, namely Europe (33, 40, 55) and Australia. (1) The proposed importance of physician attendance at HEMS search and rescue incidents is the provision of advanced care such as surgical procedures, endotracheal intubation and expert input and decision making. The crewing of helicopter services significantly impacts the costing of the service. (76)

In an audit of crewing practices for HEMS search and rescue in Europe and America, Brugger et al. (24) showed that over 60% of HEMS operations in Europe are physician-staffed, with 17.8% paramedic staffed. This is in stark contrast with the United States of America (USA) where 59.3% of HEMS search and rescue operations are paramedic staffed, 31.6% have doctor-led teams and 9.1% carry no medical personnel for HEMS rescue. Crew configurations with non-medical rescuers are described in USA and Japan, but data is insufficient to evaluate any effect on patient outcome. (31, 92) In the South African context, with little prehospital availability of doctors, doctor-based teams are unlikely to be sustainable for HEMS rescue. The South African Government published the National Emergency Medical Services Act in 2017, stating that the minimum qualification for a clinician on an aeromedical platform is an Emergency Care Technician – an advanced life support paramedic with a two-year tertiary qualification. (112) South African advanced life support paramedics, namely degree paramedics, can administer a range of analgesics, sedatives and other critical care medication, and perform endotracheal intubation and other lifesaving skills. (16)

Rescue techniques

Helicopter selection for rescue is based on several factors, including cost, helicopter performance, relevant legal requirements, weather and night flying requirements. Many high-income countries use twin-engine helicopters able to fly under instrument conditions when
they are reliant on the navigation systems in inclement weather, reducing visibility or flying at night. (85, 105) Selection of aircraft is also informed by rescue capability requirements: a hoist is added onto a capable airframe in order to perform hoisting and requires servicing as an additional aircraft component. Some services elect to have both hoisting and longline capabilities, as aligned with international recommendations. (12, 28) In some missions, it is possible for helicopters to land at the site of the rescue as the terrain allows, and as such, neither longlining nor hoisting is used. (48, 99) When evaluating the need for hoisting or longline capabilities in helicopter search and rescue operations, considerations for access to the patient using these techniques and the carrying distance or advanced rope rescue required to extricate the patient are the factors considered to demonstrate benefit for helicopter extrication. For the proportion of patients who are ill or injured, rapid access to medical care and definitive care affects morbidity and mortality. (11, 55)

Winching (1, 11, 42, 43, 47, 55, 79, 80) and hoisting (11, 13, 28, 38-40, 50, 77, 80, 85, 89, 113, 114) are terms used to describe the use of a reeled cable mounted outside of the helicopter, operated by a hoistman/winchar or external load operator, to move persons in and out of the helicopter. (11, 13) Hoisting is the most common technique utilized for terrestrial rescue and preferred for larger helicopters and where the load is smaller as the weight limits for hoist machinery is limited to one casualty and one rescuer for most hoists. (13)

Human external cargo (38) (33), static line (26), static rope evacuations (26), short-haul and longline (38) are all terms used to describe the technique of using a long rope attached to the cargo sling of the helicopter to ferry patients and rescuers. The length of the rope is not adjustable. The use of a longline can cause delays in access to a person requiring rescue. Once the rescue site is located, the helicopter must land, attach the longline to the aircraft with the rescue team attached and safe to be ferried to the patient and then fly at low speed to insert the rescuers to the patient. Once ready for evacuation, the reverse is done with the patient attached with the rescuers to the longline. (13) This technique is useful for patients requiring constant medical care, such as those requiring advanced airway interventions, and can be used to move teams of rescuers and patients at the same time, unlike hoisting. This technique for rescue is not well described in the literature, with most operations using hoists. (26, 33)

There are two mechanisms for extraction of patients using hoisting and longline techniques: a rescue stretcher or a seated sling-style device. Rescue stretchers are used for more critical patients or those requiring immobilization, and the sling-style device is for more rapid extrication of those with minor or no injuries. Spinal immobilization is regularly required in patients sustaining trauma in the HEMS search and rescue environment, and the stretcher can be difficult to operate in a confined or sloped space. For patients with minor or no injuries,
a rescue sling or purpose-built, size-adjustable rescue device for patients to be extracted in a seated position is used for rapid extraction. The usage of the sling-style extrication device has previously been shown to affect respiratory function during extrication, with one case study describing a single case of a patient losing consciousness during extrication and falling out of the sling. (77)

Extensive training is required in order to ensure the safe execution of rescue techniques. (33) Advances in rescue techniques are ever evolving to respond to developing rescue requirements. Alpine rescue of avalanche victims requires specialized equipment and techniques, as well as specialized care of the hypothermic and asphyxiated avalanche victim. (99) This is vastly different from the rescue requirements in mountainous areas, which largely involve steep slope rescue. (11, 85)

**Gaps in the literature**

The lack of a standard reporting dataset and language usage in rescue operations and research creates challenges in conducting a comprehensive literature review. The word 'rescue' is used widely internationally to describe air ambulance work, describing the wider clinical activities of helicopter emergency medical services not specific to aquatic and terrestrial rescue activity. In helicopter rescue, multiple terms are used to describe the same rescue techniques with no standard rescue terminology. One such example is the usage of the words' winching' (1, 11, 42, 43, 47, 55, 79, 80) and 'hoisting' (11, 13, 28, 38-40, 50, 77, 80, 85, 89, 113, 114) to describe the same rescue technique. Much of the literature reviewed detailed incomplete records used for reporting as a limitation for data completeness for analysis.

HEMS in the LMIC setting is not well described in the literature. In the South African context, focus on the benefit of HEMS has highlighted areas for further research in dispatch models, with a framework proposed. (23) Further research into patient outcome benefit and dispatch criteria for HEMS search and rescue would further aid evidence-based practice.

