

**DEVELOPING CALL-OUT CRITERIA FOR SOUTH AFRICAN
HELICOPTER EMERGENCY MEDICAL SERVICES: A DELPHI STUDY**

BY

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(BTech: EMC)

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DEDICATION

- My parents, for always believing in me and never letting me give up despite my many attempts!
- Garth, for supporting and carrying me through every step of this masters, and for making me promise to push through to the end!
- Willem and Tyson, for supporting and helping me through the entire process.
- My friends and family, for putting up with me through my emotional turmoil.

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LIST OF ABBREVIATIONS

AAEM: American Academy of Emergency Medicine

ACEP: American College of Emergency Physicians

ALS: Advanced Life Support

AMI: Acute Myocardial Infarction

AMPA: Air Medical Physicians Association

AMPT: Air Medical Pre-Hospital Triage

ARR: Absolute Risk Reduction

CCL: Cardiac Catheterization Laboratory

CI: Confidence Interval

DALY: Disability Adjusted Life Years

ECG: Electrocardiogram

EMS: Emergency Medical Services

GCS: Glasgow Coma Scale

GEMS: Ground Emergency Medical Services

HEMS: Helicopter Emergency Medical Services

IHT: Inter-Hospital Transfer

IQR: Interquartile Rate

ISS: Injury Severity Score

LMIC: Low and Middle-Income Countries

MO: Medical Officer

MOI: Mechanism of Injury

MVA: Motor Vehicle Accident

NAEMSP: The National Association of State EMS Physicians

NTTP: National Trauma Triage Score

OR: Odds Ratio

pPCI: Primary Percutaneous Coronary Intervention

PPV: Positive Predictive Value

QALY: Quality Adjusted Life Years

rtPA: Tissue Plasminogen Activator

RTS: Rapid Trauma Score

SMR: Standardized Mortality Ratio/Rate

STEMI: ST-elevation Myocardial Infarction

TRISS: Trauma Injury Severity Score

PART A: BACKGROUND AND LITERATURE REVIEW

1.1 Background

The European Society of Emergency Medicine has defined Emergency Medicine as a speciality aimed at prevention, diagnosis and management of any person requiring critical and urgent interventions for various medical conditions or traumatic injuries.(1) Emergency Medicine involves triage, primary assessment, stabilization and management of any medical emergency and is a speciality dependant on timely initiation of treatment or care.(2) In South Africa, according to the Western Cape regulations governing ambulance services, "Emergency Care" is defined as the rescuing of patients; assessment, treatment and care of any sick or wounded individual, as well as continuous management of patients throughout transportation to an appropriate healthcare facility.(3)

The delivery of healthcare to populations worldwide is essential in the prevention and treatment of any medical ailments. It is every citizen's right to be able to have access to healthcare for both acute and chronic medical conditions.(4) At the forefront of the healthcare system are the emergency medical services (EMS). They are the first contact many patients will have when seeking medical attention.(1) The EMS provide the initial medical treatment and transportation to the appropriate healthcare facility. The patients' outcome is largely influenced by the quality of medical attention given in the pre-hospital phase.(1) This is determined by the quality of care administered by the medical professional, the time to the delivery of initial treatment and transportation to definitive care.(5)

Helicopter Emergency Medical Services (HEMS) were first introduced in the Second World War when helicopters were used to transport injured soldiers off the battlefield to hospitals.(6) Injured soldiers were in areas that were far from medical facilities and at best, the roads to access them were in a poor state. These conditions significantly increased transport times and negatively impacted morbidity and mortality rates(6)

During the Korean (1950-1955) and the Vietnamese War (1965-1969), helicopters were utilised more frequently as their advantages over traditional ground transport were fully acknowledged.(6)

In 1972, HEMS was first introduced in the civilian setting in the United States, and has since remained an important part of civilian emergency medical care systems.(7)

In addition to being able to access generally less accessible areas, helicopters enable pre-hospital care providers to reach scenes at higher velocities, allowing patients to receive emergency medical assistance sooner. Additional to this, patients can be transported rapidly from scene to specialist facilities, bypassing inappropriate facilities. HEMS enables shorter pre-hospital times, as well as a more comfortable and convenient mode of transport.(6) Due to the dynamic nature of helicopters, the advantages of HEMS have the potential to significantly improve patient outcomes if used appropriately.(8,9)

History of HEMS in South Africa

The first HEMS in South Africa, based at JG Strydom Hospital (now known as Helen Joseph Hospital), was opened in 1976. Its main mission was to facilitate inter-hospital transfers (IHTs) for patients needing specialist treatment in cardiothoracic units. Funded by the Transvaal Provincial Administration and Republic, this service was later moved to Johannesburg General Hospital in 1977 (now known as Charlotte Maxeke Academic Hospital). The helicopter was originally medically staffed by nurses and doctors, but a decade after initiation, paramedics were also added to the team.(10)

In 1992, the national government funded a new HEMS service, Flight for Life. After this, a joint private and public company was started in 1993 between existing provincial services and Europ Assistance. Flight for Life ran two helicopters, with one stationed at the Johannesburg General Hospital (Charlotte Maxeke Johannesburg Academic Hospital) and the other from HF Verwoerd Hospital (renamed in 1994 to Pretoria Academic Hospital and now known as Steve Biko Hospital). They were both only operational during daylight hours until 1995, where the Johannesburg base operated a 24-hour service, completing both primary calls and IHTs.(10)

Through the years, many changes occurred within this HEMS, from its funding models to the areas that it serviced. Many other HEMS opened and closed their doors; possibly due to the appreciable cost associated with the operation of such services, despite offering improved mortality.(11,12) Currently, there are three private HEMS operating within South Africa: Red Cross Air Mercy Services (Cape Town, Outdshoorn, King Shaka Airport, Richards Bay), ER24 (Johannesburg), and Netcare 911 (Johannesburg) in addition to local government HEMS (Kerksdorp, Nelspruit, Johannesburg, Bloemfontein) local government services.(13–16)

South African Healthcare System: Access

One important factor when considering the role of HEMS in South Africa is to evaluate the geographical distribution of the population, their settlement patterns and the local infrastructure or accessibility to healthcare facilities. There is significant heterogeneity when evaluating these factors across South Africa. There is a large disparity between the urban and rural areas, with the rural regions having very poor infrastructure and access to healthcare facilities.(17)

There is an inconsistent distribution of facilities in relation to the provinces' size and population density, with certain provinces or areas hosting excellent facilities and large areas left under-resourced. It is evident that the South African population's access to these specialist and tertiary hospitals within an acceptable timeframe is directly influenced by where the incident occurs.(18,19)

These geographic factors result in a two-fold effect on patients' chances of receiving appropriate treatment. Firstly, due to their rural location, ambulance services are located very far from patients so there will be a long delay in the initiation of medical treatment. Secondly, rural areas will be further disadvantaged due to their geographical location, as they do not have specialist or tertiary hospitals within reasonable distances.(18,19)

The result of these two factors is patients not being appropriately managed on scene and, subsequently, on route to hospital due to inadequate staffing of ambulances. Furthermore, patients are being transported to inappropriate healthcare facilities. These patients will need to be transferred to appropriate facilities, increasing time to appropriate clinical care and overall costs.(20)

In order to overcome accessibility barriers, alternative modes of transport need to be provided to these populations requiring urgent medical attention. Due to the distribution of specialist and tertiary hospitals being predominantly in the urban areas, there is a compounding effect on the time taken to reach the appropriate facilities, which can be detrimental to priority patients.(17)

Conclusion

According to Schellack et al, the economic state in South Africa is precarious. The income range amongst the population is disproportionate, with almost 50% of the population living under developing country conditions contrary to the gross domestic product classing South Africa as a middle income country.(21) This means that there is a high unemployment rate (25%), with a large percentage of the population living under unfavourable conditions with poor health. This places large economic demands on the healthcare system in order to meet the requirements of the population.(21)

Due to the cost of HEMS and the economic state of South Africa, it is vitally important for HEMS to be used for the appropriate patients in order for the cost to be justifiable. By developing a more specific dispatch criteria, we will be able to highlight the patients who will gain maximal benefit from the service, thereby reducing costs and inappropriate use of the service. By eliminating inappropriate flights, the service will be available to fly patients actually warranting HEMS use, instead of potentially being unavailable transporting stable patients.(22)

1.2 Objectives of Literature Review

The literature review aims to support and contextualise our study within the current body of science. Specifically to:

- Identify the benefits of HEMS
- Discuss the current South African Healthcare system and its resources in the context of HEMS

The literature review is structured around these objectives in order to identify the need for a more specific HEMS dispatch criteria for the South African environment.

1.3 Literature Search Strategy

A search was performed of Medline listed journals using PubMed and is found to be accurate as of 14 January 2018. We used a variety of Medical Subject Headings (MeSH) and Boolean operators in various permutations. The search strings are provided below:

- Search string one: (Helicopter Emergency Medical Services OR HEMS OR helicopter OR Aeromedical OR air ambulance OR Aviation) AND (dispatch OR criteria OR use OR utilisation OR utilization)
- Search string two: (Helicopter Emergency Medical Services OR HEMS OR helicopter OR Aeromedical OR air ambulance OR Aviation) AND (benefit OR time OR mortality OR morbidity)
- Search string three: (Helicopter Emergency Medical Services OR HEMS OR helicopter OR Aeromedical OR air ambulance OR Aviation) AND (cost OR urban OR rural OR middle to low income country OR resource limited country)

An advanced search was used for each search string, with key words appearing only in the title of the journal. Activated filters included publication date, limited from 01/01/2000 until 14/01/2018, and only English literature involving human subjects.

Titles were screened for relevance, and those unrelated to the topic were excluded. Thereafter, irrelevant papers were excluded after viewing the abstract. The remaining articles were reviewed in full-text and referenced appropriately where deemed relevant to our study. Further to this, we reviewed the reference lists of key articles for further literature. Figure 1.1 below outlines the literature search and results yielded.

Figure 1.1: Consort Diagram- Search Result

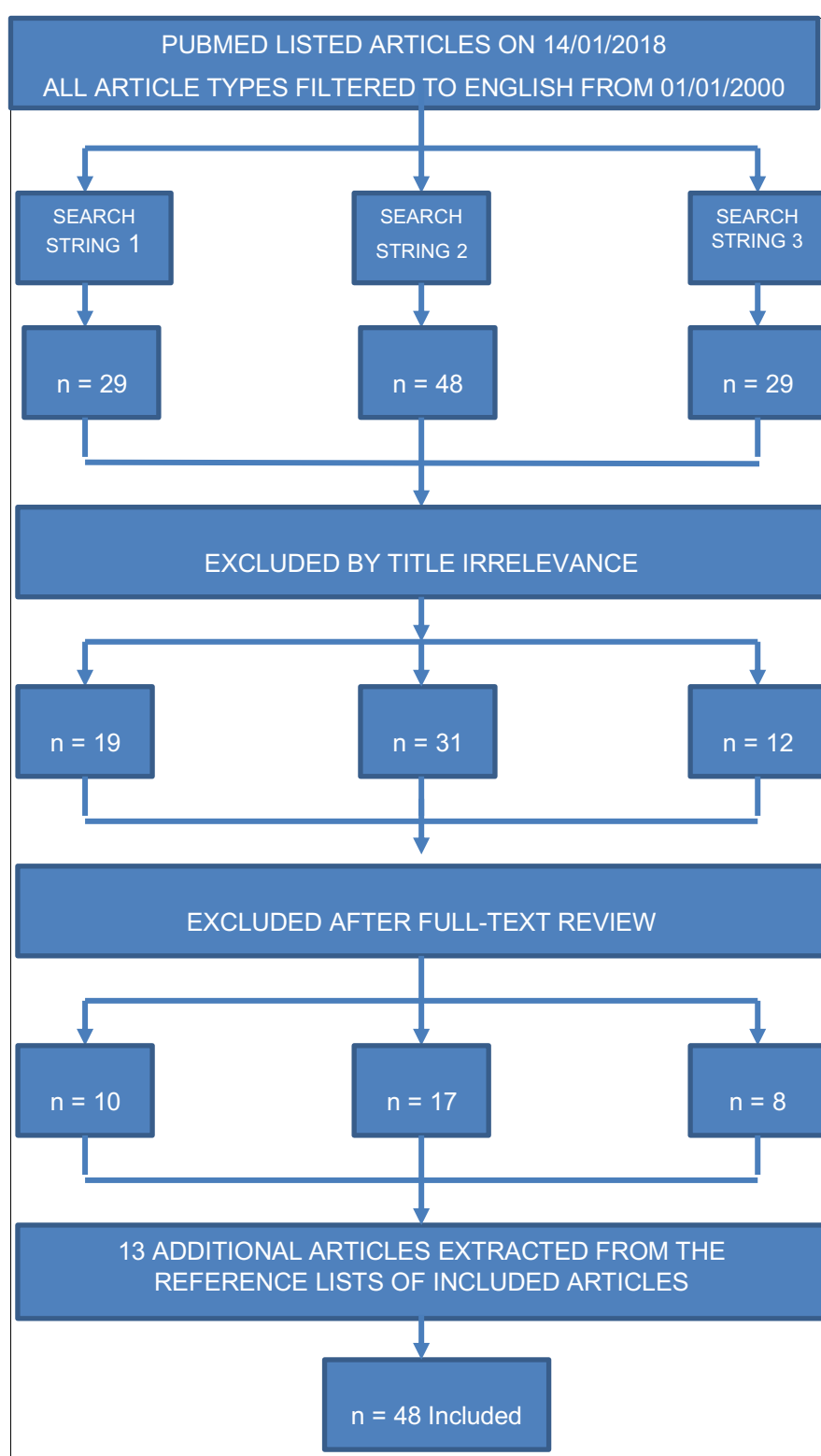


Table 1.1: Table of Evidence (Articles listed in ascending order based on level of evidence then publication date)

REFERENCE	LEVEL OF EVIDENCE*	STUDY TYPE	SAMPLE SIZE	PRIMARY OUTCOME	LIMITATIONS
Hotvedt, et al. 1996	V	Expert Opinion	370 Total (No comparison, all HEMS)	Only 11% of cases were viewed to have gained clinical benefit from helicopter emergency medical services (HEMS). Timesaving aspect identified, which was particularly beneficial in rural settings.	Old study, with out-dated literature. Assumption made that ground emergency medical services (GEMS) would be able to administer the same level of care as HEMS.
Ringburg et al. 2009	V	Retrospective Descriptive Study	16 Publications	Overall benefit of 1.1 to 12.1 additional lives saved per 100 cases flown in comparison to GEMS.	N/A
Wigman et al. 2011	V	Expert Opinion	55 Organisations completed the questionnaire	Lack of uniformity both nationally and internationally regarding trauma-related dispatch criteria.	Respondents were responsible for deciding if the Central Dispatch Centre was accountable for the dispatch decision.

Raatinieniemi et al. 2017	V	Expert Opinion	25 fictional HEMS scenarios 17 per-hospital physicians participated.	Evaluation of HBS and NACA score demonstrated significant inter-rater reliability. ICC for HBS was 0.70 (95% CI 0.57 to 0.83) and 0.65 (95% CI 0.51 to 0.79) for NACA score.	Small sample size, and potential for bias when selecting the expert panel. Personal opinion may influence results.
Schoettker et al. 2001	IIIb	Prospective observational study	610 Total 71 HEMS 539 GEMS	Median ISS for ejected group =17; for non-ejected group median ISS = 9 (P< 0.05)	Impossible to determine the effects of mode of transport, as “ejection” was already used as dispatch criteria, therefore all patients were transported by HEMS.
Silliman et al. 2003	IIIb	Prospective Observational Study	Total of 85 HEMS patients transported had a stroke.	HEMS have the ability to transport stroke patients in rural areas to specialist centres.	Potentially high percentage of stroke patients that did not call emergency line would be excluded from the study. Statistics dependant on patients calling emergency line at the onset of symptoms.

Hata et al. 2005	IIIb	Retrospective Observational Study	76 Total 56 GEMS 20 HEMS	HEMS cases had significantly shorter times to initiation of coronary angiography and percutaneous coronary intervention (PCI), as well as non-significantly reduced mortality rates.	This was a physician-staffed HEMS service, it may be different in a paramedic-staffed service. Patients unable to receive PCI were excluded from the study, excluding these poor outcomes from evaluation.
Shepherd et al. 2008	IIIb	Retrospective Case-note review	171 Total	HEMS is only able to reduce transport times when distances are >100km. Lack of evidence supporting the benefit of physician-staffed HEMS on overall survival rates.	Retrospective nature of data. Cases specific to region.
Stewart et al. 2011	IIIb	Retrospective Observational Study	10184 Total 2717 HEMS 7467 GEMS	Two-week mortality rates were 33% lower in HEMS cases, after propensity score adjustment. RTS between 3-7 was associated with greatest benefit from HEMS transportation.	Distance calculations were made using zip codes, which are unreliable in rural areas. Two HEMS services were based at a hospital, whereas the rest were regional services.

Brown et al. 2012	N/A	Prognostic Study	258387 Total 41342 HEMS 217045 GEMS	HEMS patients had higher ISS with HEMS being an independent predictor of outcome in patients with penetrating injuries, GCS <14, RR <10 or >29 and >55 years of age. These criteria were highly specific and predicted the need for specialist facility more reliably in HEMS group vs.GEMS.	Limitations include the retrospective design and the limited variables available for analysis, reducing the ability to control confounders.
De Jongh et al. 2012	IIIb	Retrospective Observational Study	372 Total 186 GEMS 186 HEMS	Increased on-scene times (and interventions) associated with poorer outcomes in head injured patients; increased times did not affect mortality rates in non-head injured patients.	Small sample population selected from a single centre environment as well as the retrospective design of the study could influence outcomes.

Desmettre et al. 2012	IIIb	Retrospective Observational Study	1958 Total 516 HEMS 1442 GEMS	Patients of similar ISS (25 and 26 for GEMS and HEMS respectively) demonstrated improved outcomes when transported by HEMS following blunt traumatic injuries. Pre-hospital times were longer for HEMS cases, as well as more clinical interventions performed.	Observational nature of study prevents causal inferences from being made. Another limitation was the lack of recording of transport distance, therefore unable to determine if longer pre-hospital times were associated with on-scene treatment or further distances to facility. Authors only assessed the mortality rates, not accounting for patients' quality of life.
Garner et al. 2012	IIIb	Retrospective Observational Study	44 Total	When HEMS physicians were used to dispatch HEMS in comparison to dispatch centre staff, there was an improved rate of severe paediatric injury identification, resulting in faster transport times to dedicated paediatric facilities.	Data not fully comprehensive, no long term outcomes were assessed.