There is a paucity of literature on aquatic HEMS search and rescue as well as HEMS search and rescue in some regions with active HEMS rescue programs. Many of the operations conducting HEMS search and rescue are military based, which may be a barrier to publication.

**Conclusions**

Heterogeneous reporting standards and terminology in helicopter search and rescue would assist in creating a more unified literature base. Difficulties in obtaining complete datasets were described widely. Helicopter rescue techniques are not well described in the literature.

The weight of the international literature on HEMS search and rescue represents high-income countries, and yet the characteristics across the systems appear universal. There is a high
proportion of persons who are uninjured and require situational assistance with no medical assistance. The largest proportion of persons requiring medical rescue is adult males who had sustained trauma. The most common clinical interventions were intravenous access, analgesia and oxygen administration.

The use of HEMS for rescue purposes is well described in high-income countries, with a large proportion of literature representing rescue in alpine conditions. The understanding of the rescue operational and epidemiological requirements in the South African and low-resource settings will assist in informing best practise for resource allocation as well as decreasing requirement for rescue through injury prevention and educational interventions.
References


PART B: JOURNAL ARTICLE
Title page

Rescue activity of a civilian helicopter emergency medical service in the Western Cape, South Africa: a five-year retrospective review

Prepared in format ready for submission to Wilderness and Environmental Medicine Journal (WEM):
Rescue activity of a civilian Helicopter Emergency Medical Service in the Western Cape, South Africa: a five-year retrospective review

Abstract

Introduction - Helicopter search and rescue in Africa is conducted primarily by military organizations. Since 2002 the Western Cape of South Africa has had a dedicated contracted civilian helicopter emergency medical service (HEMS) conducting air ambulance, terrestrial and aquatic rescue. This is the first description of the operations of an African helicopter rescue service.

Objective - To describe the terrestrial and aquatic helicopter rescue activity of a civilian operated HEMS in the Western Cape, South Africa from 1 January 2012 – 31 December 2016.

Methods - A five-year retrospective review was conducted using data from the organization's operational database, aviation documents, rescue reports and patient care records. Patient demographics and activity at time of rescue, temporal and geographical distribution, crewing compositions, patient injury, triage, clinical interventions and rescue techniques were analysed.

Results – A total of 581 search and rescue missions were conducted, of which 451 were terrestrial and 130 aquatic rescues. The highest volume of rescues was conducted within the urban Cape Peninsula. Hoisting using a rescue harness was the most common rescue technique used. 644 patients were rescued. Uninjured or minorly injured persons represented 79% of the sample. Trauma (33%, 196/644) was the most common medical reason for rescue, with lower limb trauma predominant (15%, 90/644). The most common clinical interventions performed were intravenous access (108, 24%), spinal immobilization (92, 21%), splinting (76, 17%) and analgesia administration (58, 13%).

Conclusions - The patient demographics and rescue activity described are similar to those described in high-income settings.

Keywords: helicopter rescue, hoist, longline, HEMS, rescue techniques, search and rescue
Rescue activity of a civilian helicopter emergency medical service in the Western Cape, South Africa: a five-year retrospective review

Introduction

The use of helicopters for search and rescue reduces morbidity and mortality by decreasing time to access to emergency medical care and evacuation to an appropriate medical facility. Helicopter rescue systems operate predominately in high-resource settings and have contributed significantly to the capabilities of rescue services in dangerous or inaccessible terrain through rapid patient access, the delivery of appropriately trained personnel and timely transport to medical facilities for the critically ill and injured patient.

In Africa, helicopter emergency medical service (HEMS) search and rescue capabilities are limited and generally conducted by the military. The Western Cape Province of South Africa is the exception, where a civilian operated HEMS, subcontracted by the provincial government, has partnered with volunteer rescue organizations and provincial emergency medical services (EMS) to conduct terrestrial and aquatic rescues since 2002. The subcontracted model includes air ambulance operations, with a focus on rural aeromedical retrieval, as well as rescue operations. In this mixed-service operation, the availability of HEMS must be closely managed to regulate costs and provide maximum benefit to patients and the EMS system. Through an improved understanding of the utilization of the service for search and rescue operations, multiple factors affecting the rescue operations such as budget allocation, equipment, training and personnel requirements can be optimised. This data may also be used for interventions to facilitate injury prevention and public education strategies. Importantly, in this setting, helicopters occupied in search and rescue operations are not available for air ambulance services, and as such, search and rescue dispatch criteria should be evidence-based, as has been developed for HEMS.

The role of helicopter-based rescue service in low resource settings is not yet well described. A better understanding of this service within a resource-constrained public sector could provide insights to other low-middle income (LMIC) settings with an emphasis on the provision of services with equitable benefit. By bringing an external resource into a limited resource setting, such as in rural health systems, aeromedical services do not deplete limited local resources. This is particularly important where highly skilled resources are required or protracted transport times delay the return of potentially limited local resources to their service area.

There is no published data to understand the overall service demand and delivery of an African HEMS search and rescue service. The aim of this study was to describe the helicopter rescue
activity of a civilian operated helicopter emergency medical service in the Western Cape, South Africa.

Methodology

A retrospective descriptive analysis was conducted to describe the search and rescue activities of a civilian operated HEMS in the Western Cape, South Africa, over the five-year period from 1 January 2012 to 31 December 2016. Multiple primary data sources (organizational aviation documents, operational rescue reports and patient care records) were utilized. For the purposes of this study, rescue is defined as a helicopter flight including the search for and/or extrication of persons with medical or situational difficulties in terrestrial (such as mountainous or remote terrain) or aquatic (including sea, river and any expanse of water) terrain.