Ryb et al. 2012	IIIb	Retrospective Observational Study	192 422 Total 162 950 GEMS 29 472 HEMS	Overall benefit was associated with physiologic derangements, whereas insignificant negative outcomes were observed in physiologically stable patients.	Convenience sample could be influenced by selection and information bias. Heterogeneous geographical areas. Large number of cases lacked pre-hospital RTS, influencing outcomes.
Taylor et al. 2012	IIIb	Retrospective chart review	10180 Total 391 HEMS 9789 GEMS	HEMS is associated with improved outcomes in HEMS cases, specifically those with higher ISS and head injury. These improved outcomes and improved overall cost-effectiveness.	Difficulty in extrapolation of results due to specific financial set-up. Retrospective analysis, potential unobserved confounders.
Delgado et al. 2013	IIIb	Probabilistic Sensitivity Analysis	N/A	For HEMS to be cost-effective, they need to reduce mortality >17% to cost < \$100000/ QALY; or to reduce mortality by >33% to cost < \$50000/QALY.	Results very specific to analysed data, making extrapolation difficult. Assumptions made regarding availability of GEMS in long-distance transports. Investigators only included cases

					with direct transport to specialist facility.
Floccare et al. 2013	N/A	Policy Statement	Colaboration of AMPA, ACEP, NAEMSP and AAEM.	Identified the need for Evidence Based Guidelines to be developed for maximal clinical benefit, incorporating local healthcare abilities.	Continuous evaluation of criteria is needed.
Fjaeldstad et al. 2013	IIIb	Prospective Observational Study	146 Total 101 GEMS 45 HEMS	Both mean and median transport times were significantly reduced following initial call to arrival at specialist facility in both STEMI patients and those with ISS>15.	N/A
Hesselfeldt, et al. 2013	IIIb	Prospective Observational Study	450 Total 336 GEMS 114 HEMS	There was a significant reduction in time from ECG diagnosis of STEMI and arrival at CCL in the HEMS cases vs. GEMS when transport distances >70-90kms.	The location of the PCI centre was in the city centre, which could have resulted in traffic congestion resulting in less favourable GEMS transport times.

Gordon et al. 2014	IIIb	Retrospective Observational Study	471 Total	HEMS offers advantage over GEMS if appropriately dispatched. Times saving aspects were evident.	Retrospective nature and dependence on stored data. Google maps utilised to estimate GEMS transport times, potentially affecting total times actually observed due to responding through traffic.
Hannay et al. 2014	IIIb	Retrospective Observational Study	14 440 Total 2347 HEMS 11549 GEMS	HEMS are associated with higher ISS, more pre-hospital interventions and improved survival rates.	Retrospective design and single- centre data.
Thomas et al. 2014	N/A	Prognostic Study	Multidisciplinary Panel including field experts	Results of this Evidence Based Guideline emphasize physiologic and anatomic criteria for optimal HEMS dispatch.	Due to the scarcity of literature available, assigning recommendation strengths is difficult and prone to subjective evaluation by the panel of experts.
Bekelis, et al.	IIIb	Retrospective Observational	209 529 Total	HEMS transportation to either level 1 or 2 facilities is	Associations observed can be due to indication bias. Potential

2015		Study	174 195 GEMS 35 334 HEMS	associated with improved outcomes.	for coding errors and missing data affecting estimated outcomes.
Hartog et al. 2015	IIIb	Retrospective Observational Study	2176 Total 1495 GEMS 681 HEMS	Following multivariate logistic regression analysis, HEMS saves 5.3 additional lives per 100 critically injured patients transported.	Retrospective design; potential bias in regression analysis; physician staffed may not be inferred to paramedic staffed HEMS.
Hutton et al. 2015	IIIb	Retrospective Observational Study	25332 Stroke patients transported by HEMS	HEMS have the ability to improve timely access to specialist stroke facilities, specifically for patients in rural and super-rural regions, when symptoms are detected within 2.5 hours following onset.	Potential for inaccurate data or omitted data to affect results. Use of HEMS is growing; therefore the studies results may not be uniform.
Kim et al. 2015	IIIb	Retrospective Observational Study	1626 Total 1547 GEMS 79 HEMS	Transport times were longer in HEMS transport, however 6.7 additional lives saved per 100 HEMS cases.	Exclusion of inter-facility transfers and patients with penetrating injuries was made, decreasing the total HEMS cases available

					for analysis.
Moens et al. 2015	IIIb	Prospective Observational Study	342 Total	Using HEMS in the rural setting to transport patients with ST-elevation myocardial infarction (STEMI), allows these patients to receive PCI within acceptable time frames comparable to those observed in the urban environment.	Time estimations were made using computer software; therefore extrapolation of the findings should be done with care.
Widener et al. 2015	IIIb	Retrospective Descriptive Study	3509 HEMS cases analysed. 2208 cases were geocoded	Geographic Information Systems can be used to determine fastest mode of transport for incidents, factoring in distance to facility and road conditions.	Only HEMS cases were included in the study. Mean scene times were used for predictive purposes.
Brown et al. 2016	IIIb	Retrospective Observational	222 827 Total 44 351 HEMS 178 476 GEMS	HEMS is associated with a 6.7% improvement in survival when AMPT score is utilised.	The retrospective design of the study; cases were not specifically documented for the study, potentially excluding important

					patient information.
Brown et al. 2016	IIIb	Retrospective Observational Study	Total = 155 691 HEMS/GEMS cases compared.	Survival benefit improved by 80% between 16-20 minutes (Adjusted OR 1.80; 95% CI, 1.51 to 2.14; p<0.01). After stratifying pre-hospital transport times, no time benefit was apparent. Results identify an independent survival benefit associated with HEMS.	Retrospective nature of the study resulting in 25% of cases to be excluded due to missing data. Results skewed towards areas close to trauma facilities. Quality of life following discharge not investigated.
Garner et al. 2016	IIIb	Retrospective Observational Study	Period A= 71 Period B= 126	The addition of a physician to the case identification dispatch process results in increased (double) case identifications, and reduced transport times.	Inability to adjust for temporal changes occurring independent to interventions. Case exclusion due to missing data. No sensitivity and specificity calculations.
Hirshon et al.	IIIb	Retrospective Observational Study	182 809 Total 37 407 HEMS	Stricter adherence to HEMS activation criteria resulted in reduced HEMS use and	Unable to link the old and new datasets without a unique identifier present. Validation of

			128 129 GEMS 17 273 IHT	improved patient outcomes.	the W statistic in penetrating trauma is unavailable, therefore only performed on patients with blunt trauma. Unmeasured and missing data potentially skews results in retrospective studies. Data was collected from two sources, therefore unable to link patient information between them.
Matsumoto et al. 2016	IIIb	Prospective Observation Study	N/A	They proved that automatic dispatch is a feasible option for dispatching HEMS.	Difficult to extrapolate experimental times in controlled environment into real-world settings.
Muhlbauer et al. 2016	IIIb	Retrospective quantitative, descriptive study	537 HEMS Cases	MVA most commonly utilised criteria (35.9%). After follow up: 63.1 % and 75.3% patients alive and stable following 24-hour and 72-hour respectively.	Study only included one HEMS service operating in two provinces.

Brown et al. 2017	IIIb	Retrospective Observational	Data between 2007 -2012 from the National Trauma Databank.	Current HEMS use results in 85% of patients being flown to be over the cost-effectiveness ratio, which AMPT score could reduce, as the correct patients will be identified more appropriately.	Retrospective nature of the study could interfere with results as there could be missing data in some cases. It is difficult to estimate the cost of each patient having received HEMS transportation as this is highly dependant on local resources and available healthcare.
Chen et al. 2017	IIIb	Retrospective Observational	153729 Eligible patients; 8307 matched	In HEMS cases with longer pre- hospital times than GEMS, only patients presenting with an abnormal RR, GCS <9 or those with haemothorax/pneumothorax demonstrated improved survival benefit with HEMS.	Retrospective design of the study and the inability to guarantee the removal of all potential confounders.
Englum et al. 2017	IIIb	Retrospective Observational	127 489 Total 18 291 HEMS	Survival benefit clearly demonstrated in HEMS transport. Mortality OR in HEMS	Retrospective and observational nature of the study resulted in potential of unobserved bias. No

		Study	71 820 GEMS 37 378 Other	cases was 0.7 (95% CI: 0.6 to 0.8) when compared to GEMS. High rates of over-use was also identified in HEMS cases.	data available on the transport distances was available for interpretation.
Liu et al. 2017	IIIb	Retrospective Observational	195 Total 30 Received life-saving interventions,	Vital sign reporting is inadequate to determine the needs of patients with blunt trauma for life-saving interventions and mortality rates.	Retrospective design of the study, exclusion of patients with missing data could influence results, sample size was also small and limited to one locale.
Zhu et al. 2018	IIIb	Retrospective Observational	469 HEMS 580 GEMS	After PS matching, HEMS increases odds of survival by 2.69 in comparison to GEMS (Adjusted OR = 2.69; 95% CI 1.21 to 5.97).	Retrospect design has the potential for incorrect documentation, or incomplete information. Numerous imputation may not yield valid results if data is missing. Only a single database in one area, may influence the generalisability of results.
Moront et al.	IIb	Retrospective	3861 Total	HEMS patients more severely	Lack of on-scene vital signs for

1996		Cohort	1460 HEMS 2896 GEMS	injured, but with improved outcomes. Combination of GCS <12 and HR >160bpm results in most favourable sensitivity and specificity (99% and 90%).	many patients resulted in initial vital signs estimated off admission vitals. GCS scoring needs to be appropriately taught, specifically when used to assess paediatrics not yet able to talk.
Ringburg et al. 2009	Iib	Prospective Cohort Study	781 Total	HEMS cases are more severely injured compared to GEMS. Total cost of HEMS remains under the accepted threshold per QALY. HEMS are therefore cost-effective in the Netherlands.	Low response rates (56%) may affect QALY costs.
Andruszkow et al. 2013	Iib	Retrospective Cohort	13 220 Total 8231 GEMS 4989 HEMS	HEMS patients more critically injured than GEMS patients, with higher incidence of MODS and sepsis. 25% reduction in mortality rates in HEMS patients.	Exclusion of patients with mission data could affect the results. Inclusion criteria of ISS>9 might affect outcomes, as this is not typically correlated to multiple traumatised injuries. Missing data resulting in exclusion of 6% of

					cases.
Andruszkow et al. 2016	Iib	Retrospective Cohort	52 281 Total 35974 GEMS 16307 HEMS	<p>HEMS patients more severely injured, however after multivariate regression analysis, survival benefit associated with HEMS, OR 0.81.</p> <p>Specific groups gaining maximal benefit: Age >55 Years, “low falls”, and in patients with low severity injuries.</p>	Validity of patient information following small statistical differences without required clinical importance. Missing data resulting in exclusion of 9% of cases.
Polites, et al. 2017	Iib	Retrospective Cohort	<p>HEMS:</p> <p>ISS<15= 5574</p> <p>ISS>15= 2644</p> <p>GEMS:</p> <p>ISS<15=30506</p> <p>ISS>15=4799</p>	Beneficial effect only observed in HEMS group when ISS>15, with OR 0.66, p=0.017; not in ISS<15, with OR 1.13, p=0.73.	The retrospective collection of data and inability to guarantee the removal of all confounders, such as weather, road conditions and distance to hospital.

Butler et al. 2010	Ila	Systematic Review	23 Studies Included.(5 level II and 18 level III)	14 Studies identified a significant improvement in mortality rates in trauma cases.	Variable level of evidence in reviewed literature.
Harmsen et al, 2015.	Ila	Systematic Review	20 level III evidence articles	Reduced on-scene times improve outcomes in patients suffering with neurotrauma or the haemodynamically unstable patients with penetrating trauma. However, in haemodynamically stable undifferentiated traumatic injuries, time has no influence on outcome.	Scene time vs. effect is difficult to interpret due to heterogeneous studies. Trauma mechanisms are not identical. Geographic and logistical factors influence on- scene times, difficult to extrapolate this data.
Ringberg et al. 2009	Ila	Systematic Review	34 Publications with 49 Criteria identified	Identified the lack of literature describing the validity of HEMS dispatch criteria.	Inconsistency in reporting of results, with contradicting statements.
Taylor et al.	Ila	Systematic	15 Studies	Five studies found HEMS to have a negative cost-benefit	Limitations set in the search strategy could result in omission

2010		Review		association; eight studies proving a positive cost-benefit associated with HEMS and one identified societal benefit.	of important publications. Degree of subjectivity may influence reported outcomes.
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***Journals categorised according to the Oxford Centre for Evidence Based Medicine(23)**

1.4 HEMS Benefit

A vast amount of literature exists when evaluating the benefit of HEMS. Traditionally, the focus was placed on the timesaving aspect associated with HEMS, either by delivering treatment to patients timeously or by reduced transport times to appropriate facility. However, recently more emphasis is being placed on the additional skills and expertise brought to the patient via HEMS.(24) Here, the benefit of HEMS in both domains will be reported on. Additionally, the effect of HEMS on outcome and its survival benefit will be discussed.

Improved Patient Outcomes

A study performed by Hannay et al. investigated the differences found between HEMS and GEMS cases with regard to ISS, interventions performed and survival rates.(25)

They investigated a total of 14 440 patients, with 11 408 (79%) of cases transported by GEMS and 2 394 (17%) transported by HEMS, and other means of transport in the remaining 638 (4%) admitted into a level 1 trauma facility. Median ISS's were higher in the HEMS cases in comparison to the GEMS cases (median 17, IQR 9 to 25 vs. median 9, IQR 5 to 18, $p < 0.001$). The HEMS group was also more likely to have a GCS score < 8 and have more critical injuries ($p < 0.001$). They also highlighted the increased need for advanced interventions to be performed in HEMS cases.(25)

Overall mortality rates observed in hospital were 12% with a significant variation in rates ($p < 0.001$) between modes of transport. Mortality rates in GEMS cases were 12% and 15% for patients transported by HEMS. However, GEMS cases had higher mortality rates within the emergency department when compared to HEMS cases (5% GEMS vs. 2% HEMS, $p < 0.001$). (25)

Multivariate regression analysis was used to evaluate factors related to mortality. HEMS cases showed to reduce overall mortality rates (OR 0.41, 95% CI 0.33 to 0.39). Statistically significant differences between HEMS and GEMS were observed ($p < 0.001$). (25)

These results demonstrated that HEMS cases were more likely to have higher ISS, with practitioners performing more interventions in the pre-hospital phase. They were also associated with higher survival rates in comparison to patients

transported by alternative modes, with a reduction in mortality rates, having an odds ratio of 0.41. These results identify the benefit of appropriate HEMS utilisation, despite the increased costs and safety concerns associated with HEMS.(25)

Limitations of this study is the retrospective design, as well as their data, only analysed from a single centre, without assessing the quality of the practitioners' skills and expertise working at the services investigated.(25)

Butler et al. performed a systematic review in order to ascertain whether HEMS specifically improves trauma patient outcomes, or if it is purely the EMS (irrespective of mode of transport) that plays a role in patient survival. Twenty-three published articles were eligible for inclusion, with 14 proving a significant reduction in mortality following traumatic injuries. Only level II (five articles) and level III (18 articles) were included in the review, ensuring quality of data. They discussed the three important aspects associated with HEMS, being: 1) HEMS staffing 2) Airway management rates and 3) Total pre-hospital times.(24)

Their findings were indicating that the improved outcomes in HEMS cases were a result of the clinical expertise brought to the patient, and not the mode of transportation. Airway management rates are higher in HEMS cases, which has been proven to be of benefit in specific cases, such as traumatic brain injuries (OR 1.4, 95% CI 1.1 to 1.8).(24) Again, this can be attributed to the experience brought to scene by HEMS. The time saving aspects associated with HEMS are misleading. They managed to prove that HEMS increases on-scene times, but this increased time was offset by the improved survival rates. The increased number of interventions performed by HEMS crews can explain this. Additionally, prolonged pre-hospital times can also be due to the greater transport distances and HEMS being utilised for the more critical cases. The improved mortality rates with HEMS are also due to the ability of HEMS to transport to specialist facilities immediately. This systematic review supported the value of HEMS in the pre-hospital environment and identified explanations behind common misconceptions. These beneficial effects however, are only appreciable in patients meeting certain requirements or specifications.(24)

A study performed by de Jongh et al. investigated the effect HEMS has on mortality rates in trauma patients as well as the effect of the pre-hospital times in relation to HEMS and mortality rates. They included a total of 372 patients, with 186 transported by both HEMS and GEMS. Mean ISS was 22.7 (SD 14.2), and 158 (43%) patients had sustained a traumatic brain injury. Total pre-hospital times were

longer in the HEMS cases, despite their response times being shorter than GEMS response times. This is accounted for by their longer on-scene times (as well as higher advanced airway management rates) when compared to GEMS cases. HEMS appeared to improve short-term mortality rates. However, this survival benefit was reduced after hospital admission, resulting in decreased rates of survival in head injury patients transported by HEMS. These increased mortality rates in head injury patients were associated with the longer pre-hospital times. Increased pre-hospital time did not have an effect on non-head injury patients. These results highlight the need to reduce pre-hospital times in patients suffering head injuries. The limitations of this study are the small number of patients enrolled and their selection from a single centre. (55)

Andruszkow et al. performed a study investigating the survival benefit of HEMS in comparison to GEMS in trauma patients. They reviewed 13 220 patients, of which 8 231 (62.3%) were transported by GEMS and 4 989 patients (37.7%) were transported by HEMS. On analysis of their ISS score, HEMS patients were more critically injured than GEMS patients (ISS 26.0 vs. 23.7, $P < 0.001$). Due to the severity of injuries in HEMS cases, on-scene times were longer in the HEMS group (39.5min vs. 28.9min, $P < 0.001$). HEMS patients had higher incidence of multiple organ dysfunction syndrome and sepsis, increasing ICU and total hospital stay ($p < 0.001$). Using multivariate regression analysis, the OR for HEMS patient mortality was 0.75 (95% CI: 0.636 to 0.862).

Analysis was done on a subgroup of patients transported to a level 1 facility investigating the influence of treating facility capability had on outcomes. The standardized mortality ratio (SMR) was significantly reduced in the HEMS group after the Trauma Score and Injury Severity Score and after the revised injury severity classification score (HEMS: 0.647 and 0.772 vs. GEMS 0.815 and 0.864, respectively; $P = 0.045$). (26)

Limitations of the study include small statistical differences affecting the validity of included data; exclusion of 6% of patients due to missing information related to their mode of transport; and a wide inclusion criteria ($ISS > 9$) could influence outcomes of the study. (26)

A more recent study by Andruszkow et al. published in 2016, supports the beneficial outcomes associated with HEMS transport for specific patient groups. A multivariate regression analysis was performed in order to determine the benefit HEMS had on various traumatic sub-groups. The total number of trauma cases included in the

study was 52 281, of which 35 974 (68.8%) were transported by GEMS and 16 307 (31.2%) transported by HEMS. It was found that HEMS patients had more serious injuries in comparison to GEMS patients, with ISS of 24.8 ± 13.5 and 21.7 ± 18.0 respectively. HEMS cases also had higher incidence of shock, with a systolic blood pressure $<90\text{mmHg}$ in 18.3% of HEMS cases and 14.8% of GEMS cases.(27)

After analysis, HEMS cases were associated with improved outcomes (OR 0.81, 95% CI [0.75 to 0.87], $p<0.001$, area under the ROC curve 0.922, 95% CI [0.919 to 0.925]). They also identified sub-groups having the most benefit from HEMS transport as patients over 55 years of age (OR 0.62, 95% CI [0.50 to 0.77]). Additionally, HEMS was associated with the largest improvement in outcomes in patient sub-group “low falls”, (OR 0.62, 95% CI [0.50 to 0.77]) as well as those patients in the sub-group “minimal severity wounds” with ISS between 9 and 15 (OR 0.66, 95% CI [0.49 to 0.88]).(27)

Limitations of the study include differences in patient details which were not of clinical relevance, therefore results were not reported with statistical significance. Missing data in nine percent of cases resulted in omission of these patients, however this potential bias was deemed minimal.(27)

A 2015 study by Hartog et al. investigated the survival benefit associated with physician-staffed HEMS in critically injured patients.(28) A total of 2 176 patients were included in the study, with 1 495 transported by GEMS and 681 transported by physician-staffed HEMS. They found that in the HEMS group, there were a larger percentage of patients suffering blunt trauma (93% vs. 90%; $p=0.008$). The patients transported by HEMS had higher ISS (26 vs. 22; $p<0.001$) and had greater vital sign abnormalities (decreased GCS and RTS; $p<0.001$). Their crude mortality rate was also higher than the GEMS group (27% vs. 21%; $p=0.001$). (28)

A multivariate logistic regression model was used to account for the intrinsic bias, demonstrating HEMS to save 5.33 lives for every 100 patients transported when compared to GEMS. Uncertainty exists with reproducibility of observed results when inferring these findings into paramedic-staffed HEMS. This paper may not be externally valid to the South African context, as it relates to physician-staffed HEMS- the norm in South Africa is paramedic-staffed HEMS. However, due to the statistical power of the findings ($>90\%$), it can be confirmed that HEMS has a beneficial influence on severely injured patient outcomes.(28)

Another study conducted by Desmettre et al. investigated the influence of HEMS on patient outcomes. The patient subgroup included those with blunt force trauma following transportation directly to an academic hospital with a trauma centre.(29)

A total of 1 958 patients were included in the study, with 516 (26%) transported by HEMS and 1442 (74%) transported by GEMS. The mean ISS was 26 (IQR 19 – 34) for HEMS and 25 (IQR 18 – 34) for GEMS patients.(29)

They found that the HEMS group's median pre-hospital times were longer, and that they received more clinical interventions prior to hospital admission. Unadjusted mortality rates until discharge was equal in both groups. However, once an adjustment of the initial clinical status was made, there was an appreciably lower mortality rate (OR 0.68, 95% CI 0.47 – 0.98, P=0.035) in the HEMS group.(29)

The study was unable to identify the reason for the improved outcomes in the HEMS cases; however, it was apparent that patients with blunt traumatic injuries would have a beneficial outcome if transported by HEMS to an appropriate trauma centre. A major limitation of this study was the observational design, preventing authors from making causal analyses. They did not report on the transport distance, therefore increased pre-hospital times could not be accounted for.(29)

Stewart et al. compared helicopter vs. ground transportation on patient mortality using propensity score analysis. All trauma patients in Oklahoma transported to a level I or II trauma facilities were included. A total of 10184 trauma cases were included in the study. HEMS cases had a lower crude survival rate, and these cases had increased distances to facilities. HEMS cases had lower RTS scores, however larger percent of patients in the high injury severity classifications. After propensity score adjustments, covariates and transportation mode was equal.(30)

Two-week mortality rates for HEMS cases were 33% lower than GEMS (Hazard ratio=0.67, 95% CI: 0.54 to 0.84). The mortality reduction in HEMS cases was noticeably higher in patients with RTS between 3-7 (Hazard ratio=0.61, 95% CI = 0.46 to 0.82). There were a large percentage of HEMS cases within normal vital sign parameters and moderate ISS identifying the need for improved trauma triage and HEMS criteria development. In this group of patients, HEMS did not influence survival rates.(30)

A study conducted in Korea by Kim et al. compared patient outcomes and transport times in HEMS vs. GEMS cases. A total of 1 626 patients following blunt traumatic injuries were included in the study, of which 49% were involved in road traffic accidents. GEMS transported 1 547 patients and HEMS transported only 79 patients. Median ISS scores were the same for both groups, with the upper value of the IQR being slightly higher in the HEMS group (ISS IQR 4-17 for GEMS and 4-22 for HEMS). Median transport times were 60 minutes in HEMS group and 47 minutes for GEMS group, $P < 0.001$. By combining TRISS with other values such as patient age, mechanism of injury, etc. and utilising regression analysis of cases, survival rates were calculated to be higher in the HEMS group (survival rate, 94.9% vs. 90.5%; Z score, 2.83 vs. -1.96; W score, 6.7 vs. -0.8; $p = 0.005$ vs. 0.05) these results show that 6.7 additional lives are saved for every 100 patients transported by HEMS. Limitation of this study is the small sample size for HEMS cases. Despite this, they were able to identify improved outcomes in HEMS cases despite the longer pre-hospital times.(31)

Supporting evidence for the beneficial effects of HEMS, Ringburg et al. did an overview of available literature. They included 16 publications in their overview, all supporting the beneficial effect of HEMS on patient outcomes. They found that in the HEMS group, an additional 1.1 to 12.1 lives were saved per 100 transported. They combined the results of four reliable studies, demonstrating an overall mortality reduction, with 2.7 additional lives saved for every 100 HEMS cases. Their findings support the importance of stricter dispatching criteria, as these beneficial effects were only observed in the more severely injured patients. There needs to be a more accurate way for pre-hospital providers to identify the more critically injured patients, where HEMS will be beneficial.(32)

Ryb et al. performed a retrospective observational study comparing outcomes between HEMS and GEMS patients. They included a total of 192 422 patients in their study, 162 950 transported by GEMS and 29 472 transported by HEMS. HEMS patients were associated with increased mean ISS (10 vs. 6; $p < 0.001$), lower RTS (7.02 vs. 7.53; $p < 0.001$) as well as longer transport times (73.4 min. vs. 70.0 min; 0.001). After applying multivariate regression analysis to results, HEMS cases exhibited a 78% improvement in survival rates (OR, 1.78; CI 1.65 to 1.92) over GEMS cases. It was observed that survival rates were improved in cases having longer pre-hospital times (> 60 min. OR 1.68; CI 1.52 to 1.87). HEMS only appeared to benefit patients having RTS < 6 (OR, 2.28; CI 2.10 to 2.49); however, ISS did not affect transport benefit. They identified shorter transport times < 60 minutes to be

beneficial in outcomes (OR 1.77; CI 1.51 to 1.90) and times >60 minutes associated with a non-significant negative effect (OR 0.88; CI 0.72 to 1.08).(33)

From these results, they identified that HEMS had a greater positive effect on outcomes in patients having greater physiologic instability (RTS < 6: adjusted OR 1.69; CI 1.32 to 2.17) but was not limited to specific severity sub-group. Interestingly, they observed a negative effect associated with HEMS transport in patients with normal physiologic parameters. This data identifies the importance of triaging patients to determine mode of transport, as HEMS is only beneficial when physiologic instability is present, with the potential for negative effect with this absence. Potential for selection and information bias exists when using a convenience sample. In summary, they found overall positive outcomes across all injury severity scores.(33)

A recent study analysed survival outcomes of trauma patients in the rural setting when being transported to a level I or II trauma centre. Inclusion criteria were patients over 15 years of age and those injured in rural regions (10-35 miles from facility) between 1999-2012. Propensity score matching was performed to calculate the mortality rates between HEMS and GEMS cases. After adjustment, HEMS displayed an increase of 2.69 times the odds of survival in comparison to GEMS (Adjusted OR = 2.69; 95% CI 1.21 to 5.97). Therefore their results supported the benefit of HEMS in the rural setting for patients needing specialist trauma centres.(34)

Polites et al. did a study comparing outcomes following transportation by HEMS vs. GEMS in the paediatric population.(35) A total of 8 218 HEMS (5574 ISS<15 and 2644 ISS >15) and 35 305 GEMS (30506 ISS<15 and 4799 ISS >15) patients were transported to hospital (ISS<15 being 'low' and ISS>15 being 'high'). Overall mortality was higher in the HEMS patients (4.0 vs. 1.4%, $p<0.001$); however, after propensity score correlation, results demonstrated comparable mortality rates in patients with low ISS (0.2 vs. 0.2%, $p=0.82$) and decreased mortality in HEMS patients with high ISS (9.0 vs. 11.1%, $p=0.014$). Therefore, in the high ISS group, HEMS patients had a decreased mortality rate, with OR of 0.66 ($p=0.017$) but this beneficial effect of HEMS were not demonstrated in the low ISS group, with OR of 1.13 ($p=0.73$). (35)

This identifies the need to develop a system in order to identify patients more accurately on scene, in order to reduce HEMS transport of patients with ISS<15, which will result in more beneficial use of HEMS in the paediatric population.

Limitations of this study include potential confounders associated with the retrospective design, for example weather, road conditions and distance to hospital.(35)

To summarise the above-mentioned articles, there is an overall acceptance of the clinical benefit associated with HEMS transport in specific patient groups. They all address the need for stricter adherence to dispatch criteria, as the clinical benefit is more appreciable in the more critically injured patients or those that are more physiologically unstable. Greater clinical benefit is seen when HEMS are used to bring pharmacological agents or expertise to the scene, which was unavailable otherwise, thereby decreasing time to initiation of critical interventions and bypassing facilities, transporting patients directly to appropriate facilities.

Time-saving benefit

When deciding when to use HEMS, there are various aspects that need to be considered when analysing the timesaving potential. Time can be reduced in various aspects, including reduced time to initiation of treatment if unavailable on scene, faster total transport times, bypassing inappropriate facilities, etc. Specific conditions or ailments are time-sensitive and their outcomes are dependent on reduced times to initiation of treatment.

In particular, certain trauma and medical presentations are believed to benefit from HEMS transportation. These emergencies are very time-sensitive, requiring immediate intervention at specific specialist facilities.(36,37) Traditionally, HEMS has been associated with reduced pre-hospital times, however evidence supporting this is variable. Literature evaluating scenarios that HEMS are able to reduce pre-hospital times will be reviewed.

Widener et al. used geographic information systems to determine transportation times for HEMS and GEMS. Current literature identifies the survival benefit of HEMS in trauma cases, however evaluations of the cost-effectiveness of these benefits are not clear. This study describes a tool that can objectively calculate the transportation times predicted for both modes of transport.(38)

The aim of this study was to develop a way of accurately determining transportation times from incident location to desired healthcare facility. This will aid HEMS dispatch decisions for patients with time-critical injuries requiring imminent interventions.(38)

Computed transport times were calculated for all cases documented in the Maryland State Police for both HEMS and GEMS transport. Geospatial interpolation was used to extrapolate the total response times for both HEMS and GEMS in the region.(38)

By mapping these incident locations and estimating response times, the results indicate the usefulness of the geographic information systems for determining transportation times, taking into consideration the mode of transport, distance covered and road conditions. This information can be used to identify areas best served by GEMS or HEMS either prospectively or during dispatching of resources. As transport distances increase, the timesaving benefit of HEMS increases.(38)

Gordon et al. performed a retrospective chart review on 471 cases where they examined clinical and operational indications for dispatching their HEMS. They analysed response times of GEMS vs. HEMS to an incident. Median scene arrival times of GEMS were 11 minutes and 44 seconds and HEMS being 26 minutes. Median transport time from incident to hospital was 49 minutes by GEMS and 15 minutes with HEMS. There was a median “waiting time” before HEMS arrived on scene after GEMS of 27 minutes and 37 seconds. The median time saved either reaching patients or transporting to hospital in priority one patients was 35 minutes and 45 seconds using HEMS. The limitation of this study is the location: Being based in New Zealand, the service operates under differing financial and geographical constraints, making it difficult to extrapolate the data to the South African environment. Another limitation is the retrospective analysis of data, relying on the precision of case documentation. The authors did perform cross analysis of data correlating to other archives. The study did not analyse outcomes of the cases reported on, therefore patient benefit associated with HEMS is unable to be determined. Despite this, they were able to identify a time-saving aspect associated with HEMS, which is a key role in the value of this resource.(39)

Moens et al. investigated the timesaving benefit of HEMS treating patients with AMI specifically situated in the rural environment. By using a computer program, they were able to estimate total pre-hospital times of patients had they been transported by GEMS in order to compare time saved utilising HEMS.(40)

A total of 4 485 patients were flown in their study period, with 342 patients experiencing AMI (8%) who were transported by HEMS directly to PCI facility. Median response times were 11 minutes in HEMS cases and 32 minutes for GEMS (IQR: 8 to 14 min. HEMS; 25 to 44 min. GEMS; $p < 0.0001$). Median transport time was 12 minutes in HEMS cases and 50 minutes by road (IQR: 9 to 15 min. HEMS;

36 to 56 min. GEMS; $p < 0.0001$). Median times due to system delays were 52 minutes in HEMS cases in comparison to 110 minutes in GEMS cases (IQR: 45 to 60 min. HEMS; 95 to 126 min GEMS; $p < 0.0001$).⁽⁴⁰⁾

This data validate the use of HEMS in Acute Myocardial Infarction (AMI) cases as it affords patients in the rural environment access to Percutaneous Coronary Intervention (PCI) within similar time frames as those observed in urban cases. The further the patient is from a PCI facility, the greater the benefit HEMS can contribute toward patient outcomes. This can be extended to 200km radius from PCI facility, where patients would traditionally receive pharmacologic agents, if available. As total transport distances increased, the time saving properties of HEMS increased statistically ($r^2 = 57.3$, $p < 0.0001$). HEMS reduced times by 0.49 minutes for every additional kilometre by ground.⁽⁴⁰⁾

The authors of this study were able to state that 78.3% of patients with ST-elevation Myocardial Infarction (STEMI) analysed in their study were transported to PCI facility in under 60 minutes using HEMS, following initial call. Their computer program projected that only 0.88% STEMI patients would have reached PCI facility in less than 60 minutes using GEMS. In addition to this, of the HEMS cases, 99.4% of patients were in the PCI room within 90 minutes of dispatch, whereas this was only true for 17.3% of GEMS cases. Mean transport distances were 50 kilometres, which were inline with current literature. For distances above 73.14 kilometres, times to reperfusion therapy were greater than 90 minutes.⁽⁴⁰⁾

Results of this study are statistically significant, having a decent sample size and being robust in design. The Statistical Analysis System (SAS version 9.3) and S-PLUS (version 8.1) is a computer-based program that was used for comparison, and is a widely accepted. Estimates ideal conditions were proposed, producing an underestimation in influence. Therefore, the timesaving benefit reported by authors seems to be realistic. Again these results are in line with current trends identifying the time-saving potential associated with HEMS, specifically where transport distances are increased.⁽⁴⁰⁾

Another study conducted by Fjaeldstad et al. investigated the time saved from initial call to the hand-over of patients at a specialized centre in patients diagnosed with STEMI or those with ISS > 15 when transported by HEMS. In their results, they found significantly shorter times to trauma centre in HEMS cases.⁽³⁷⁾

GEMS patients arrived at trauma centre 322 minutes after initial call (n=31; 95% CI: 271 to 374), HEMS transport cut this time to 97 minutes (n=14; 95% CI: 86 to 107) resulting in a mean reduction of 225 minutes (p= 0.0001; 95% CI: 171 to 280) and a median time saving benefit of 235 minutes (p= 0.0001). In the STEMI group transported to PCI centre, the time from initial call to arrival at specialist centre in GEMS cases was 102 minutes (n=70; 95% CI: 97 to 108 min.) and in HEMS cases was 84 minutes (n=31, 95% CI: 77 to 90min). The mean reduction in HEMS cases was 18 minutes (p= 0.0004; 95% CI: 10 to 27) and a median time saving benefit of 22 minutes (p=0.0004).(37)

This significant time difference is a result of HEMS being able to bypass inappropriate facilities, as the total transport times were increased by their need for inter-facility transfer. This has been identified as a key indication for utilising HEMS as they are able to reduce overall times by transporting patients directly to an appropriate specialist facility. This is a sound study as it is prospective in design with statistically significant outcomes. A limitation of the study is their limited sample size.(37)

Hesselfeldt et al. investigated the difference in time to delivery of patients diagnosed with STEMI on-scene to cardiac catheterisation, if distance to hospital was >30 minutes driving time. A total of 450 patients were included in the study, 336 transported by GEMS and 114 by HEMS.(36)

Following transportation to hospital, patients receiving immediate primary-PCI (pPCI) were similar between both modes of transport, with 80% of HEMS and 78% of GEMS. There was a significantly noticeable reduction in time from initial Electrocardiogram (ECG) to arrival at Cardiac Catheterization Lab (CCL) in the HEMS patients, with a median time of 84 minutes (60 to 160 min.) in comparison to 104 minutes (63 to 225 min.) following GEMS transportation, $P<0.01$, despite longer transport distances in HEMS group (97km vs. 94km; $p<0.01$). In field triaged cases, when distance to PCI facility was >70-90 km's there was a noticeable reduction in HEMS times. On 30 day follow-up, mortality rates were 2.2% for HEMS patients and 6.9% for GEMS patients (p= 0.10), and one year follow-up was 6.7% and 9.9% respectively (p=0.35).(36)