Data captured for analysis included geographical, temporal, patient, and operational rescue data. Patient data included the age, sex, activity prior/leading to rescue, medical interventions performed, provisional patient diagnosis and disposition. Patient acuity was described using the South African Triage Score (SATS) as used in the Western Cape of South Africa. (17) Red code patients require immediate medical care; orange code patients require urgent care; yellow code patients and green code patients require less urgent medical attention. Critical patients were defined as patients with initial triage of red or orange code, including patients who died during the rescue. Patients triaged as blue describe fatalities. Geographical data included rescue location and terrain. Operational rescue data included crewing composition, medical qualifications and rescue techniques used.

All patients rescued by the SA Red Cross Air Mercy Service (SARC AMS) helicopters during aquatic or terrestrial helicopter rescues in the study period were included. Terrestrial or aquatic helicopter rescues completed by other organizations were excluded, as well as any helicopter rescues outside of the Western Cape Province of South Africa. Service requests for rescue missions where the helicopter did not take off or reach the rescue scene were excluded. When patient data was incomplete, the rescue information was included for analysis but not the patient data.

Univariate descriptive analysis was used to summarize and report on the geographical, temporal, patient and operational rescue data. Means, medians and ranges were used to describe all summarised data. Data were captured using Microsoft Excel (Version 16.22, Microsoft, Washington) and analysed using Microsoft Excel and Tableau Desktop Professional (Version 2019.1.10). Ethical approval was granted by the University of Cape Town’s Human Research Ethics Committee (HREC 296/2017).
Setting
The Western Cape is the southernmost of the nine South African provinces, spanning 129 462km², with approximately 6.2 million inhabitants, the majority of whom are located within the Cape Town Metropole. (118) The province is a popular travel destination for local and international travellers with seasonal influxes of visitors over the summer months from December to February. Table Mountain National Park is an open-access national park within the Cape Town Metropole spanning 212km² from Table Mountain to Cape Point. The park receives an estimated 4 million visitors per annum, including one million summitting Table Mountain via cable car. (5)

The South African Red Cross Air Mercy Service (SARC AMS) is a non-profit organization subcontracted by the Western Cape Department of Health to deliver aeromedical services in the province, including aquatic and terrestrial helicopter rescue and air ambulance operations. The service operates two helicopter bases in the Western Cape – one in Cape Town in the West of the province and one in Oudtshoorn in the East (see Figure 6). Missions are dispatched centrally through a specialised provincial EMS dispatch centre, with authorisation for dispatch of the HEMS for all missions obtained from a core group of medical doctors from provincial EMS management.

The SARC AMS utilizes the single-engine Augusta Westland AW119 helicopter as a rescue platform, with hoisting and longline capabilities. All rescues are conducted under visual flight rules as a single pilot operation with assistance from an external load operator (ELO). Rescues are conducted using mission dependant deployable multi-disciplinary teams from various organizations and with varying medical training. The medical crew include doctors and emergency medical services personnel with qualifications ranging from basic to advanced life support.

Results
Between 1 January 2012 and 31 December 2016, a total of 4998 HEMS missions were conducted by SARC AMS in the Western Cape, of which 581 (12%) were rescue missions (either aquatic or terrestrial) (Table 1). Persons were rescued by helicopter in 410/581 (71%) search and rescue missions. No person was found by any party (ground or HEMS) at the conclusion of 108/581 (19%) search and rescue missions (Figure 1). A successful search with persons extricated by alternative means such as boat or ground crew was the conclusion of 47/581 (8%) of missions undertaken. The mean mission time from take-off to mission completion (i.e., helicopter returned to base) was 2 hours and 15 minutes (range 18 minutes to 9 hours and 29 minutes) for terrestrial rescue and 1 hour and 34 minutes (range 18 minutes – 9 hours and 32 minutes) for aquatic rescue.
Table 1: Aquatic and terrestrial rescue missions per annum

<table>
<thead>
<tr>
<th></th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>Total n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquatic</td>
<td>47</td>
<td>30</td>
<td>18</td>
<td>22</td>
<td>13</td>
<td>130 (22)</td>
</tr>
<tr>
<td>Terrestrial</td>
<td>99</td>
<td>86</td>
<td>80</td>
<td>97</td>
<td>89</td>
<td>451 (78)</td>
</tr>
<tr>
<td>Total</td>
<td>146</td>
<td>116</td>
<td>98</td>
<td>119</td>
<td>102</td>
<td>581 (100)</td>
</tr>
</tbody>
</table>

Figure 1: Rescue missions and patient extraction techniques utilised

Rescue activity overall did not increase per annum over the five-year sample though aquatic rescue activity decreased. (Table 1). A seasonal surge in rescue activity was evident in the summer months, with 42% (245/581) of rescues conducted between December and February (Figure 2). A peak in rescue activity was evident between 13:00 and 18:00 (Figure 3) and on weekends (266/581, 45%, figure 4).
**Figure 2**: Temporal distribution of rescue activity

**Figure 3**: Time of helicopter departure for rescue

**Figure 4**: Number of rescues per day of the week
The highest medical qualification of the personnel deployed to the patient during rescue was a doctor in 15/581 (3%), an advanced life support paramedic in 414/581 (71%), an intermediate life support practitioner in 120/581 (21%). In 4% (22/581) of missions, only a non-medical technical rescuer or rescue swimmer was deployed.

Rescues around the Cape Metropole accounted for 66% (299/451) of terrestrial rescue, with 50% (226/451) of all terrestrial rescue occurring in Table Mountain National Park (TMNP) (Figure 5, 6). Nearly half of all rescue activity within TMNP was conducted on the popular hiking trails Platteklip Gorge (74, 25%), Lions Head (47, 16%) and India Venster (14, 5%) on Table Mountain (Figure 6). Dehydration or heat-related illness was the primary reason for rescue in 14% of patients rescued from Table Mountain National Park.

![Map of rescue activity over five years by municipal district in the Western Cape](image)

**Figure 5:** Map of rescue activity over five years by municipal district in the Western Cape

Patients were rescued using the helicopter in 14% (18/130) of aquatic search and rescue missions undertaken, with 54% (70/130) of missions resulting in unsuccessful searches with no patient found (Figure 1). There was patient contact by the HEMS crew in 41 (32%) of total aquatic rescue cases, of which 50% (20/41) were fatalities.
During the period, 644 persons required rescue. Patient details were available for 600 patients (93%); thus, 44 patients were excluded from analysis for diagnosis, triage and intervention. Adult patients (≥18 years) comprised 93% of the sample (551/600). For those with a recorded sex and age, 61% were male (213/352) with a median age of 40 years (IQR 19–85) for both sexes. The median age for adolescent patients (aged 13–18 years) was 16 (27/32, IQR 13–18). Paediatric patients (age 1–12 years) represented 2% of the sample (11/600) with a median age of 7.5 years (8/11, IQR 3–11). Hiking and swimming were the most frequent activities, accounting for 429/600 (71%) and 40/600 (7%), respectively. Single patient rescues accounted for 60% (354/581) of all rescue missions, with multiple persons rescued in 14%. More than 3 persons were rescued in 6% of rescues undertaken, with all persons uninjured in rescues involving 6-20 patients.

Figure 6: Heat map of performed rescues in the Cape Peninsula
Uninjured and less urgent patients (triage green and yellow) comprised 79% of the sample, received the fewest interventions and were least likely to receive further care (Table 2). Medical assistance was required for 343 patients (57%), of which 230 (60%) were transported to hospital for further care: 73 by helicopter and 157 by ground ambulance. Patient care records were available for 35% (119/343) of patients treated. Patient care records were not available for 41% (19/45) of patients who were triaged as red code.

Lower limb trauma, dehydration and spinal injury were the most common diagnosis (Table 2). Polytrauma patients comprised 7% (40/600) of all patients and accounted for 38% of critical patients (22/58) triaged orange or red code.

Table 2: Patient diagnosis and triage

<table>
<thead>
<tr>
<th>Category n (%)</th>
<th>Diagnosis</th>
<th>Red</th>
<th>Orange</th>
<th>Yellow</th>
<th>Green</th>
<th>Blue a</th>
<th>Total n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uninjured 257 (43%)</td>
<td></td>
<td>257</td>
<td>257</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deceased 53 (9%)</td>
<td>Unknown cause</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>53 (9)</td>
</tr>
<tr>
<td>Medical 88 (15%)</td>
<td>Dehydration</td>
<td>1</td>
<td>21</td>
<td>17</td>
<td></td>
<td></td>
<td>39 (7)</td>
</tr>
<tr>
<td></td>
<td>Heat-related illness</td>
<td>5</td>
<td>10</td>
<td>6</td>
<td></td>
<td></td>
<td>21 (4)</td>
</tr>
<tr>
<td></td>
<td>Seizures</td>
<td>4</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>6 (1)</td>
</tr>
<tr>
<td></td>
<td>Drowning</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td>2</td>
<td>6 (1)</td>
</tr>
<tr>
<td></td>
<td>Chest pain</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
<td>5</td>
<td>1 (1)</td>
</tr>
<tr>
<td></td>
<td>Envenomation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>3 (0)</td>
</tr>
<tr>
<td></td>
<td>Hypothermia</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td>3 (0)</td>
</tr>
<tr>
<td></td>
<td>Miscellaneous b</td>
<td>2</td>
<td>2</td>
<td></td>
<td>1</td>
<td></td>
<td>5 (1)</td>
</tr>
<tr>
<td>Trauma 196 (33%)</td>
<td>Trauma - lower limb</td>
<td>3</td>
<td>4</td>
<td>77</td>
<td>6</td>
<td></td>
<td>90 (15)</td>
</tr>
<tr>
<td></td>
<td>Polytrauma</td>
<td>19</td>
<td>3</td>
<td>13</td>
<td>5</td>
<td></td>
<td>40 (7)</td>
</tr>
<tr>
<td></td>
<td>Spinal injury</td>
<td>1</td>
<td>3</td>
<td>25</td>
<td></td>
<td></td>
<td>29 (5)</td>
</tr>
<tr>
<td></td>
<td>Head injury</td>
<td>4</td>
<td>7</td>
<td>2</td>
<td></td>
<td></td>
<td>13 (2)</td>
</tr>
<tr>
<td></td>
<td>Trauma - upper limb</td>
<td>2</td>
<td>8</td>
<td>1</td>
<td></td>
<td></td>
<td>11 (2)</td>
</tr>
<tr>
<td></td>
<td>Unspecified</td>
<td>2</td>
<td></td>
<td>1</td>
<td>4</td>
<td></td>
<td>7 (1)</td>
</tr>
<tr>
<td></td>
<td>Soft tissue injury</td>
<td></td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td>4 (1)</td>
</tr>
<tr>
<td></td>
<td>Trauma - chest</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td>2 (0)</td>
</tr>
<tr>
<td>Total n (%)</td>
<td>46 (8%)</td>
<td>12 (2%)</td>
<td>178 (30%)</td>
<td>294 (49%)</td>
<td>64 (11%)</td>
<td>594 c</td>
<td></td>
</tr>
</tbody>
</table>

a Deceased persons;
b Includes abdominal pain, anaphylaxis, overdose (unknown substance), shortness of breath and syncope;
c Six patients with no triage or diagnosis documented were excluded from the table
Table 3: Most frequent clinical interventions performed