These results align with the notion of bypassing facilities in order to transport patients directly to a specialist facility. Limitations of the study were the geographical location of the facility being in the city centre, potentially being the reason GEMS

times were increased, due to traffic congestion, however this 'limitation' adds to the beneficial effects of HEMS, as they are not influenced by this.(36)

Hata et al. investigated the effect HEMS had on time to initiation of treatment for AMI patients as well as the effect it had on mortality rates. A total of 76 AMI cases were investigated, with 20 HEMS cases and 56 GEMS cases. Times to coronary angiography and PCI were both significantly shorter in the HEMS cases (98.8 ± 29.2 min. and 169.6 ± 57.4 min.) in comparison to the GEMS cases (126.6 ± 48.7 min. and 203.2 ± 57.0 min; $p < 0.05$). Mortality rates were also lower in the HEMS cases (5.0%) in comparison to GEMS cases (10.7%). Longer transport times in GEMS were reported to be due to traffic congestion on route to the specialist facility, which HEMS is able to by-pass. This study identified the beneficial effect HEMS has on reducing time to intervention, which is critical in AMI cases. Limitations of this study include the staffing of the HEMS service being different to that found in South Africa, as well as the exclusion of patients not receiving PCI, which excludes these poor outcomes from evaluation and influencing results reported on. (51)

Silliman et al. performed a prospective, observational study investigating the benefit of HEMS in initiating thrombolytic therapy prior to the arrival at specialised stroke centres in the rural setting. They identified stroke patients located in rural regions as a potential indication where HEMS will be beneficial for patients needing transportation to facilities with capabilities of administering tissue plasminogen activator (rtPA). Treatment with rtPA needs to be initiated within three hours of symptom onset and has the ability to improve morbidity rates by 30%. HEMS have the ability to transport patients to facilities capable of administering rtPA that would otherwise not have received this treatment. A total of 85 (76%) patients transported by HEMS had a stroke, and of those, 18 (38%) received rtPA. Average transport distance was 29.4 miles, and majority of patients ($n=65$) arrived at an appropriate facility in less than 135 minutes following the onset of symptoms.(41)

This study proved that HEMS results in faster transportation of stroke patients from rural regions to definitive care, resulting in reduced time to initiation of rtPA therapy. This is particularly beneficial for the South African setting, where a large percentage of the population resides in the rural areas. The limitation of this study is the reliance on patients calling for medical assistance. There is no way of accounting for patients experiencing these symptoms of stroke who decided not to call EMS.(41)

Another study done by Hutton et al. analysed all HEMS cases in the US electronic medical records database over a seven-year period. They identified 25 332 patients transported by HEMS to stroke facilities. Over the period of analysis, stroke incidence increased from 1.4% to 3.9%, and 96% of cases reached appropriate healthcare facilities within two hours, with 59.2% in under 60 minutes.(42)

Stroke has been defined as one of the medical conditions that require time-sensitive initiation of treatment, with patients reporting to lose 1% of possible recovery for every eight minute delay in initiation of treatment. Stroke centres are not widely accessible, with many rural regions lacking access to stroke care.(42) They had 41% of cases transported from rural regions; 17% from super-rural regions; and 42% from urban areas. Of these cases, 72% were inter-facility transfers and only 28% from primary scene. More transports occurred from rural regions (32%) compared to urban regions (22%). This high percentage of inter-facility transfers identify the need to improve field identification of strokes, and increases the need to bypass facilities for appropriate treatment.(42)

Limitations of the study include missing or inaccurate data used for interpretation. The time of onset of symptoms is not included/analysed in the study, which could affect results. Stroke classification was not included in analysis.(42)

Chen et al. investigated the benefit of HEMS transportation in trauma patients despite GEMS being the faster mode of transport. Using mixed-effects logistic regression, they were able to investigate the influence of the mode of transport on patient outcomes. A total of 153 729 patients were suitable, however only 8307 matched. In these cases, the HEMS pre-hospital times had a median time of 13 minutes longer than GEMS (IQR 6, 22). They identified three clinical criteria to be indicative of improved mortality associated with HEMS, regardless of longer pre-hospital times. Three sub-groups had a significantly improved mortality rate with HEMS transport were those having an abnormal respiratory rate; GCS <9 and patients with a haemothorax/pneumothorax. Contrary to this, patients without these signs and symptoms did not demonstrate any benefit when transported by HEMS ($p>0.05$). (43)

In Australia, Shepherd et al. evaluated the role of HEMS in the rural areas. A total of 171 cases were reviewed. Results revealed time-benefit of HEMS only to be apparent when distance to hospital is >100km. Mean transport times in GEMS for distances <50km was 29.44 minutes and 48.11 minutes for HEMS (Difference 18 min; $P=0.00$). For distances falling between 50 and 100km, mean transport times for

GEMS was 56.34 minutes and 62.63 minutes in HEMS cases. When distance exceeded 100km, mean transport time in GEMS cases was 141.21 minutes and 93.16 minutes in HEMS cases (Difference 48 min; $P=0.00$). Mean ISS was 12.82, with only 30% of patients having ISS >15, and 26% of patients were discharged from hospital within 24 hours following admission.(44)

This highlights the difficulty in identifying the correct patients who will benefit from HEMS. When dispatching is done pre-emptively, there was a 45% association of Motor Vehicle Accidents (MVA) and severe injury; whereas other trauma aetiologies only had a 25% association with severe injury. They were also unable to prove the benefit of doctor-staffed HEMS over paramedic-staffed HEMS when comparing ISS or survival rates. They identified that 70% of their cases have ISS <15, highlighting the need to improve the sensitivity of dispatch criteria to reduce unnecessary flights. Limitation of this study is the retrospective nature of the data, as well as the data being accurate for their region; it may be different if repeated in a different setting.(44)

Hotvedt et al. performed a Delphi study investigating expert opinion on patients transported by HEMS, and whether they believe that any beneficial outcomes could be linked to the mode of transport. A total of 370 cases were included in the study. In 283 (76%) cases, experts agreed that HEMS did not provide any benefit to patient outcome than if patient had been transported by GEMS. An additional 49 cases were added to this “no benefit” group, leaving 41 (11%) of patients gaining clinical benefit from mode of transport. The “no benefit” decision was based on a lack of interventions performed in the transport phase that the patient would not be able to receive if transported by GEMS. Time saving aspects was still noticed in HEMS cases, with patients arriving 69 minutes (0 to 615, 60) faster to specialist facilities than if they were transported by road in the rural setting.(45)

This is a dated study, published in 1996, with opinions based on out-dated literature. The authors also make the assumption that GEMS is able to provide equivalent level of care as HEMS, which is not necessarily the case in the South African context, specifically in the rural areas. Their outcomes fail to identify specific patient groups that would benefit from HEMS; however, we can infer from the time-saving aspect, patients needing time-sensitive interventions will benefit from HEMS, specifically those located in the rural regions.(45)

Bekelis et al. performed a retrospective cohort study in order to investigate the beneficial effect HEMS had on mortality in patients suffering from traumatic brain injury. They applied regression methods with propensity score matching in order to analyse the association of improved outcomes in HEMS patients in comparison to GEMS suffering traumatic brain injury. A total of 209 529 patients with traumatic brain injury met inclusion criteria. For patients transported to level 1 facility, multivariate logistic regression analysis displayed a link between HEMS and improved mortality, OR: 1.95; 95% CI, 1.81 to 2.10; ARR, 6.37%. This finding continued following propensity score matching, with OR, 1.88; 95% CI, 1.74 to 2.03; ARR, 5.93%. These findings were also noticed in patients transported to level 2 facilities.(46)

Limitations of this study include the potential for confounders to have influenced associations reported. There is also potential for outcomes to be affected by coding errors or missing data. However, the results are reliable due to the large sample size. The OR is indicative of benefits associated with HEMS transport, with the confidence interval being within an acceptable range. Therefore, results indicated a clear beneficial effect of HEMS in patients suffering traumatic brain injury, provided they were transported to level 1 or level 2 facilities.(46)

A recent study published by Englum et al. investigated the current use of HEMS for paediatric trauma, and their outcomes. All children under 18 years in the National Trauma Bank suffering blunt or penetrating trauma, with ISS >8 and admitted to level 1 or 2 paediatric trauma facility were included for analysis. (47)

A total of 127 849 patients were registered, with 14% (18 291) of them transported by HEMS and 56% (71393) transported by GEMS. In HEMS cases, ISS was higher (ISS>25; 28% vs. 14%) and more decreased level of consciousness was noted (GCS <9; 29% vs. 11%). Despite these higher ISS and lower LOC, many of the HEMS cases only had minor injuries without significant physiologic derangements. Before adjustment using regression analysis, mortality was increased in the HEMS cases, at 7.4% vs. 4.8% in GEMS cases ($p<0.001$). However, after adjustment HEMS mortality rates were consistently and significantly lower in HEMS transport. Propensity paired OR for mortality was 0.7 (95% CI: 0.6 to 0.8). This relays into 2.1 lives saved for every 100 HEMS transports. Sensitivity analysis estimated shorter travel distances in GEMS cases vs. HEMS cases (median transport distance of 10 miles vs. 19 miles; $p<0.001$).

Despite confirming the survival benefit associated with HEMS in paediatric trauma cases, an apparent over-use of this resource was noted. Limitations of the study include the retrospective and observational dataset. Unnoticed bias could result in the more critically injured patients being transported by HEMS. No information regarding distances for pre-hospital transport was available for interpretation.

To conclude, all the studies analysed above clearly highlight the beneficial effect HEMS has on timesaving aspect of pre-hospital mode of transport. All the studies were able to identify the improved patient outcomes and mortality rates when HEMS transported patients. Specific patient groups were described which will appreciate a greater benefit from this mode of transport, specifically those with time critical injuries/pathologies such as AMI, stroke, traumatic brain injury, as well as patients in rural settings with further distances to appropriate facilities gaining greater beneficial effects from this mode of transportation.

Clinical benefit independent of time

HEMS are staffed with the most highly qualified practitioners, bringing with them invaluable knowledge and skills, which are beneficial in patient assessment, treatment and transport. The expertise brought to the scene by HEMS often exceeds that available on-scene, increasing the care available for specific patient groups.

These benefits are particularly pronounced in rural and resource-limited settings, where no Advanced Life Support Paramedic (ALS) is available in the pre-hospital environment.(48) By bringing these ALS procedures and medications to the patient who otherwise wouldn't receive them, HEMS is able to offer a beneficial aspect capable of improving clinical outcome beyond that of timesaving aspects.

Harmsen et al. performed a systematic review assessing the influence of pre-hospital times on the outcomes of trauma patients. They opposed the opinion linking reduced pre-hospital times to improved outcomes. A total of twenty observational journals were included, nine being prospective and eleven retrospective. They identified improved outcomes associated with increased times in patients suffering undifferentiated trauma. This improvement is linked to the clinical expertise brought to scene by the HEMS. Only in patients suffering from penetrating injuries together with haemodynamic instability, or those with neurotrauma, will reduced pre-hospital times be beneficial. In patients with undifferentiated trauma and are haemodynamically stable, pre-hospital times do not influence outcomes. This

proves that increased on-scene times typically associated with HEMS is not detrimental. Furthermore, authors suggested shifting the emphasis away from time and more towards appropriate pre-hospital management, except in cases with TBI, haemodynamic instability and neurotrauma.(49)

A study done by Brown et al. investigated the benefit of HEMS on patient outcomes independent of their timesaving benefits. They performed a retrospective study matching all GEMS and HEMS cases over five years. They calculated the survival benefit of HEMS over various transport times using conditional logistic regression.(50)

A total of 155 691 HEMS and GEMS cases were matched. Following matching, HEMS and GEMS cases had similar response, on-scene, and transportation times. HEMS cases were associated with higher ISS scores and specialist facility requirements.(50)

HEMS transport was associated with improved outcomes at various transport times, however the optimal benefit was seen at 16 to 20 minute transport time, with an 80% improvement in survival odds (AOR, 1.80; 95% CI, 1.51 to 2.14; $q=0.004$; $p<0.01$). There were no differences in patient outcomes for transport times above 30 minutes ($q>0.05$). (50)

A significant improvement in patient outcomes associated with HEMS as a mode of transport, even in the absence of a timesaving benefit was seen. These transport times relate to transport distances between 14.3 to 71.3 miles in HEMS transportation and 3.3 to 16.6 miles in GEMS transportations. The study was unable to determine what aspect of HEMS transportation was responsible for the improved survival odds, however the HEMS crew's capabilities and experience are believed to influence patient outcomes.(50)

Limitations of this study include the retrospective nature, with missing data resulting in the elimination of 25% of total cases in the study period. The database was not a population based, therefore results were skewed to the larger trauma facilities.(50)

Conclusion

These studies were able to highlight the advantageous aspects of HEMS and how, when utilised appropriately, we are able to use HEMS to improve patient outcomes. This is done by either reducing overall pre-hospital times in conditions requiring interventions only available at specialist facilities; or by initiating critical treatment prior to transportation that was otherwise unavailable on-scene, thereby manipulating time-saving aspects. This will be beneficial in the South African environment in cases where patients are far from specialist or tertiary facilities or where there is no ALS available by GEMS. By incorporating these considerations into dispatch criteria, we will be able to improve service delivery of EMS to all patients, regardless of their geographical location and access to healthcare facilities.

The time saving aspect associated with HEMS is particularly important in rural regions. As identified by literature, prolonged transport times increase mortality rates in specific trauma and medical conditions. In light of this, and being aware of the disproportionate distribution of healthcare facilities in the rural regions, it is apparent that HEMS use in these locations will decrease time to definitive care.

1.5 Risks and Cost-Effectiveness of HEMS

HEMS have become a very popular alternative mode of transport internationally and its benefits have been increasingly investigated. However, there is limited data available to identify the cost implications on this mode of transport. Analysis of the cost-benefit ratio needs to be assessed. This is specifically important in the South African environment due to the critical resource limitations, being a Low and Middle Income Country (LMIC).

Ringburg et al. evaluated the cost-effectiveness and Quality Adjusted Life Years (QALY) of physician-staffed HEMS in the Netherlands. They performed a prospective cohort study based at a trauma level 1 facility. QALY were calculated using patients' health outcomes and total cost. HEMS have been shown to improve outcomes in patients following moderate to severe traumatic injuries. In these cases, HEMS patients were more severely injured than GEMS cases. During the four-year observation period, HEMS saved 29 additional lives. Despite this, there was no statistically significant difference observed in patients' quality of life when comparing HEMS to GEMS cases. They calculated the cost of HEMS vs. GEMS for each QALY and sensitivity analysis. Results indicated that the overall cost of HEMS per QALY is under the acceptance level, indicating HEMS to be cost-effective.

These results are difficult to relate to the South African environment, as overhead-operating costs will be different. The level of care in GEMS has a large degree of variance depending on region and ALS availability.(51)

Taylor et al. performed a similar study where they analysed the cost-effectiveness of doctor-staffed HEMS service transporting patients to trauma centres in Australia. Their aim was to compare the cost-effectiveness of physician-staffed HEMS to patients transported by GEMS to the closest level one facility. They estimated costs associated with one life saved, as well as cost per life-year saved in three sub-groups: 1) All patients 2) patients with ISS > 12 and 3) patients with head injuries. They found that the cost-effectiveness of HEMS transport in patients improved as the patients' clinical condition worsened (i.e. higher ISS and head injuries). This information highlights the need for more accurate dispatch criteria in order to optimise the cost-effectiveness of the service. Limitations of this study include the difficulty in extrapolating the results into different settings, as costs and budgets are different in various countries. However, despite these limitations, the outcomes identifying patient groups obtaining the most benefit from HEMS will remain the same.(52)

Another study performed by Delgado et al. evaluated the cost-effectiveness of HEMS vs. GEMS in trauma cases in the United States. They found that in order to make HEMS cost-effective despite higher operating costs and risks associated with HEMS, there must be a minimum of 15% reduction of mortality rates amongst HEMS patients. For HEMS to be beneficial, 1.3 lives need to be preserved for every 100 critical patients flown to be considered beneficial financially. Considering the reservations, HEMS needs to reduce mortality rates by >26% (2.7 lives saved/ 100 patients transported with serious injury) in order to reach 95% probability of attaining cost-effectiveness. They were unable to determine whether these targets were being met, however they were able to suggest that by reducing over triage of patients on scene, thus reducing HEMS use in minor injuries, the cost-effectiveness will be more favourable.(53)

Taylor et al. was involved in another study conducting a systematic review investigating the costs and benefits associated with HEMS. A total of fifteen studies were included and differentiated according to patient diagnosis and the type of transportation offered (i.e. Inter-facility vs. primary response). Five studies proved HEMS to be more costly alternative to GEMS without concurrent clinical benefit. Eight studies identified cost-effectiveness associated with HEMS transport, and one

study evaluating the societal benefit due to HEMS and the cost thereof. They found large variations amongst studies reporting the cost and benefit of HEMS. They identified HEMS to be a very expensive resource when compared to GEMS, however a number of the studies suggested HEMS to be cost-effective. This included analysis of patients' quality adjusted life years as a result of mode of transport. It is, however impossible to infer these findings into the South African setting as the economic state of the country is different as well as local operating costs of various services.(12)

In a more recent study, Brown et al. calculated the cost-effectiveness of current HEMS use in comparison to using the AMPT score as HEMS activation criteria. They based their cost-effectiveness evaluation on a US health care system from 2007 to 2012. Data interpreted included patient demographic information, mortality, overall health care expenses, and utility estimations. Using probabilistic sensitivity analysis, they determined current HEMS utilisation trends to be poorer in 85% of iterations. This was only favourable if the cost-effectiveness threshold was increased per QALY. The AMPT score proved to be more cost-effective as it is able to categorise patients which will gain greater benefit from HEMS, thereby improving the cost-effectiveness ratio.(54)

The risks associated with HEMS need to be considered when dispatching HEMS as well. Helicopter accidents are not uncommon and more attention needs to be paid to this aspect of the cost-benefit ratio. In the USA, there was a documented incident of 85 HEMS accidents between 2003 and 2008, with 77 deaths.(55) From these statistics, it is apparent that we need to be more calculated when deciding when to utilise this service, as inappropriate use increases the number of flights and overall flight hours, thereby increasing the probability of accidents occurring, which could be avoided.(55)

This identifies the need for an appropriate call out criteria to be developed in order to reduce over triage of patients on scene. Over-triage is linked to increased costs on the health care system, thereby reducing overall cost-benefit ratios. Over-triage of patients results in HEMS crews' overall flight hours increasing, which increase their risk of exposure to safety concerns. (56) Over-triage of patients results in flying patients whose injuries are not time sensitive or do not require reduced transport times and therefore, these patients will not benefit from the advantages associated with HEMS thereby wasting an expensive resource as well as increasing risk aspects for crews.