<table>
<thead>
<tr>
<th>Intervention</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intravenous access</td>
<td>108 (24)</td>
</tr>
<tr>
<td>Spinal immobilization</td>
<td>92 (21)</td>
</tr>
<tr>
<td>Splint</td>
<td>76 (17)</td>
</tr>
<tr>
<td>Analgesia</td>
<td>58 (13)</td>
</tr>
<tr>
<td>Oxygen</td>
<td>37 (8)</td>
</tr>
<tr>
<td>Assisted ventilation</td>
<td>13 (3)</td>
</tr>
<tr>
<td>Medication administration</td>
<td>13 (3)</td>
</tr>
<tr>
<td>Other b</td>
<td>12 (3)</td>
</tr>
<tr>
<td>Sedation</td>
<td>10 (2)</td>
</tr>
<tr>
<td>Endotracheal intubation</td>
<td>10 (2)</td>
</tr>
<tr>
<td>Oral fluid</td>
<td>8 (2)</td>
</tr>
<tr>
<td>Cardiopulmonary resuscitation</td>
<td>7 (2)</td>
</tr>
<tr>
<td>Total</td>
<td>444</td>
</tr>
</tbody>
</table>

*Some patients required multiple interventions.*

*Warming, cooling, dextrose administration, intra-osseous access and needle thoracentesis*

A total of 444 medical interventions were performed on 230 of the 343 patients requiring medical assistance (Table 3). The most common interventions were intravenous access, spinal immobilization and splinting of limbs (Table 3). Trauma patients required 77% (340/444) of all interventions. Critical patients (58/600, 10%), defined as patients who triage orange or red, required 189/444 (43%) interventions, including endotracheal intubation, assisted ventilation, sedation, drug administration, intra-osseous access and needle thoracentesis. Medications administered included sedatives, cardiac drugs, analgesics, dextrose, antemetics and inotropes. Return of spontaneous circulation was achieved in three of seven attempted resuscitations, including two children who were successfully resuscitated after drowning. The median number of interventions during cardiopulmonary resuscitation was 6 (range 6-8).

There were 64 bodies recovered, with hiking (26/64, 41%), swimming (10/64, 16%) and fishing (4/64, 6%) accounting for the most activity amongst this subset. On arrival of rescue personnel, 60/64 (94%) were deceased on first contact, and four patients died during the rescue.

Discussion

This data suggests that the search and rescue operations of a civilian operated HEMS in the Western Cape of South Africa are comparable to rescue operations described in the international literature, most of which are in high-income settings. Temporal peaks, rescue techniques, crewing configurations, and common patient presentations are similar to high-income countries across Europe, North America and Australia. In this mixed-use aeromedical
model, the utilisation of HEMS for rescue represented 12% of all missions undertaken, which is comparable to other mixed-model operations with similar crewing configurations. (11, 62)

The Western Cape is a popular tourist destination for local and international visitors during summer periods which correlates with the increase in rescue activity. Popular travel destinations in Europe, North America and Asia have reported similar temporal trends in HEMS rescues. (90, 91, 98, 99) The increase in rescue demands over weekends and afternoons further demonstrates the largely recreational activities, such as hiking and running, requiring rescue efforts.

Helicopter search and rescue epidemiology globally demonstrates two predominant groups of persons requiring rescue: uninjured persons and those who have sustained trauma. (26, 85, 86, 89-91, 95). Over 40% of persons rescued in this study were uninjured and required situational assistance due to inaccessibility, as reported in other HEMS search and rescue (SAR) operations. (11, 84, 85, 91) In Australia, persons with minor or no injuries have been reported to constitute 90% of HEMS SAR missions. (11) For these circumstances, usage of a helicopter is ideal for rescue, with timeous rescue preventing further harm and limiting risk for both patients and rescuers. (116) Male adult patients who had sustained trauma were found to be the most common group requiring rescue, which aligns with trends in international systems. (32, 90, 91, 95, 96) In Canada, Europe, Australia, Nepal, Taiwan and the United States of America, male patients sustaining minor trauma comprise a large proportion of rescues. (1, 11, 32, 84, 85, 87, 90, 91, 95, 119) The proportion has been reported as high as 78% of all persons rescued. (32) The substantial proportion with potentially preventable causes for rescue, such as dehydration and heat-related illness on popular hiking trails and beaches where drowning commonly occurs, provide areas of focus for injury prevention strategies.

The data highlighted several high-risk areas where frequent helicopter rescues occur, which can inform injury prevention strategies. Most terrestrial rescues occurred on popular hiking trails and tourist destinations in the Table Mountain National Park. Two hiking trails in Table Mountain National Park, namely Platteklip Gorge and Lions Head, accounted for one-quarter of all terrestrial rescues undertaken in the province, with the predominant reasons for rescue including dehydration and heat-related illness. One in ten patients in the Western Cape required rescue for dehydration or heat-related illness, some of which were critically ill and required advanced life support intervention. Interventions, such as signage and public awareness campaigns, would seem to be viable prevention strategies.

Drowning is a significant cause of unintentional death in South Africa, especially amongst children under the age of 15, with no national drowning prevention strategy in place. (10) In
the Western Cape, 42% of fatal drownings occur during the peak summer period, consistent with the increased aquatic rescue activity. (120) The high incidence of drowning around the coastline of the Cape Town metropole as well as increases in drowning over weekends aligns with findings in the provincial Drowning Prevention Framework. (10). While helicopters have been shown to be effective in aquatic search and rescue and are used extensively in both military and civilian settings, patients were rescued by helicopter in only a small proportion of aquatic rescue missions in the Western Cape. (101) The factors affecting the aquatic rescue success may include the time between incident occurrence and request for assistance and response time to the scene. These factors require further investigation to optimise resource utilization and benefit. During aquatic rescue, the multi-agency approach was evident in boat and ground crew patient extractions following helicopter location of the patient.