However, despite the risks associated with over-triage, there are also serious implications associated with under-triage. Under-triage of patients results in patients who would benefit from HEMS not being afforded this mode of transport, thereby potentially resulting in poorer outcomes. Cost-benefit should also incorporate instances where HEMS is the only mode of transport that is able to access patients, or that will be able to transport patients to appropriate facilities.(56)

1.6 HEMS Dispatch Criteria

Rapid transportation to specialist facility and timely initiation of appropriate medical treatment determine survival outcomes in critical patients. HEMS have the ability to deliver these benefits to patients, if utilised appropriately.

The identification of patients that will gain maximal clinical benefit from this service can be challenging, given the shortage of evidence and resources currently available in the pre-hospital environment. In addition to this, the high costs and risks associated with HEMS make appropriate patient selection a necessity.(57)

For maximal benefit on patient outcomes, HEMS need to be fully integrated into the existing EMS system, both locally and regionally. A standardised dispatch criteria, appropriate communication, and synchronisation with scene and hospital personnel as well as destination considerations, are paramount to the efficient utilisation of HEMS. It is also important to continuously evaluate the outcomes of patients in order to improve the current systems.(58)

In a position statement published by Floccare et al, the opinions from the Air Medical Physician Association (AMPA), the American College of Emergency Physicians (ACEP), the National Association of EMS Physicians (NAEMSP) and the American Academy of Emergency Medicine (AAEM) were combined to develop guidelines to ensure the appropriate and safe use of HEMS to improve patient outcomes.(59) Three characteristics of HEMS were identified to produce measurable clinical benefits to patients: 1) Reducing pre-hospital times in patients with time-sensitive injuries or conditions, 2) Delivering appropriate medical expertise (e.g. skills, equipment, pharmacological agents etc.) to patients prior to and during transport, 3) Entering areas which are otherwise, geographically inaccessible.(59) The guidelines highlight the importance of specialist training and careful selection of cases appropriate for HEMS transport with the need to integrate the HEMS services into healthcare systems.(59)

The NAEMSP published a list of time-sensitive conditions deemed suitable for HEMS. However, no literature exists to direct decisions regarding the timesaving aspect of transportation.

The authors identified the need to develop clear guidelines identifying patient conditions and geographical locations from which patients will gain clinical benefit from HEMS, with specifications regarding the time-saving aspects related to transport mode. These guidelines need to overcome local resource restrictions by either delivering expert care more promptly and/or by transporting the patient to the appropriate facility faster. This requires a more structured approach to authorizing HEMS utilisation, rather than relying on the opinion of the on-duty Medical Officer (MO).(59)

The key point made by this document was the importance of integrating the HEMS into the local healthcare infrastructure. HEMS have the capability to manipulate time to benefit patient outcomes. However, the degree of time manipulation is dependant on the local EMS capabilities and distance to appropriate facilities. Clinical benefit needs to be weighed up against the cost and safety concerns. Continuous refinement of evidence-based HEMS utilisation guidelines is necessary.(59,60)

In line with these recommendations, we will appraise current literature available classifying various triage or patient identification criteria in order to gain further insight for appropriate HEMS utilisation.

A study conducted by Brown et al. determined the validity of the Air Medical Pre-hospital Triage (AMPT) Score that aimed to identify trauma patients who would benefit from HEMS.(57) The AMPT score includes eight criteria: 1) GCS <14; 2) RR <10 or > 29 respirations/minute; 3) Unstable chest wall fractures; 4) Suspected haemothorax or pneumothorax; 5) Paralysis; 6) Multisystem Trauma; 7) Physiologic & Anatomic Criteria, with one point allocated to each criteria. Patients triaged with an AMPT score <2 were transported by GEMS and those with AMPT score >2 were transported by HEMS.(57)

Multilevel regression analysis was used to determine the effect of mode of transport on patient outcomes. A total of 222 827 patients were transported, 44 351 by HEMS and 178 476 by GEMS. In the group triaged to GEMS, the mode of transport did not have an impact on survival outcome (ARR 1.004; 95%CI 0.999 to 1.009, p=0.077) and identified GEMS transport of these patients to be comparable to HEMS. In the group transported by HEMS (AMPT >2), there was an independent increase of 6.7%

on the relative probability of survival (AAR 1.067; 95% CI 1.040 to 1.094, $p < 0.001$). The improved survival outcomes associated with HEMS was only demonstrated in patients with AMPT score > 2 (ARR 1.058; 95% CI 1.033-1.083, $p < 0.001$). Results showed no correlation between outcomes and mode of transportation in patients with an AMPT score of one (ARR 1.005; 95% CI 0.995-1.016, $p = 0.331$) and comparable outcomes associated with GEMS for these patients.(57)

Current triage criteria is useful in establishing the need for transportation following traumatic injury to a trauma facility, whereas air medical triage aims to classify patients needing a trauma facility who will additionally benefit from HEMS as a mode of transport specifically.(57)

Limitations of the study include the retrospective design; the registry data was not purposely collected for this study. There was missing data in the pre-hospital information, however several imputations were used to mitigate these, validated in the trauma registry. Transport distances were not included in the study and quality of life was not assessed.(57)

These results are statistically significant, demonstrating the reliability and validity of the AMPT score in classifying patients who will gain clinical benefit from HEMS as a mode of transport following traumatic injuries. This is the first evidence-based criteria developed for HEMS triage of trauma patients. The AMPT score must be used in combination with logistical considerations including traffic, distance, weather and GEMS availability.(57)

A previous study by Brown et al assessed the National Trauma Triage Protocol (NTTP) and its ability to predict which patients would benefit from HEMS transportation. The NTTP uses four categories for on-scene EMS to use to triage patients. These categories are: 1) Physiologic parameters, 2) Anatomical considerations, 3) Mechanism of Injury and 4) Special considerations. This tool is used to determine which patients need to be transported to a specialist trauma facility. It is important to differentiate between the need for transportation to a specialist trauma centre and the patient in need of the trauma centre which would also benefit from HEMS transportation.(61)

Logistic regression analysis was used to establish whether mode of transport was an independent predictor of patient outcomes. A total of 258 387 patients were included, 16% transported by HEMS and 84% transported by GEMS. Patients in the HEMS group were more critical than the GEMS group, with a mean Injury Severity

Score (ISS) of 15.9 vs. 10.2 ($p < 0.01$). Logistic regression identified HEMS to be an independent predictor of patient outcome in patients meeting the following triage criteria: Penetrating injury, GCS < 14 , RR < 10 and > 29 /minute, and > 55 years old. These criteria had a high positive predictive value (PPV) and specificity and were able to predict the need for transport to specialist trauma centre in the HEMS group compared to the GEMS group ($p < 0.01$).⁽⁶¹⁾ Survival benefit was greater in patients with more than one physiologic derangement.⁽⁶¹⁾

The author acknowledges the need to incorporate logistical considerations such as time, distance and GEMS capabilities when considering the need for HEMS. Limitations of the study are the retrospective design and the limited variables available to be analysed.⁽⁶¹⁾

Liu et al investigated the inefficacy of routine vital sign monitoring for determining mortality rates and the need for pre-hospital interventions. Study inclusion was patients transported by HEMS following blunt trauma. They compared patient groups receiving life saving interventions to those not receiving life saving interventions in the pre-hospital environment. Various statistical tests were used in order to predict survival rates and the need for pre-hospital life saving interventions.⁽⁶²⁾

A total of 195 patients met inclusion criteria, with 15% of patients receiving pre-hospital life saving interventions, of which 40% died. Vital sign monitoring included pre-hospital heart rate, lowest systolic blood pressure, pulse pressure, GCS and shock index. Based on these vital signs, the need for life saving interventions and mortality predictions were determined using ROC curves (AUC= 0.72, 0.65 and 0.61). From these results, it is apparent that conventional vital signs are not adequate to predict severity of injuries and patient clinical needs.⁽⁶²⁾

Thomas et al. developed an evidence-based guideline for the use of HEMS in trauma patients. They used a multi-institutional group of recognised establishments in the trauma field to recommend a system to select patients in the pre-hospital environment that would benefit from HEMS transportation.⁽⁶³⁾

The aim of the study was to 1) Develop triage criteria for on-scene risk stratification of ISS to guide hospital choice and mode of transport; 2) describe the role and function of a medical officer (MO) for allocating HEMS resources and 3) determine specific criteria in which HEMS will improve outcomes.⁽⁶³⁾

The National Evidence-based Guideline Model Process was utilised. They reviewed current literature, and participants designated a strong/weak recommendation for each criteria, whilst rating available evidence.(63)

They recommend using the 2011 Centre for Disease Control (CDC) Guidelines to triage patients, using anatomy, physiology, mechanism of injury and comorbidities. If the patient meets CDC anatomical or physiological criteria, HEMS should be utilised only if it results in a notable time reduction. No MO consultation is recommended for these criteria. In patients without physiologic/anatomic criteria, GEMS is recommended, provided there are no system factors preventing this. MO consultation can be sought to aid this decision. If any system factors are present, HEMS should be utilised.(63)

CDC triage guidelines place the emphasis on patient physiology and the anatomy of injuries. They identify the potential of over-triage, however their aim was to identify patients with increased probability of serious injuries, thereby improving resource allocation of HEMS to patients that will gain the most benefit from reduced pre-hospital times.(63)

Ringburg et al. performed a systematic review assessing the validity of HEMS dispatch criteria in traumatic cases. A total of 34 publications met their inclusion criteria, and from these publications they were able to identify 49 criteria used for dispatching HEMS. These were subdivided into four categories.(56)

In their review, they found that dispatch based on “mechanism of injury” (MOI) has a very low PPV (27%) with a sensitivity ranging from 0-73% and specificity between 72-97%. These results identify significant over-triage, but minimal under-triage. When analysing dispatch criteria based on “anatomy of injury”, they had low PPV (22-38%) with a sensitivity of 45%. They have a 13% under-triage rate, however over-triage rates were reported as “unacceptable”. “Physiologic parameters” had contrasting results. Rhodes et al. reported high sensitivity (98%) and low specificity (43%), whereas Wuerz et al. reported moderate sensitivity (56%) and high specificity (86%). Overall, however, this criterion resulted in minimal over-triage and reasonable under-triage. They identified level of consciousness as a suitable criterion for appropriate HEMS dispatch. The last category, “other” was not adequately reported on to include.(56)

In conclusion, the systematic review identified the lack of literature describing validity of HEMS dispatch criteria, and that they were unable to apply results generally. This was a poorly reported systematic review; there was inconsistency with reporting of results as well as contradicting statements.(56)

Wigman et al. investigated dispatch criteria used by HEMS services operating within Europe. "Mechanism of injury" was the most frequently used criteria, with a specificity rate between 72-97%, resulting in an acceptable level of over-triage (calculated as 1-specificity). The sensitivity rate was 0-73%, which results in high under-triage. The high utilisation of HEMS for "mechanism of injury" results in significant over-triage, resulting in excessive use of a very expensive and specialized service. "Penetrating injury" was used in 18 organizations (41%), contradicting the "scoop and shoot" teachings for trauma. It was noted that for this criteria, it was more beneficial for patients in rural areas, or for those in difficult-to-access locations. (64)

The category "physiological parameters" appeared popular with approximately 82% of organizations utilising it. They identified "Low Glasgow Coma Scale" (GCS < 13) to be the most commonly utilised sub-category, with a sensitivity of 98% and specificity of 96%, advocating the appropriateness of this indication for HEMS dispatch criteria. These criteria are highly dependent on the ability of on-scene personnel to appropriately assess patients.(64)

The use of the category "transport considerations" was significant, and was identified as an important resource in situations where patients are inaccessible by road, or where road transport times would be significantly long. The use of this criteria was largely dependent on geographical settings and population density of the country.(64)

Specific dispatch criteria were not used in Bulgaria, France and Slovenia, as they rather employ physicians who then make individual decisions on HEMS utilisation based on received information. Four services in the UK also made use of similar structure, with paramedics operating in the dispatch centre, tasking HEMS. This dispatching system was reported to reduce aborted missions from 40% down to 12%. This highlights the importance of medical knowledge and training when dispatching HEMS. It identifies the ability physicians possess to integrate their knowledge into the system and more accurately identify patients who will benefit from the service.(64) The study highlighted the absence of uniformity of dispatch criteria for trauma cases. They identified "mechanism of injury" and "physiological

parameters” to be the most acceptable criteria, each having high specificity and moderate sensitivity.(64)

Raatinieni et al performed a study determining the reliability of HEMS benefit and the use of the National Advisory Committee for Aeronautics (NACA) score. The NACA score is used to gauge the severity of injury or disease of patients in the pre-hospital environment, but has been criticised for being subjective. A Finnish HEMS uses a HEMS Benefit Score (HBS), however this score is not backed by sufficient literature. This study determined the reliability of these two scores using intraclass correlation coefficients, inter-rater and rater-against-reference reliability tests. Fictional scenarios were created and an expert panel was asked to calculate NACA and HBS with given information. The intraclass correlation coefficients were 0.70 (95% CI 0.57 to 0.83) for HBS and 0.65 (95% CI 0.51 to 0.79) in the NACA calculation. Results identified adequate inter-rater reliability using NACA score and HBS, despite large differences seen between individual raters and references in certain scenarios.(65)

Schoettker et al. calculated the type and extent of injuries of patients ejected from motor vehicles, and the potential influence of HEMS on patient outcomes. Outcomes demonstrated more severe injuries associated with patients ejected from vehicles when compared to those not ejected, with a median Injury Severity Score (ISS) of 17 and 9 respectively ($p < 0.05$).(66) These patients also required more ALS interventions than the not-ejected patients. Ejection of occupants occurs in approximately 1.5% of all motor vehicle accidents however, despite the low frequency, their fatality rates are high.(66)

This study identified “ejection” to be a good indicator for identifying critical patients, who will most likely benefit from HEMS transportation. They also found that increasing physician involvement in triaging patients resulted in reduced rates of over-triage. By using “ejection” as dispatch criteria, total time to ALS interventions and arrival to appropriate facility is reduced, thereby improving patient outcomes. The limitation associated with this research is the inability to distinguish between modes of transport on outcomes, as HEMS transported all patients. Despite this, it is still apparent that utilising “ejection” as criteria for identifying critical patients is feasible. (66)

Research conducted by Matsumoto et al. investigated the feasibility of using an Advanced Automatic Collision notification system to identify major incidents and reduce time to dispatch of HEMS.(67) Their findings demonstrate a marked

reduction in time to EMS notification of major incidents. In the United States, it was estimated that the implementation of this system can reduce mortality rates following road traffic accidents by 12% in the rural regions and by 1.5 to 6% nationally.(67) Various information, such as speed, impact, occupant numbers, rollover and change in speed, can be obtained using this system relating to the incident. This allows dispatchers to make a more informed decision on the need for HEMS as the incident occurs, eliminating the time taken for bystanders to report incidents. Limitations of this study include the difficulty to extrapolate these findings into uncontrolled, real-world setting. Additionally, this mode of dispatch will result in high over-triage rates, which decreases the benefits of HEMS. In a resource limited country, this mode of dispatch is not ideal.(67)

In 2012, Garner et al. investigated the impact that the dispatcher's qualification or knowledge had on the identification of cases requiring HEMS assistance. They specifically investigated this in the paediatric population, and its effects on transportation of patients to appropriate paediatric trauma centres.(68)

It was documented that when physicians directly involved in HEMS were used to identify cases requiring direct transport to paediatric trauma centre, more cases were identified resulting in a larger percentage of transportation to the appropriate facilities (RR 1.81, 95% CI 1.20-2.73). This study also reported shorter arrival times using HEMS (HEMS available 92 minutes, IQR 50-261 vs. GEMS 296 minutes, IQR 84-583, $P<0.01$). Their data identified the beneficial effect that HEMS crew dispatch had on accurately identifying cases that would benefit from HEMS transportation and influencing direct transport to appropriate facility. Limitations of the study was the lack of long term data available for interpretation of cases.(68)

Following this, in 2016, Garner et al. investigated the differences in case identification of severely injured paediatric patients needing transportation to appropriate paediatric Trauma Facility. In the first time period, physicians staffing the HEMS were used to identify appropriate cases in addition to paramedic dispatcher ($n=71$) and in the second time period the paramedic in the control room operated alone ($n=126$). (69)

Multivariable regression analysis was used to control confounders. Without the addition of the physician in case identification, the rates of paediatric case identification dropped from 62% to 31% ($p<0.001$) and the identification of critical cases dropped from 100% to 47% ($p<0.001$). Rates of direct transport to a paediatric centre dropped from 66% to 53% ($p=0.076$) and median hospital arrival

times increased from 69 minutes (IQR 52 to 104) up to 97 minutes (IQR 56 to 305) with $p=0.003$.(69)

These results demonstrate the advantages associated with physician screening of cases, with case identification halving following the removal of physicians and a simultaneous increase of 28 minutes to paediatric facility arrival. These results have the potential to adversely affect outcomes in critical patients.(69)

Limitations of this study include the temporal changes which potentially happen independent to the intervention. Missing data resulted in exclusion of cases. Sensitivity and specificity calculations were not reported on.(69)

Moront et al. did a comparison of HEMS and GEMS in paediatric patients being transported to a level 1 paediatric facility. Additional to this, they retrospectively analysed triage criteria and deployment patterns for HEMS.(70)

Looking at the Trauma Injury Severity Score (TRISS), HEMS saves 1.1 lives for every 100 patients flown. Despite mortality rates being reduced from 52% to 21% in HEMS cases, it was found that >83% of paediatric patients transported by HEMS were only moderately injured, with ISS <15 and TRISS probability of survival > 0.90, representing significant over-triage. Physicians are not consulted prior to HEMS activation, potentially accounting for this high rate of over-triage by on-scene medics.(70)

Vital sign parameters are difficult to use as dispatch criteria in paediatric patients, as their “normal” values are so wide. They found that using GCS as an indication to fly resulted in acceptable sensitivity and specificity rates (97.9% and 96%, respectively). If heart rate was found to be >160 bpm, this increased sensitivity to 99%, but resulted in a simultaneous reduction in specificity (96% to 90%) increasing over-triage rates to approximately 85%.

This study is limited by the assumption of on-scene vital signs in cases where these values were missing. GCS was shown to be the most consistent vital sign, identifying it as a reliable tool for accurate triage.(70)

Hirsham et al. investigated the effects of HEMS system amendments on patients' outcomes over a ten-year period in Maryland's HEMS experience. They adapted the Centres for Disease Control Triage guidelines to guide HEMS activation. By applying these trauma triage guidelines across the state, HEMS use was reduced by 49%, and by 59.9% for trauma cases (95% CI 51.2 – 60.5%). HEMS use

decreased by 78.2% (95% CI: 74.3 – 82.1%) for transport distances below 30 minutes and 12.9% (95% CI: 5.1 – 20.7%) for those above 30 minutes. A resultant reduction in adjusted trauma fatalities was observed over this time as well, with 24-hour hospital discharge numbers decreasing and increased overall ISS. After statistical analysis and adjustments were made, patient mortality rates improved, signifying system enhancement and improved patient selection.(71)

Limitations of the study are the inability to link results between the old and new datasets without unique identifiers being present. Retrospective data analysis is always subject to missing or unmeasured data, having the potential to skew the results. The statistical test used is only validated on patients with blunt trauma, therefore patients with penetrating injuries were excluded. The data used was collected from two independent sources, thus patient information could not be directly linked.(71)

Currently the dispatch criteria utilised by South African helicopters are not strictly adhered to, resulting in a large number of patients being flown that do not gain clinical benefit from the use of HEMS. A study conducted by Muhlbauer et al. analysed patients transported by a private HEMS in South Africa. Their results identified a potential over-triage in patients flown as ten patients (1.9%) were discharged from hospital within a 24-hour period. Additionally, 339 patients (63.1%) were alive and clinically stable following the 24-hour follow-up. The findings were reported as statistically significant, with a p-value of 0.049. At the 72-hour follow-up, 37 patients (6.9%) had been discharged and 404 patients (75.3%) were alive and clinically stable.(10)

These results highlight the need to develop dispatch criteria specific for the South African environment, as HEMS appears to be over-utilised. Additionally, their results identified the urban areas utilising HEMS more frequently. This contradicts the timesaving aspect associated with HEMS, as (unless traffic congestion is present) HEMS has been linked to reduced transport times only as transport distance increases.(38) Limitations associated with the study was their sample being from one private service only, and only two bases.(10)

There are large costs associated with the use of HEMS as well as safety concerns or risks that need to be considered when determining the benefits of HEMS for each scenario. In essence, dispatch criteria should aim to improve patients' outcomes by assessing their clinical condition, the need for interventions unavailable on scene and the distance or transport time to the most appropriate facility.(58)

There are specific clinical presentations or injuries benefit when transported by HEMS. By identifying these and implementing more appropriate call-out criteria for the South African environment, we will be able to ensure HEMS affords the greatest benefit to the appropriate patients, resulting in improved cost-benefit ratios.

1.7 Conclusion

To conclude, we have identified and elaborated on the various benefits HEMS brings to pre-hospital patient care. Literature clearly supports the clinical benefit associated with HEMS transportation, however they all emphasise the need for specific selection of patients whom will gain this benefit. As cost is always a consideration when utilising such a valuable resource, there are many studies identifying the need to develop selection criteria in order to render HEMS more cost-effective, which is particularly important in the South African environment with limited resources. To this end, we aimed at systematically utilising expert opinions to reach consensus on HEMS call-out criteria that are contextual to the South African setting.

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PART B: ARTICLE

**Article formatted according to the African Journal of Emergency Medicine
Author Information Pack.**

Please note: Appendices start from “Appendix B” as per AfJEM Author Information Pack

DEVELOPING A CALL OUT CRITERIA FOR SOUTH AFRICAN HELICOPTER SERVICES: A DELPHI STUDY

2.1. ABSTRACT

Background

Helicopter Emergency Medical Services (HEMS) are an expensive resource that should be utilised efficiently to optimise the cost-benefit ratio. This is especially true in resource-limited settings, such as South Africa. This may be achieved by implementing call-out criteria that are most appropriate to the healthcare system in which HEMS operate. Currently, there are no published evidence-based HEMS call-out criteria developed for South Africa. By identifying patients that are most likely to benefit from HEMS, their utilisation can be enhanced and adjusted to ensure optimal patient outcome.

Aim

To systematically utilise expert opinions to reach consensus on HEMS call-out criteria that are contextual to the South African setting.

Methods

A modified Delphi technique was used to develop call-out criteria, using current literature as the basis of the study. Purposive, snowball sampling was employed to identify a sample of 118 participants locally and internationally, of which 42 participated for all three rounds. Using an online survey platform, binary agreement/disagreement with each criterion was sought. Acceptable consensus was set at 75%. Statements were sent out in the third round ascertaining whether participants agreed with the analysis of the first two rounds.

Results

After two rounds, consensus was obtained for 63% (36/57) of criteria, while 64% of generated statements received consensus in the third round. Results emphasised the opinion that HEMS dispatch criteria relating to patient condition and incident locations were preferential to a comprehensive list. We present these criteria in a collated format, favouring further inquiry on a case-by-case basis. Participants suggested the use of a screening tool, which can guide dispatch decision-making.

Conclusion

The combination of existing literature and participant opinions, established that call-out criteria are most efficient when based on clinical parameters and geographic

considerations, as opposed to a specified list of criteria. This could improve resource allocation, specifically in a low to middle income country such as South Africa.

WORD COUNT: 310

2.2 INTRODUCTION

Utilised internationally since the Second World War,(1) Helicopter Emergency Medical Services (HEMS) were first introduced to the South African civilian setting in 1976. Based in Johannesburg, the first helicopter service was utilised for inter-hospital transfers.(2) Currently, HEMS are used for both inter-hospital transfers and primary scene responses, with services operating in six out of the nine South African provinces.(2)

In the South African setting, a number of factors delay patients' access to healthcare, including the heterogeneous distribution of specialist and tertiary hospitals, the disproportionate population distribution between rural and urban areas, and the shortage of paramedics.(3,4) If used appropriately, HEMS can reduce time to definitive care, increase accessibility for patients in remote or inaccessible areas, as well as bypass hospitals, and deliver patients directly to the most appropriate level of care. In this manner, HEMS may potentially reduce the burden on local EMS systems by reducing inter-hospital transfers and prolonged hospital stay.(5–7)

Unfortunately, HEMS are known to be a costly resource. Delgado et al. suggested that in order for HEMS to be cost-effective in the United States, there must be a minimum of a 15% reduction in mortality amongst critically injured patients transported.(8) This relates to 1.3 lives saved for every 100 critical patients flown by HEMS to cost <100 000 USD for every quality adjusted life year gained. Reducing over-triage will improve cost-effectiveness.(8) This information highlights need to optimise dispatch criteria to improve HEMS cost-effectiveness.(9)

Internationally, HEMS are dispatched to incidents following three modes of activation: 1) Immediate dispatch 2) Interrogated dispatch and 3) Crew request. These are based on the mechanism of injury, physiological parameters, the severity and location of injuries, age, distance/time to appropriate facility and the geographical accessibility of the incident.(10) This model is not practical for the low to middle income countries (LMIC), as this results in a high over-triage rate, reducing the cost-benefit ratio.

In South Africa, HEMS activation is not standardised, resulting in inconsistent HEMS dispatch between different services. Typically, on-scene EMS providers are required to perform a clinical assessment of the patient before consulting with the Chief

Medical Officer (CMO) on duty. CMO's are ultimately responsible for determining eligibility, and authorisation for flight. This process however, constitutes a highly subjective dispatch procedure, as there is no definitive criteria guiding CMO's decision, rather depending on information gathered during consultation, which is not standardised.

A more detailed HEMS authorisation procedure specifically designed for the South African environment is needed; identifying which patients would gain maximal benefit from HEMS. The aim of this study was to systematically utilise expert opinions to reach consensus on call-out criteria that are contextual to the South African setting.

2.3 METHODS

A modified Delphi methodology was utilised, as this allows the researchers to gain insight from experts in the field, with an understanding of the specific resources and needs within the South African environment. Gathering currently accepted criteria from literature and well-established HEMS homepages was used to develop a list of call-out criteria.(11–14)

These criteria were collated and presented to participants to decide whether these specific HEMS call-out criteria were applicable to the South African setting.

A total of 62 call-out criteria were listed under four headings: 1) Mechanism of injury [25 criteria]; 2) Patient Characteristics – Anatomical location of injury [14 criteria]; 3) Patient Characteristics – Physiologic Parameters [15 criteria]; 4) Miscellaneous [8 criteria].

An online survey platform, SurveyMonkey® (Palo Alto, CA, USA)(15), was used for the study and potential participants were invited via personalised email links. Purposeful, snowball sampling was used to identify an appropriate sample of physicians and paramedics locally and internationally. The majority of participants who responded to the initial invitation to participate were South African, this therefore means that snowball sampling yielded a greater number of South African participants being enrolled. (16) Physicians needed a minimum of two years experience within the fields of Emergency Medicine, Surgery or Anaesthesiology. In addition to this, HEMS exposure was required- either operationally or involvement in the authorisation process. Paramedics needed a minimum of two years experience in the pre-hospital environment with at least part-time HEMS experience. The survey had a binary outcome, either agree/disagree with criteria listed and consensus was

set at 75%. Participants also had the opportunity to provide any justifications or suggestions in a free text field after each criterion, giving the researcher insight into their reasoning behind their answers.

After each round, content analysis was performed, with researcher extracting certain themes or ideas that were popular amongst participants. Feedback of those criteria not reaching consensus was presented back to the panel for re-evaluation. A total of three rounds were conducted.

This study was approved by the Human Research Ethics Committee of the University of Cape Town (774/2015). Participants gave consent by clicking “agree” on the first question of the survey, with anonymity remaining throughout each round using customised program settings.

2.4 RESULTS

We identified and invited 118 experts, of which 65 completed surveys for round one, 49 participants completed surveys in round two and 42 completed surveys for round three. This yields an initial response rate of 55% and an attrition rate of 25% after round one, and 14% after round two. Our results are in line with previous studies describing acceptable sample sizes ($n=15-20$) (17) and attrition rates ($<30\%$). (18)

The demographic information of the expert panel is presented in Table 2.1. The majority of the panel were South African paramedics ($n=41$, 63%) with 11-15 years post-graduate experience ($n=18$, 27%) and greater than five years of part-time HEMS experience ($n=17$, 27%). Notably, 20% ($n=13$) of the panel had greater than five years' full-time HEMS experience.

Table 2.1: Demographic data of the panel

Qualification	n	%
Paramedic	47	72%
Critical Care Assistant	10	15%
NDip: Emergency Medical Care	5	8%
BTech: Emergency Medical Care	24	37%
Non South African Qualification	8	12%
Doctor	18	28%
Anaesthesia	6	33%
Emergency Medicine	9	50%
Surgery	1	6%
Aviation	2	11%
Country of qualification		
South Africa	58	89%
Other	7	11%
Experience		
2-5 Years	10	15%
6-15 Years	30	46%
More than 16 Years	25	39%
Years HEMS Experience		
Part-time Experience	41	63%
Full-time: Under 5 years	11	17%
Full-time: More than 5 years	13	20%

Consensus was obtained in 32% (18/57) of the collated criteria after the first round, increasing to 63% (36/57) following the second round. Criteria were sub-divided into categories, with “Mechanism of Injury” obtaining 48% (12/25), “Patient

Characteristics: Anatomy” obtaining 86% (12/14), “Patient Characteristics: Physiologic parameters” obtaining 60% (6/10) and “Miscellaneous” obtaining 75% (6/8) consensus after two rounds. The individual consensus levels at each round for every criteria is contained in Appendix B.

Free text responses from the first two rounds were subject to content analysis, which were used to generate a list of statements (see Table 2.2) that were sent out to participants in the third round of the study. Consensus was met in 71% (10/14) of these statements. The entire Delphi process is depicted in Figure 2.1, detailing each round’s consensus and sample size. These results were used to gain further insight into the factors participants felt were important when dispatching HEMS in the South African setting.

Figure 2.1: Delphi process flow

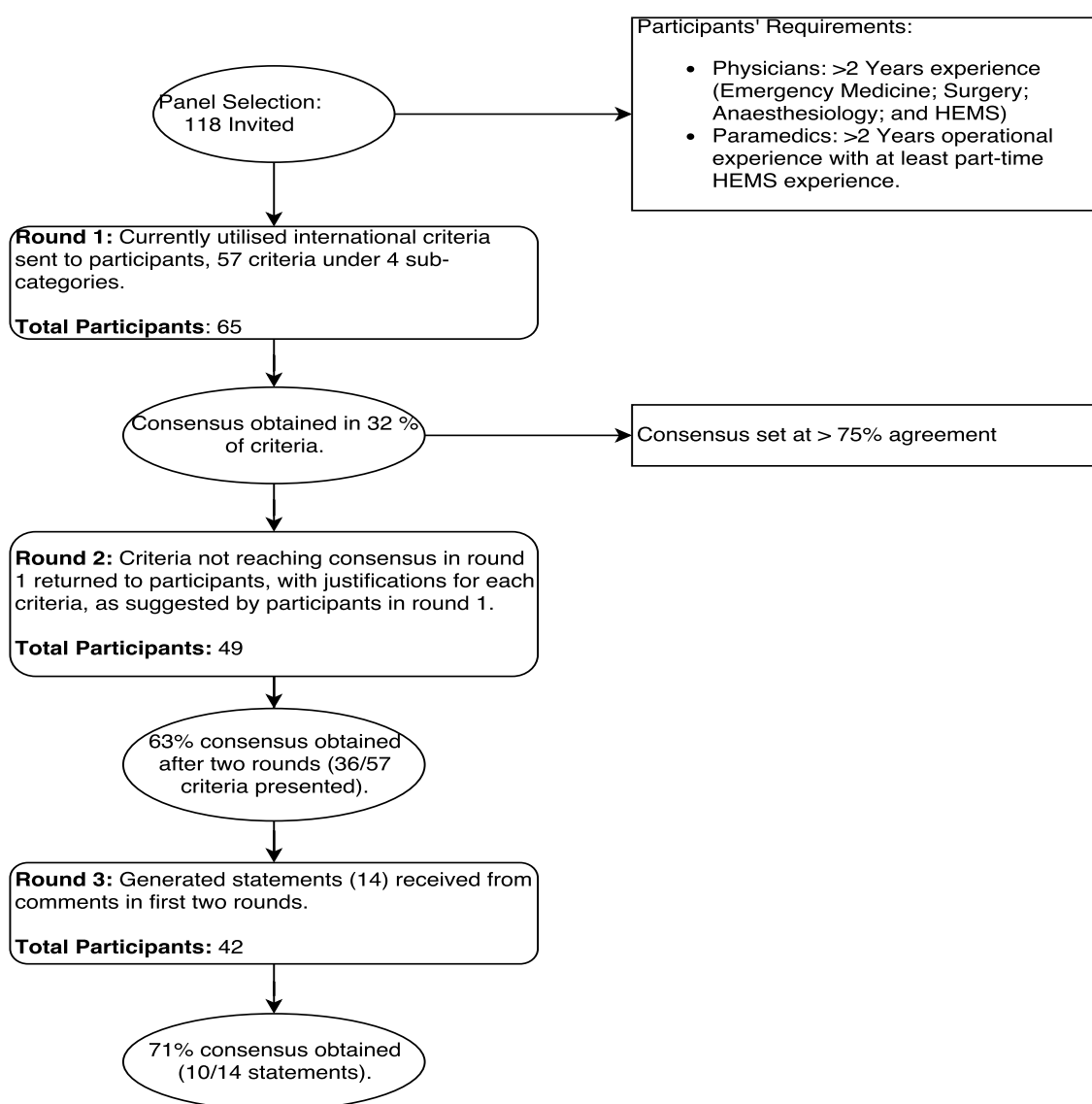


Table 2.2: Summary of Round Three Statements

STATEMENT
1) HEMS dispatch should be based on the patients' clinical condition, the on-scene resources, the environmental and geographical conditions, and the distance to appropriate facility.
2) Time-saving aspect of HEMS is often overestimated, need for consideration of delays typically associated with HEMS.
3) HEMS should be dispatched if, after clinical evaluation, the patients' injuries require surgical interventions and HEMS is guaranteed to be the fastest mode of transport to appropriate facility.
4) HEMS should be dispatched if, after clinical evaluation, the patient needs pre-hospital stabilization and there is no ALS on or near scene.
5) HEMS should be dispatched only if time for HEMS to reach patient/scene is faster than ground transportation without ALS to hospital ("load-and-go").
6) HEMS should be dispatched for difficult or delayed ground access by ambulance, i.e. Bad terrain, poor road conditions, traffic, etc. Which will delay time to hospital significantly ONLY in the case of time-critical injuries.
7) Alternatively, regardless of the severity of the injury, HEMS should be dispatched for difficult or significantly delayed ground access by ambulance, i.e. Bad terrain, poor road conditions, etc.
8) For "Patient Characteristics: Anatomy", isolated injuries cannot justify HEMS use, additional signs and symptoms or comorbidities indicating critical injuries requiring surgical interventions are necessary. Even in these cases, the deciding factor should be the time-saving aspect of HEMS.
9) For "Patient Characteristics: Anatomy", even with the presence of comorbidities, a thorough clinical examination needs to be performed to justify HEMS use. Again, the time-saving aspect of HEMS is the prime factor to be considered.
10) Only in extreme cases without paramedics available on GEMS or exceptionally poor road conditions, does analgesia warrant HEMS.

11) Time-saving ability of HEMS supersedes the medical expertise associated with HEMS

12) Known cardiac/respiratory disease, if HEMS can guarantee reduced transport times.

13) Utilising a CRAMS score <8 as an indication for HEMS is a helpful score for clinical assessment, however it is too unfamiliar to utilise as a new evaluation tool.

14) Cardiac arrest (post-traumatic) with ROSC does not warrant HEMS, unless HEMS has the ability to effectively treat patient with thoracotomy, blood transfusion, etc.