The rescue configuration and standard crewing of the SARC AMS meets international helicopter medical rescue recommendations. (121) While many international systems use doctors for HEMS rescue, the availability of doctors in the pre-hospital setting in South Africa is limited. The most common medical interventions performed in HEMS SAR include analgesia, intravenous fluid administration and oxygen administration in international HEMS rescue (1, 11, 116) with splinting and spinal immobilisation also frequently performed in the Western Cape. Critical care interventions, such as endotracheal intubation, are uncommon in the HEMS rescue setting. (122) Advanced life support paramedics were most commonly utilised as the primary medical provider in this setting and would seem to be appropriate, given that they are able to perform all common interventions as well as critical care interventions. (123)

Patients with an initial red triage, including four in-care deaths during rescue, comprised 10% of the sample and required more clinical interventions than the other triage groups. Nearly half of red triage patients sustained significant polytrauma requiring advanced life support interventions. While critical advanced life support skills such as advanced airway management are infrequently performed in the rescue environment before extraction, these skills are important to prevent further morbidity and reduce mortality. (78) International guidelines on the determination of death in the wilderness environment detail the difficulties experienced in patient examination, access, poor patient history and access to cardiac monitoring. (124)

Multi-patient incidents accounted for 14% of rescues, and although not as frequent as single patient rescues, multi-patient rescues of more than three persons pose significant logistical and operational challenges for rescue personnel, including carrying limited equipment for extrication. It is of note that the large multi-patient rescues undertaken in this sample were largely uninjured and required primarily situational assistance. Helicopters are beneficial for
multi-patient incidents and can be used to both deploy extra assistance at the scene and evacuate patients. (61)

The SARC AMS HEMS operation serves as a rescue platform and an aeromedical service, performing inter-facility transfers and primary emergency scenes and servicing a vast low-resource rural population. The selection of cases for dispatch of this resource must be considered in the light of beneficence, and further research is required to describe the case-mix of the operation. Rescue missions may require several hours of dedicated time, limiting the availability of the resource for medical missions. While some data describes no trauma mortality benefit for the use of HEMS in the South African setting, (21) further research into dispatch criteria and benefit in the rescue setting are needed.

Limitations

Only search and rescue missions conducted utilizing the SARC AMS helicopters were described, with the exclusion of the South African Airforce and any ground rescue operations. The South African Air Force (SAAF) performed only ten terrestrial helicopter rescues during the sample period, which were not included in this research. (117) This research represents the activity of a single civilian operated service providing both aeromedical and rescue services in a state service within a single province with unique and varied geography, which may limit applicability to other settings.

Data was limited by the consistency of the records kept and the availability of records, particularly patient care records, as is widely reported in the search and rescue literature. (11, 90, 91, 95) Clinical information was limited by the availability of the records, with missing records possibly due to patients being handed over to EMS staff for transport or further treatment. A focus on improved record-keeping would better inform future research, with emphasis on clinical record keeping.

As the research was retrospective, the data set was not designed for the purpose of this research. Records were captured as found, with incomplete data detailed in the results. Challenges in data capture included incompleteness of records and records being kept in different sites in the organisation, prolonging the time period required for data capturing due to travel.

Conclusions

The epidemiology of patients rescued, including the prevalence of male patients, uninjured persons and a high burden of trauma, is similar to that described in high-income settings.

Through improved understanding of the search and rescue operations of the SARC AMS, dispatch criteria for rescue can inform beneficent and fair utilization of resources in a mixed-
model aeromedical and rescue HEMS operation in a resource-constrained pre-hospital setting.

Contributions
JPR completed all data collection, completed the data analysis and drafted the manuscript.

IH and PH provided oversight over the data collection and analysis process and reviewed and provided input on the manuscript.

Acknowledgements
Wayne Smith provided invaluable insight into the writing of this manuscript.

Disclosures
The authors have no interests to disclose. The research was self-funded by JPR.

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1. Isakov A. Urgent air-medical transport: Right patient, place and time. CMAJ. 2009;181(9):569-70.


PART C: ADDENDA
Appendix A: Relevant journal Instructions to Authors

Instructions to authors from the selected journal, Wilderness and Environmental Medicine (WEM):

https://www.wemjournal.org/content/authorinfo
Appendix B: Acknowledgements

Thank you to my supervisors, Peter Hodkinson and Ian Howard, for their support through the challenges of finishing this dissertation.

Thank you to Ashwin Krishna for the opportunities you gave me and the endless advice.
Appendix C: Research Protocol

Rescue activity of a civilian Helicopter Emergency Medical Service in the Western Cape, South Africa: a five-year retrospective review

Abstract

Internationally, emergency medical service helicopters may conduct terrestrial and aquatic search and rescue as appropriate. The SA Red Cross Air Mercy Service, contracted to the Western Cape of South Africa Department of Health, provides a helicopter emergency medical service in the Western Cape. The service includes aeromedical retrieval and aquatic and terrestrial rescue in conjunction with various interdisciplinary teams from various agencies. This research will describe the terrestrial and aquatic rescue activity of the service between 1 January 2012 and 31 December 2016. This research is the first analysis of the data.

Background

In the Western Cape Province of South Africa, the SA Red Cross Air Mercy Service (SARC AMS) is contracted to the Western Cape Provincial Department of Health for the provision of helicopter emergency medical services (HEMS). As part of the contract, the AMS provides terrestrial and aquatic rescue services in conjunction with various interdisciplinary teams from multiple agencies, including: Lifesaving South Africa, the National Sea Rescue Institute (NSRI), Wilderness Search and Rescue (WSAR), and the Provincial Government of the Western Cape Emergency Medical Services. The SARC AMS operates two helicopters in the province, based in Cape Town and Oudtshoorn respectively. Rescue operations employ a combination of both hoisting and longline techniques for rescue team insertion and team/patient extraction, a configuration in use since 2006.

The contracted services offered by the SA Red Cross Air Mercy Service HEMS in the Western Cape of South Africa include aeromedical retrieval as well as aquatic and terrestrial search and rescue. It is for this reason that the service being delivered must be informed by use. Through a better understanding of the utilization, multiple factors affecting the rescue operations such as budget allocation, equipment and personnel requirements, information feedback into public education strategies etc. can all be optimized.