* Grey Highlighted Criteria are those which met >75% consensus

Due to the limited resources in South Africa, participants felt that mechanism of injury should never be used in isolation as an indication for HEMS dispatch. The participants reported that no matter how significant the mechanism of injury seems, HEMS should only ever be utilised after trained professionals perform patient assessment, and confirm the clinical condition and severity of injury. One participant commented that the *“Mechanism of injury does not imply clinical condition; with the advances in pre-hospital emergency medicine, we should be able to adequately diagnose injuries requiring HEMS. Resource allocation should definitely not be allocated based on mechanism alone”*. Further to this, 93% (39/42) of participants felt that the distance to hospital, road condition, appropriateness of closest facilities and the availability of paramedics on scene should all be factored in to the decision.

In most urban settings, the participants felt that the timesaving benefit of HEMS was not justified. One participant stated, *“This is a controversial issue. I would specify that the ‘total time’ from injury to hospital should be significantly less than that which could be achieved by road transportation”*. In these settings, it was suggested that pre-hospital providers of the most basic level should rather transport patients to hospital than await HEMS arrival on scene.

However, participants did not recommend this in the rural settings. They felt that as distances increase, the potential timesaving for HEMS increase. As mentioned by one participant, *“HEMS only saves time where distance is greater than 72 kilometres or 30 minutes from hospital by road.”*(19) Other factors such as weather, urban vs. rural, distance to closest versus most appropriate facility, and on-scene

need for advanced skills were factors participants felt needed consideration. Nevertheless, the majority of participants acknowledged that reduced times were not the only benefit of HEMS and emphasised that the expertise of the crews and the ability to bypass closer facilities in order to reach appropriate facilities are crucial aspects.

Participants agreed that very specific conditions are necessary for HEMS to be justifiable if a paramedic is available on scene. They listed criteria such as poor road conditions and peak traffic as warranting HEMS under these circumstances.

Finally, the participants raised concern around the ability of the CMO making a telephonic dispatch decision. The CMO needs to understand the specific clinical and logistical needs of patients within the pre-hospital phase of care in order to make appropriate decisions. All participants agreed (100% consensus) that a set list of criteria is not feasible for the South African setting. They suggested using a dynamic questionnaire that can be adapted to the specific circumstances. This tool was proposed to be used in conjunction with patient data in order to make the overall decision to fly more appropriate and reliable. One participant stated *“feedback and information gathering should be done at the initial request with a dedicated questionnaire that takes between 30 seconds and one minute to complete in addition to the patient data”*.

2.5 DISCUSSION

From the responses obtained in this Delphi study, we present a possible screening tool that could be used to guide dispatch in Figure 2.2. Our proposed screening tool has been adapted from the Centre of Disease Control and Prevention (CDC) guidelines, the National Association of EMS Physicians (NAEMSP) and comments received from participants in all three rounds.(21,22) We combined criteria identified as appropriate for HEMS activation, with the feelings of the participants. For example, all participants were of the opinion that there should be no definitive criteria, and that any indication for authorising HEMS should be viewed with as much knowledge of the incident location and available resources. They felt that by determining the benefit of HEMS as a mode of transport was important prior to determining the clinical need. By doing this, there will be a reduction in the over-utilisation of HEMS.

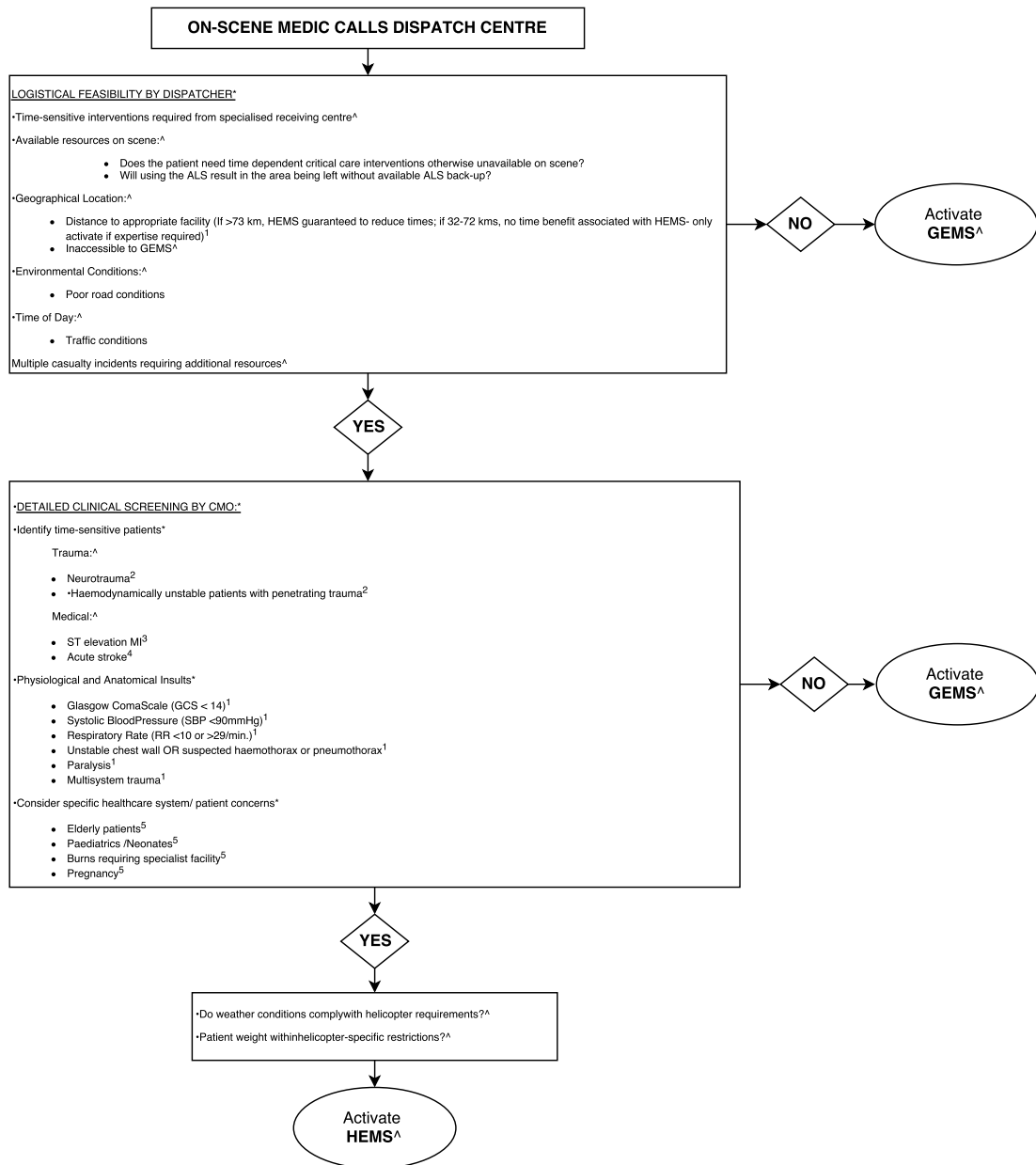
Participants felt that by doing this, there will be a more methodical approach to dispatching HEMS, where the logistical benefit of HEMS is identified primarily. Only if HEMS meets one or more of these criteria, will the patient's clinical need be investigated. This was included in order to try to eliminate inappropriate flights. Only in the second phase of screening, will the CMO do a telephonic interrogation of the clinical need for HEMS. The CMO will need to combine pre-hospital knowledge with the intricacies of flight operations. They rely heavily on the information given to them from the scene, determining the appropriateness of HEMS for the specific incident.

Thomas et al. reinforced this approach to HEMS dispatch as their findings recommended that the CDC guidelines have the potential to positively impact patient outcomes. They emphasise the importance of adapting the criteria to the local healthcare systems' abilities.(23) Therefore, by combining clinical and logistical components, patient risk stratification can be performed, identifying patients that will benefit maximally from HEMS.

Participants felt that correct selection of the CMO was key to improving the selection of patients requiring HEMS transportation. The European Aeromedical Institute has a list of criteria that the CMO should meet in order to comply with their specified standards. The requirements include a licence to practice within the country of the service provider; four years clinical experience in either emergency medicine, anaesthesia or intensive care medicine; at least two years working in the critical care environment; maintaining clinical skills; fluent in the preferred language; and a safe understanding of aeromedical requirements and local resources.(24) By implementing a stricter compliance to CMO selection, more informed decisions can be made regarding patient selection.

Our findings are in accordance with current literature, incorporating Evidence Based Guidelines into currently utilised criteria. The American College of Surgeons Committee on Trauma (ACS-COT) collaborated with the CDC in publishing triage guidelines for the pre-hospital environment.(22) In their guidelines, they incorporate these factors into their decision-making process.

Figure 2.2: Suggested Screening Tool/ Questionnaire



* For example, not limited to

[^] Criteria by Delphi consensus

1. Diaz M,Hendey G, Bivins H. When is the helicopter faster? A comparison of helicopter and ground ambulance transport times. J Trauma. 2005;58(1):148-53.

2. Harmsen AMK,Giannakopoulos GF, Moerbeek PR, Jansma EP, Bonjer HJ, Bloemers FW. The influence of prehospital time on trauma patients outcome: A systematic review. Injury. Elsevier Ltd; 2015;46(4):602-9.

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6. Andruszkow H,Schweigkofler U, Lefering R, Frey M. Impact of Helicopter Emergency Medical Service in Traumatized Patients : Which Patient Benefits Most? PLoS One.2016;11-12.

1) Dispatch Screening

Before the clinical need is determined, the participants felt that the logistical benefit of HEMS needs to be justified. During this phase of the screening tool, the call-taker is required to perform this investigation. As all participants agreed, the timesaving ability, geographical or environmental conditions, traffic congestion, or multiple casualties are all factors that could necessitate HEMS.

The majority of participants agreed that distance to the appropriate hospital is an important factor in determining reduced total pre-hospital time. This is particularly true considering that multiple studies have established transport distances and transport times that correlate with an overall reduction in total pre-hospital time. (25,26)

MacKenzie et al investigated the importance of direct transportation to specialist facility. Their research found a 25% improvement in mortality rates when critically injured patients are treated at level 1 trauma facilities in comparison to level 3 facilities.(27) These findings reinforce participants' views regarding bypassing inappropriate facilities. Participants felt that HEMS was indicated in instances where the closest facility was not appropriate for the patients' specific needs.

In South Africa, where the access to specialist facility is determined by the patients' geographical orientation, HEMS has the ability to overcome these spatial barriers. The geographical location of the incident will play an important role in determining the need for HEMS based on their expertise treating these conditions. In the urban setting, there are often appropriately qualified paramedics on scene who are able to manage the patient's, however during peak-time traffic or multiple-casualty incidents, HEMS can be considered. In rural areas, where there is inadequate paramedic coverage, HEMS could be the fastest transportation mode to ensure appropriate management. However, the timesaving aspect of HEMS is only appreciable for transport distances >73km as well as inaccessible or difficult-to-reach locations.(26)

2) Detailed Clinical Investigation by CMO

After logistical factors have deemed appropriate for HEMS, the CMO will then perform a thorough clinical investigation in order to determine the clinical benefit of HEMS on a case by case basis. Findings from a critical review performed by Lee et al. identified that patients with more serious injuries (ISS>15) or physiologic derangements gain the greatest benefit from HEMS.(20) This reinforces the need for a detailed clinical investigation in order to improve patient selection, thereby positively influencing patient outcomes.

Patients with time-sensitive injuries, physiologic or anatomical insults, or those with specific healthcare requirements or needs are factored into this phase of authorisation.

In South Africa, trauma is the second leading cause of death, resulting in this being a common incident for EMS personnel to treat. Due to the high mortality rates associated with trauma, it is common for pre-hospital providers to seek additional resources when treating critical patients.(11) This results in a large volume of trauma patients being airlifted to a trauma hospital. Muhlbauer et al. identified road traffic accidents as the leading incident utilising HEMS, making up 36% of analysed cases.(2)

A systematic review was done by Harmsen et al. investigating the influence of pre-hospital times on trauma patients. Their findings determined the importance of performing the appropriate pre-hospital clinical interventions rather than saving time when treating traumatised patients. They found that reduced pre-hospital times are only beneficial in haemodynamically unstable patients with penetrating trauma or in patients suffering neurotrauma.(28) This is inline with the participants' views, as they emphasized the importance of the correct patient being flown in preference to basing the decision purely on the hypothetical time-saving aspects of HEMS.

HEMS call-out criteria should be tailored to the local burden of disease of the system in which it functions. A shift in the current burden of disease is becoming apparent towards a larger incidence of non-communicable diseases such as stroke and myocardial infraction.(29,30)

These conditions require time-sensitive interventions only available at specialist facilities. A study conducted by Philips et al. assessed the effectiveness of HEMS in saving time to reach primary percutaneous intervention (PCI).(31) Transport times

were reduced in HEMS cases, thereby improving patient outcomes. HEMS has the advantage over GEMS by improving access to specialist facilities to patients in rural and urban areas.(32,31) This timesaving ability of HEMS in rural areas was reinforced in a study conducted by Moens et al. They investigated the transport times of HEMS vs. GEMS for patients with acute myocardial infarction living in rural areas.(33)

HEMS authorisation is not restricted to a pre-defined list of clinical conditions or injuries. Individual cases warranting HEMS are considered during this phase, such as patient age, patients requiring specialist facility such as burns unit, and pregnancy, scenarios triggering a high-index of suspicion for critical injuries, etc.(34)

3) Weather/Weight Restrictions

Once the logistical and clinical indications are determined, a flight risk assessment needs to be performed. This should be conducted independently of the patient information, and should preferentially be completed by an aviator. When considering HEMS dispatch, the safety of the crews overrules any stipulated criteria. Pilots are to abide strictly to weather regulations and safe landing zones are to be prioritized. By abiding to this, the HEMS crews are protected from being pressured into flying patients.(7) Patient weight is also an important factor when determining the safety or feasibility of the flight. Each HEMS operation has weight and balance specifications for their specific aircraft, bearing in mind fuel, equipment, and crew weights. Strict adherence to these regulations enhances the overall safety of the HEMS team.(7)

By implementing stricter dispatch criteria, there will be a lower incidence of HEMS activation. Hirshon et al. analysed the influence of pre-hospital trauma triage protocols on HEMS patient outcomes (utilising adapted CDC guidelines). Patient acuity and Injury Severity Score (ISS) increased in HEMS cases, with a simultaneous improvement in mortality rates. Stricter criteria results in reduced over-triage rates, which is particularly important in the South African setting.(35)

2.5 LIMITATIONS AND RECOMMENDATIONS

Despite the sample size and heterogeneity of participants, there are not many international individuals (11%) on the panel of experts, which would be beneficial to gain a broader opinion. This small percentage of international participants introduces an element of bias however, this may be mitigated by a larger local response bringing specific contextual views. The methodology utilised expert opinion, which is the lowest level of evidence, can only yield results identifying 'first principles'.⁽³⁶⁾ Recommended sample size is variable within the Delphi methodology. Literature lists participant groups ranging from four to a few hundred. Additionally, consensus was not reached in all criteria, however the design of the study was created to only take three rounds. This was done in order to maintain the opinions without forcing participants into consensus.^(16,37)

HEMS justification needs to be continuously assessed, this could be done by implementing regular audits on HEMS in South Africa and their impact on the populations quality-adjusted life years. Further to this, further validation and refinement of the screening tool is recommended. Additionally, a cost-benefit analysis of individual HEMS is recommended.

2.6 CONCLUSION

HEMS are a costly resource that should be dispatched to patients who would maximally benefit from its expedited transport and increased skillset. Within resource-limited settings such as South Africa, specific criteria should be developed that are aligned to the healthcare system and burden of disease. By appropriately selecting patients who will maximally benefit from HEMS, we will be able to optimise HEMS utilisation, thereby improving the cost-benefit ratio. A possible screening tool was developed as part of this study, emanating from the results. Further research and validation is required prior to implementation.

2.7 CONFLICT OF INTEREST STATEMENT

No conflicting interests are present to declare by authors.

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PART C: ADDENDA

3.1 JOURNAL INSTRUCTIONS

AUTHOR INFORMATION PACK

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DESCRIPTION

The *African Journal of Emergency Medicine* (AfJEM) is the official journal of the *African Federation for Emergency Medicine*. It is an Africa-centric, peer-reviewed journal aimed in particular at supporting emergency care across, you guessed it, Africa. AfJEM publishes original research, reviews, brief reports of scientific investigations, case reports as well as commentary and correspondence related to topics of scientific, ethical, social and economic importance to emergency care in Africa. Articles will be of direct importance to African emergency care, but may have originated from elsewhere in the world.

AfJEM publishes manuscripts of international quality. This is ensured through a process of rigorous peer-review (see below) where manuscripts are evaluated for accuracy, novelty and importance. It is however recognised that African researchers in emergency care are disadvantaged in the available range of journals into which they can publish their work. The editorial team is aware that this is due to many reasons, including that developing world topics are often considered too basic for western Emergency Medicine journals, or that topics are concerned with conditions which are largely irrelevant to those audiences. Furthermore, the quality of submitted manuscripts is often lower than acceptable international journal standards due to inadequate research training. AfJEM is dedicated to support all authors who wish to make an attempt at publication on an African Emergency care topic. In order to maintain and produce a high quality, international standard Emergency Medicine journal, AfJEM has devised *Author Assist*. For more detail go to <http://www.afjem.com/author-assistance.html>.

AfJEM is uniquely tailored to the needs and requirements of emergency care workers dedicated to improving emergency medicine in Africa. AfJEM specifically aims to address resource limitations as it pertains to the African continent. It will be ideal reading material for physicians, nurses and pre-hospital care workers wishing to improve their knowledge on general emergency medicine, trauma care, paediatrics, injury and disease prevention, service improvement, policy and ethics, disaster preparedness and response, and all other aspects of emergency care. In keeping with the *African Federation for Emergency Medicine*, it is our aim to be recognised as the international voice of quality emergency medical care in Africa.

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Details of publisher

GUIDE FOR AUTHORS

INTRODUCTION

The African Journal of Emergency Medicine (AfJEM, ISSN: 2211-419X) is the official journal of the [African Federation for Emergency Medicine](#). It is an international, peer-reviewed journal aimed in particular at supporting emergency care across Africa. AfJEM publishes original research, reviews, brief reports of scientific investigations, case reports as well as commentary and correspondence related to topics of scientific, ethical, social and economic importance to emergency care in Africa. Articles will be of direct importance to African emergency care, but may have originated from elsewhere in the world.