Literature Review

Search and Rescue operations are conducted globally by civilian helicopter emergency medical services (HEMS), utilizing both hoisting and longlining techniques. (1-4) Search and rescue in the aeromedical setting are both costly and time-consuming, and may limit the availability of the aircraft for medical responses in a dual role (medical and rescue) model such as that used by the SA Red Cross Air Mercy Service in the Western Cape. (1)
There is consensus that HEMS needs to be well integrated into the pre-hospital system for early and rapid dispatch in cases of terrestrial rescue. (1) Staffing of the HEMS varies between services and countries, but most include a physician and paramedic or nurse. (2, 4, 5)

Much of European HEMS terrestrial search and rescue missions involve avalanche or alpine skiing accidents, with literature focusing on the advanced level care required for avalanche victims but there is little snow or alpine skiing in the Western Cape of South Africa. (1, 6)

Drowning is one of the top five causes of death in children in South Africa, with no national drowning prevention strategy and there is as yet no literature in South Africa about the role of HEMS in aquatic rescue. (7)

Research question

What is the rescue activity of a civilian operated helicopter emergency medical service in the Western Cape, South Africa from January 2012 to December 2016?

Research Aim

To describe the terrestrial and aquatic helicopter rescue activity of a civilian operated helicopter emergency medical service in the Western Cape, South Africa from January 2012 to December 2016.

Research Objectives

To describe the geographical and temporal distribution of rescue missions.

To describe the operational allocation of resources during rescue missions.

To describe the type and severity of injuries and illnesses requiring rescue.

To describe the rescue techniques and medical interventions commonly performed during helicopter rescue missions.

Methodology

A retrospective review of terrestrial and aquatic helicopter rescue activity of a civilian operated HEMS in the Western Cape, South Africa from January 2012 to December 2016 will be conducted. The expected sample size over the five-year period chosen is approximately 500 rescues for analysis.

The SA Red Cross AMS operational database is a comprehensive electronic database maintained by the organization to document all aircraft and patient treatment activity conducted by the service. The SA Red Cross Air Mercy Service database has been operational since 2010. All operational employees and managers of the organisation have access to the database through a personalized user name and password.
In the case of helicopter rescue, the data is logged onto the database by the medical personnel who completed the helicopter mission as soon as practical after the mission, and checked by the flight coordinators of the SA Red Cross Air Mercy Service National Operations Centre. The data logged for a rescue mission include a ‘service request’, ‘mission’, ‘rescue report’ and ‘patient’. Patient details are not logged onto the database unless the patient was transported by helicopter to hospital, and as such the patient data (such as medical interventions) will be captured from the original patient report form which is kept in paper copy in the archives.

Study Design

A retrospective descriptive review using data from the SA Red Cross Air Mercy Service operational digital database and data captured from paper patient records, flight folios and written rescue reports where needed.

Characteristics of study population

Patients included in this study will include all patients rescued by the SA Red Cross Air Mercy Service helicopters during aquatic or terrestrial helicopter rescues between 01 January 2012 and 31 December 2016 in the Western Cape of South Africa.

Inclusion criteria:

All terrestrial and aquatic rescue missions serviced by the SA Red Cross Air Mercy Service helicopters between 01 January 2012 and 31 December 2016 in the Western Cape of South Africa as classified by AMS operational database.

All rescue missions will be included with or without complete patient data or no patient treated.

Exclusion criteria

- Any terrestrial or aquatic helicopter rescues completed by any organisation other than the SA Red Cross Air Mercy Service, such as the South African Air Force.
- Any terrestrial or aquatic helicopter rescues completed by the SA Red Cross Air Mercy Service outside of the Western Cape of South Africa.
- Service requests for rescue missions which do not include flying time.

No patients will be identifiable. Rescues will not be excluded even if there is no patient report form for the patient. As interventions and medical treatment are not documented in the database, all data on the database will be checked against the paper originals as the data is captured from the patient report form.
Research Procedure and data collection methodology

Relevant data will be extracted from the SA Red Cross Air Mercy Service operational database and onto a data extraction form, which will be tabulated into a Microsoft Excel document. Patient data will be extracted from the paper patient records, paper rescue report and flight folio. The paper records for every rescue include the flight folio and a written rescue report, and a patient record where applicable. The flight folio is completed by the pilot and includes the flying and mission time, as well as the insertion and extraction methods. The written rescue report contains the same information as that which is logged on the electronic database and can be used for data checking where needed. As patients are only logged onto the database if transferred to hospital via helicopter from scene, data collection of patient details such as medical interventions done on scene and diagnosis will be done from the original paper copies stored in archives at Cape Town and Oudtshoorn bases respectively. All data extraction and data capturing from paper originals will be done by the principal investigator. The data capturing process will involve:

- Identifying included patients from the electronic database.
- Drawing the paper patient records from the archives.
- Capturing relevant data into spreadsheet.

As archives are based at the Cape Town and Oudtshoorn base, data capture will involve travel to Oudtshoorn for data collection.

For the instances in which there is no patient record available, a list of patient records missing will be communicated to the SA Red Cross Air Mercy Service Western Cape Regional manager for follow up with other departments such as finance who may have stored the records in their archives.
Data safety and monitoring

The data will be kept in a password-protected file on a password-protected computer accessible only to the principal investigator. No paper copies will be kept. The electronic data will be kept for a period of five years. Data will be backed-up into a password protected Dropbox folder.

All primary data sources will be anonymized. No patients will be identifiable in the data.

Data Analysis

The data gathered will be subjected to descriptive analysis using standard procedures. Data will be presented as numbers, means, medians and standard deviations as appropriate. Microsoft Excel will be used for data capturing and analyses.

For mapping of rescues, the database will classify areas such as ‘Table Mountain’ which will be used for analyses.

Ethical considerations

This research will be conducted in compliance with the Declaration of Helsinki 2013 and can be categorised as minimal-risk research. All patients will be anonymous as no specific identifying data will be recorded. Confidentiality will be ensured and no information will be disclosed. All data will be secure and password protected. Only the principal investigator and supervisors will have access to the raw data. There is no foreseeable risk or danger to participants, as confidentiality will be ensured.

Ethical approval will be sought from the Human Research Ethics Committee (HREC) of the University of Cape Town.
The researcher, Ms. Park-Ross, is an employee of the SA Red Cross Air Mercy Service. Data will be published regardless of the findings.

Written approval from the SA Red Cross Air Mercy Service will be sought through the organisations Research Committee. The researcher is a member of said committee, and will excuse herself from the meeting while her research is considered for approval.

After approval by the EMDRC, provisional acceptance from the SA Red Cross Air Mercy Service will be sought pending HREC.

The research will be self-funded by the principal investigator.

**Risks and benefit and limitations**

As this is a first analysis of civilian helicopter rescue in South Africa, as well as a first for the SA Red Cross Air Mercy Service and Provincial Government of the Western Cape, there is great benefit in creating a better understanding of the current operations. A better understanding of needs and challenges can be used to improve the efficiency of the service.

The risk to the SA Red Cross Air Mercy Service is the description of the terrestrial and aquatic rescue programs may bring criticism of their performance, but as the organisation upholds a strong Just Culture (8), this research can be used to engage stakeholders such as partner organisations in order to encourage positive and collaborative discussion about the findings. This research is focusing only on the aquatic and terrestrial rescue by the SA Red Cross Air Mercy Service as a civilian operation, and as such is excluding the helicopter rescues completed by the South Africa Air Force and any other helicopter operators. This is partially done as the SA Red Cross Air Mercy Service is the biggest helicopter rescue operation in the province, and also because data for the other operations would be difficult to gather. The record keeping at the SA Red Cross Air Mercy Service is stringent, and thus likely to provide complete data.

With reference specifically to the South African Air Force helicopter rescues, there are different criteria for which the aircrafts are used due to their abilities. The helicopters used by the South African Air Force are larger and more advanced machines, and thus are legally allowed to operate in conditions in which the helicopters used by the SA Red Cross Air Mercy Service are not. This means there is little overlap in the services as the criteria for usage of each aircraft is vastly different: the South African Air Force is used only in conditions, such as at night, where the SA Red Cross Air Mercy Service cannot service. For these reasons, the South African Air Force completed only eleven terrestrial rescues during the five-year research period, and the records would be difficult to access as the permission procedure to access the records would be lengthy. (9)
The Mountain Club of South Africa (MCSA) volunteers maintain an open access database of all mountain rescues. (10) As the SA Red Cross Air Mercy Service database captures more detail and the data captured is checked rigorously, the researcher has elected not to use the MCSA database as there is not sufficient need.

The researcher is an employee of the SA Red Cross Air Mercy Service and as such recognizes the potential for organizational bias, which is mitigated through the organisations open working culture and promotion of a just culture in the workplace.

The quality of the data is limited by the database completeness and quality, as well as the availability and completeness of the paper patient records. As patients who are not flown to hospital are not logged onto the electronic database, the details of the patient and their treatment being available to the researcher relies mainly on the availability and completeness of the patient record and written rescue report. Should the documents not be available, the patient’s diagnosis and some demographic details are likely to be recorded in the ‘Service Request’, ‘Rescue Report’ and ‘Mission’. Patient reports are more likely to be available in the event of a critical patient in which medical intervention and advanced care was required.

**Dissemination of findings**

The findings will be written up into the format of a journal article and will be published in a suitable journal such as Journal of Wilderness and Environmental Medicine. The journal is open access.

The findings of the research will be reported to relevant stakeholders, including the SA Red Cross Air Mercy Service and the Western Cape Provincial Government Emergency Medical Services. The report to stakeholders can be used to identify areas in which more training of personnel is required and areas that could be targeted for injury prevention strategies.

An analysis of the data will be presented at an appropriate conference, either in the format of a poster or oral presentation.

**Resources utilization**

The study is self funded by the researcher, and will as such be limited by funds. As the SA Red Cross Air Mercy Service database is used as part of the daily operations, and there is no cost to the organisation.
References

5. Ausserer J, al. e. Physician staffed helicopter emergency medical systems can provide advanced trauma life support in mountainous and remote areas. Int J Care Injured 2016.
Appendix D: HREC approval letter

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

Room EE3-26 Old Main Building
Groote Schuur Hospital
Observatory 7935
Telephone (021) 650 6626
Email: rod lampie@uct.ac.za
Website: www.health.uct.ac.za/fhs/research/humanethics/forms

22 May 2017

HREC REF: 296/2017

Prof P Hodkinson
C/o Ms A Maas
Emergency Medicine
FS1
Old Main Building

Dear Prof Hodkinson

PROJECT TITLE: RESCUE ACTIVITY OF A CIVILIAN HELICOPTER EMERGENCY MEDICAL
SERVICE IN THE WESTERN CAPE, SOUTH AFRICA: A FIVE-YEAR RETROSPECTIVE REVIEW
(M.Phil.-candidate J Park-Ross)

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics
Committee 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 30th May 2018.

Please submit a progress form, using the standardised Annual Report Form if the study continues
beyond the approval period. Please submit a Standard Closure Form if the study is completed within
the approval period.

(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

We acknowledge that the following student will be involved in this study: J Park-Ross.

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

Please quote the HREC REF in all your correspondence.

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

Yours sincerely

Signature Removed
Appendix E: AMS letter

28 March 2017

Dear Jocelyn Park-Ross

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.

Thank You

Yours faithfully

Signature Removed

Gary Mc Cormick
Quality & Technical Manager

Fax: (+27) 86 554 6313
E-mail: gary@ams.org.za
## Appendix F: TurnItIn Report

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"Comparison of mean on-scene times: road versus air transportation of critically ill patients in the Western Cape of South Africa", Emergency Medicine Journal, 2008