TYPES OF ARTICLES

Original Research: Original studies of basic or clinical investigations in areas relevant to emergency medicine. Reference to the relevance of the research in a resource poor setting is essential and should be alluded to in the discussion section. References and a structured abstract (see Preparation below) are required. Maximum length: 3,000 words, 5 tables and/or figures, plus the abstract (300 words) and references (max 50). The checklists found on the following websites should be used to structure your manuscript (a completed checklist showing that you adhered to the reporting format should be submitted with your manuscript):

- a. For randomised control trials: <http://www.consort-statement.org>
 - b. For cohort, case-control, and cross-sectional studies: <http://www.strobe-statement.org/>
 - c. All other studies: <http://www.equator-network.org/library/>
-

3.2 TECHNICAL APPENDICES

Appendix B

Table 3.1 represents the list of criteria sent out to participants in the first round of the Delphi process. All highlighted criteria are those that reached consensus (>75% agreement) amongst participants. All criteria not reaching consensus were sent back to participants in round 2 with the level of consensus obtained in round 1, for participants to re-evaluate their opinions. Using the results of these two rounds, and specifically looking at comments received, we were able to generate a new list of criteria which participants were asked to comment on and this was done in round 3. After this round, we were able to use this information in order to combine this new information with current literature to develop a screening tool to aid HEMS dispatch.

Table 3.1: Results Round 1

CRITERIA	YES	NO
MECHANISM OF INJURY		
Fall from height (>2 floors/20 feet/6 meters)	60.94	39.06
Fall or jumped in front of a train	50.00	50.00
Death of a same compartment/ vehicle occupant	42.19	57.81
Patient ejected from vehicle	67.19	32.81
High speed (>40 mph; >65km/h) moving vehicle accident	23.44	76.56
Multiple casualty incidents	78.13	21.87
Motor vehicle collision with significant vehicle deformity	21.88	78.13
Frontal collision on hardened roads outside urban area	51.56	48.44
Significant compartment intrusion on patient side, or on opposite side	37.50	62.50
Significant displacement of front or rear axle	20.31	79.69
Lengthy extrication and significant injury/entrapment	84.38	15.63
Vehicle turnover	29.69	70.31
Accident on known high speed roads	26.56	73.44
Thrown from motorcycle >20mph (32km/h)	35.94	64.06
Pedestrian struck >20mph	42.19	57.81
Electricity or lightning accident	54.69	45.31
Fire in confined space, or inhalational injury	51.56	48.44
Logging/farm/industrial accidents	48.44	51.56
Exposure to hazardous materials	23.44	76.56
Diving accident (i.e. diving in shallow water, etc.)	51.56	48.44

Drowning incident	67.19	32.81
Shooting	40.63	59.38
Stabbing	26.56	73.44
Explosions	60.94	39.06
Hanging	32.81	67.19

PATIENT CHARACTERISTICS – ANATOMY

Penetrating injury to head, neck, chest, abdomen or groin	75.81	24.19
Blunt injury with significant involvement of head, neck, chest, abdomen, or pelvis	75.81	24.19
Presence of a “seatbelt” sign or other abdominal wall contusion	37.10	62.90
Skull fracture/ severe facial and eye injuries	64.52	35.48
Head injury with focal neurological deficit	74.19	25.81
Flail chest / pneumothorax/ suspected cardiac injury/ obvious rib fracture below nipple line	74.19	25.81
Two or more proximal long bone fractures, or open long bone fractures	72.58	27.42
Major pelvic fracture	90.32	9.68
Suspected neurological fall out due to injury to spinal cord or column	70.97	29.03
Partial/total amputation of a limb (excluding digits)	62.90	37.10
Amputation or near amputation when emergent evaluation for replantation	85.48	14.52
Fracture or dislocation with vascular compromise (extremity ischemia)	82.26	17.74

Burns of:	85.48	14.52
Adults: 20-80% body surface area		
Children: >10% body surface area		
Face, head, hands, feet or genitalia involved		
Inhalation injury		
Electrical or chemical burns		
Burns with associated injury		
Injuries sustained to numerous anatomical areas	59.68	40.32

PATIENT CHARACTERISTICS – PHYSIOLOGIC PARAMETERS

Low or high respiratory rate, risk of airway obstruction or other signs of respiratory distress	58.33	41.67
Low systolic blood pressure (<90mmHg systolic)	45.00	55.00
Tachycardia (HR >120bpm)	23.33	76.67
Cardiac arrest (Post-traumatic)	30.00	70.00
Low CRAMS score: circulation, respiration, abdomen, motor function and speech	56.67	43.33
Low Glasgow Coma Score (GCS <12 but >5) or deteriorating mental status	68.33	31.67
Low Revised Trauma score (<12)	65.00	35.00
Significant trauma in patients <5yr or >55yr	81.67	18.33
Known cardiac or respiratory disease/cardiovascular instability	48.33	51.67
Medical patients where the expertise of the crew is required	91.67	8.33

-Unstable myocardial infarction		
Medical patients where the expertise of the crew is required	85.00	15.00
-Unstable arrhythmia		
Medical patients where the expertise of the crew is required	81.67	18.33
-Refractory anaphylaxis		
Medical patients where the expertise of the crew is required	85.00	15.00
-Refractory seizures		
Imminent eclampsia	75.00	25.00
Neonatal emergencies	83.33	16.67

OTHERS

Medical control approval based on discussion of clinical findings with on-scene medic	83.33	16.67
Paramedic judgement/ intuition	66.67	33.33
Anticipated need for procedures or medications not available on-scene	90.00	10.00
Analgesia	40.00	60.00
Expectation of prolonged transport time/prehospital time	83.33	16.67
Inaccessible road/area	90.00	10.00
Heavy traffic conditions	66.67	33.33
Under staffing of ground units in a region/local resources overwhelmed (ie. Leaving area 'uncovered')	58.33	41.67

* Grey Highlighted Criteria are those which met >75% consensus

Table 3.2: Results Round 2

CRITERIA	YES	NO
MECHANISM OF INJURY		
Fall from height (>2 floors/20 feet/6 meters)	82.35	17.65
Fall or jumped in front of a train	80.39	19.61
Death of a same compartment/ vehicle occupant	62.75	37.25
Frontal collision on hardened roads outside urban area	58.82	41.18
Significant compartment intrusion on patient side, or on opposite side	56.86	43.14
Vehicle turnover	52.94	47.06
Accident on known high speed roads	50.98	49.02
Thrown from motorcycle >20mph (32km/h)	58.82	41.18
Pedestrian struck >20mph	50.98	49.02
Electricity or lightning accident	76.47	23.53
Fire in confined space, or inhalational injury	68.63	31.37
Logging/farm/industrial accidents	70.59	29.41
Diving accident (i.e. diving in shallow water, etc.)	62.75	37.25
Drowning incident	84.31	15.69
Shooting	62.75	37.25
Stabbing	49.02	50.98
Explosions	80.39	19.61
Hanging	50.98	49.02
PATIENT CHARACTERISTICS – ANATOMY		
Presence of a “seatbelt” sign or other abdominal wall	44.90	55.10

contusion

Skull fracture/ severe facial and eye injuries	81.63	18.37
Head injury with focal neurological deficit	85.71	14.29
Flail chest / pneumothorax/ suspected cardiac injury/ obvious rib fracture below nipple line	87.76	12.24
Two or more proximal long bone fractures, or open long bone fractures	83.67	16.33
Suspected neurological fall out due to injury to spinal cord or column	85.71	14.29
Partial/total amputation of a limb (excluding digits)	83.67	16.33
Injuries sustained to numerous anatomical areas	71.43	28.57

PATIENT CHARACTERISTICS – PHYSIOLOGIC PARAMETERS

Low or high respiratory rate, risk of airway obstruction or other signs of respiratory distress	79.59	20.41
Low systolic blood pressure (<90mmHg systolic)	57.14	42.86
Cardiac arrest (Post-traumatic)	36.73	63.27
Low CRAMS score: circulation, respiration, abdomen, motor function and speech	57.14	42.86
Low Glasgow Coma Score (GCS <12 but >5) or deteriorating mental status	79.59	20.41
Low Revised Trauma score (<12)	75.51	24.49
Known cardiac or respiratory disease/cardiovascular instability	51.02	48.98

OTHERS

Paramedic judgement/ intuition	77.55	22.45
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Analgesia	48.98	51.02
Heavy traffic conditions	83.67	16.33
Under staffing of ground units in a region/local resources overwhelmed (ie. Leaving area 'uncovered')	73.47	26.53

* Grey Highlighted Criteria are those which met >75% consensus

3.3 RESEARCH PROTOCOL

DEVELOPING CALL-OUT CRITERIA FOR SOUTH AFRICAN HELICOPTER EMERGENCY MEDICAL SERVICES: A DELPHI STUDY

BY

DIANE LAATZ
STUDENT NO: LTZDIA001

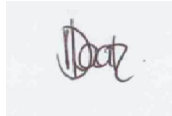
DIVISION OF EMERGENCY MEDICINE
THE UNIVERSITY OF CAPE TOWN
IN PARTIAL FULFILMENT OF
MPHIL CLINICAL EMERGENCY MEDICINE

SUPERVISOR: W. STASSEN (BTEMC, MPhil EM)
CO-SUPERVISOR: T. WELZEL (MBChB, EMDM, MMedSc(Clin Epi))

Declaration:

I, Diane Inge Laatz, hereby declare that the work contained in this assignment is my original work and that I have not previously submitted it, in its entirety or in part, at any university for a degree.

Signature:

A small, square, light gray box containing a handwritten signature in dark ink. The signature appears to be 'Diane Inge Laatz' written in a cursive, flowing style.

Date: 24 July 2015

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TITLE

Developing call-out criteria for the South African helicopter emergency medical service: A Delphi Study.

ABSTRACT

Introduction: Modern medical practice utilizes helicopter transportation in the pre-hospital environment in order to improve patient outcomes. However, there is no clear call out criteria within the South African Emergency Medical Services (EMS) leading to potential misuse of the Helicopter Emergency Medical Services (HEMS). Current literature supports the utilization of HEMS in the pre-hospital environment for the appropriate patients. Due to the lack of call out criteria specific to the South African environment, there is a lot of uncertainty surrounding which patients will gain maximal benefit from HEMS.

By refining key criteria needed to identify ideal patients whom will gain the maximal benefit from HEMS, validity of call out criteria can be improved. This will enhance current HEMS use and ensure optimization of current services available within the South African environment to improve patient outcomes.

Aims: To systematically utilise expert opinions in order to identify current shortfalls and develop agreed call out criteria in order to improve HEMS utilisation within the South African setting.

Objectives: To conduct a modified Delphi study utilising field experts in order to identify views and opinions regarding local and internationally utilised HEMS call out criteria for the South African environment to improve appropriate utilization and benefit of HEMS.

Setting: All regions serviced by private HEMS within South Africa. All primary call out criteria will be reviewed for the adult, paediatric and neonatal populations.

Methodology: A two-stage process will be used. Firstly, local and international HEMS services will be approached for their current call out criteria as well as identification of key players in HEMS using purposeful and snowball sampling. These identified experts will be representative of the field being studied. Participants will be required to have a minimum of two years post-graduate experience for sufficient exposure to HEMS utilization and current needs of the country in study. The expert panel should be comprised of twenty participants who are registered with their local statutory professional board. Participants no longer involved in HEMS in

the last ten years or any person with conflicting interests will be excluded from participation.

Once identified, experts will be invited to participate in a modified Delphi study either electronically or telephonically. SurveyMonkey will be used where currently used criteria will be listed and the respondents will be able to vote on each criterion individually, with either a 'YES' or 'NO' response. This binary data allows participants to decide whether the criteria are applicable to the South African context specifically. Each criterion will have a comment box where they are able to add any additional information or comments regarding their opinion. Received responses will be analysed, calculating the percentages for or against each criteria. In the second round, these percentages will be sent back to the participants, along with received comments for further review of their opinions.

All responses will be kept anonymous using specialized programs on SurveyMonkey. Consent forms will be attached to the survey and completed prior to participation.

This interactive process will continue until 75% consensus is achieved or after stabilization of responses between rounds.

BACKGROUND

Helicopters have been used to transport patients to hospital from the civilian environment since 1972 in the United States.(7) Subsequently, the use of helicopters in the pre-hospital environment has increased significantly.(8) Due to the dynamic nature of helicopter transportation and the advantages it offers over traditional ground transportation, air transportation can significantly improve patient outcomes if used appropriately.(9)

South Africa is a middle-income country with scarce resources needing conscious and deliberate management thereof. Patients in rural areas may benefit from Helicopter Emergency Medical Services (HEMS) needing transportation to more appropriately equipped facilities instead of traditional ground transportation to basic health care facilities found in the region. It is common for these rural areas to have small clinics or hospitals, which do not have the appropriate equipment or medical expertise working there.

Due to the size of South Africa, together with the limited available resources, special attention needs to be paid to transportation of patients to appropriate facilities. These concerns need to be incorporated into the dispatch criteria when evaluating current call-out criteria used within the South African setting.

Specific criteria have been listed as indications to utilize HEMS, with specific patient conditions that will gain clinical benefit from HEMS. Clinical benefit may be categorised as a significant reduction in transport times for patients requiring time-sensitive interventions in hospital; provision of medical expertise or for the provision of transportation to patients inaccessible via other means.(59) However, these guidelines were not designed for the South African context specifically.

Decisions made on whether or not to airlift a patient to hospital are based on the patient's physiological parameters, the severity of sustained injuries, mechanism of injury, age, distance to appropriate facility and geographical accessibility of the incident.(7) Patients who gain the maximal benefit from HEMS are those who sustained severe injuries, while still remaining potentially salvageable. (3) These decisions are generally made by personnel on scene working under stressful conditions. Without definitive call-out criteria, the decision to request HEMS can be daunting for on-scene crews and may be subject to a number of biases(89).

Based on reviewed literature, it appears that air transportation adds numerous benefits to the treatment of patients.(26,90) The difficulty arises in prospectively deciding who may best benefit from this rescue and treatment modality. In many instances the decision is left to an on-call doctor who makes a decision as to which patients they deem feasible or not, incorporating a large subjective element. A more detailed method of determining which patients should be airlifted to hospital is needed.(1,2)

Call out criteria used within South Africa was not specifically designed for the South African context. This results in numerous discrepancies arising when deciding whether HEMS will be beneficial over traditional road transportation.(1,3) Call out criteria needs to be more specific where the cost to benefit ratio should be considered. By utilizing HEMS more appropriately, unnecessary costs such as inter-hospital transfers, prolonged admissions, etc. can be limited.

Due to the misuse of HEMS, there have been numerous studies done evaluating whether or not HEMS is affecting the mortality and morbidity rates of patients

needing transportation to the various facilities. (1,3-5) The common drawback of these studies is that no universally accepted call-out criteria exist.

This lack of guidance leads to HEMS being dispatched to patients who won't necessarily gain the intended advantages of HEMS, where transportation by road would have been just as effective.(7) Due to the cost associated with HEMS, there needs to be a greater potential for improved outcomes or overall patient benefit for HEMS to be advantageous.

Due to the fact that the decision whether HEMS will be beneficial to patients is purely a medical decision, it is imperative that physicians with exposure and experience within the EMS and HEMS play a key role in the decisions regarding the development of HEMS. HEMS needs to operate parallel to ground EMS (GEMS) and function together with local, regional and national health care systems. HEMS guidelines need to be developed appropriate to their specific setting for the maximal benefit to be obtained from this valuable resource.(59)

WHY THE PROJECT IS WORTH DOING

The proposed study is valuable as it will gain insight into the perceptions of field experts as to which criteria used internationally is applicable and appropriate for our unique setting. This might assist in utilizing resources more efficiently and promoting cost effectiveness, both directly (flying salvageable patients) and indirectly, as an improved service will lead to a reduction of social costs as well as a reduction in unnecessary inter-hospital transfers. It may expose the need for revised HEMS call-out criteria, if any exist within a service, as decisions currently are not necessarily based on best-available evidence.

The majority of HEMS activation is based on mechanism of injury and the patients' physiological state, and is largely subjective to on-scene paramedics' discretion.(91) Evidence shows that this current method has a high specificity but only a moderate sensitivity in identifying the correct patients.(92) By correctly identifying which patients are most likely to benefit from HEMS, we will be able to allocate resources more appropriately. Further research is needed to identify key criteria that will be able to identify ideal patients that will benefit from HEMS, with high sensitivity and specificity. This will improve the validity of call out criteria, and enable a more rigid implementation of these identified criteria when dispatching HEMS in the future.

RESEARCH QUESTION

What is the opinion amongst national and international experts regarding the current HEMS call out criteria, in order to best utilise HEMS, in the South African environment?

AIMS AND OBJECTIVES

Aim

The aim of this study is to systematically utilise expert opinions in order to identify current shortfalls and develop key themes and call out criteria necessary for improved HEMS utilization within the South African setting.

Objectives

- To conduct a modified Delphi study utilising field experts in order to identify views and opinions regarding local and internationally utilised HEMS call out criteria for the South African environment to improve appropriate utilization and benefit of HEMS.
- Using the above data to develop specific criteria applicable for the rural and urban areas serviced within South Africa.

METHODS

Research Design

The research will be conducted using a two stage process. Firstly, current call out criteria will be obtained from large, well-known HEMS services accredited through recognised boards, such as the Commission on Accreditation of Medical Transport Services (CAMTS), the European Aeromedical Institute (EURAMI), etc. The researcher will collate these identified criteria, duplicate or similar criteria will be combined and written up as an individual criteria list, open for experts to comment on. This list will be the criteria sent out to participants in round one of the study. Secondly, all major decision makers regarding authorisation of HEMS use within each service will be identified. Contact will be made with these individuals inviting them to participate in the research project. A snowball sampling method will be employed, as it is a non-probability method used to identify and approach typically hidden or hard to reach populations.(93)

Once the sample population is identified, a modified Delphi methodology will be employed to gain these experts opinions regarding HEMS call out criteria in the South African environment. It is an interactive process used to facilitate the

interaction of experts' opinions, whilst maintaining anonymity. This process is continued until the group of experts comes to a final consensus (>75% agreement) or once stabilization participants' opinions or answers are stabilized. When used appropriately, the Delphi methodology can expand awareness of chosen topics within the healthcare profession. It is most suited for research where there is incomplete information regarding issues as it works ideally when the aim of the research project is to develop understanding related to problem areas and to develop ways to address the problems.(88)

As the experts will highlight the criteria that they deem important in the South African setting, we will be able to propose important criteria to use that will benefit both rural and urban environments covered by HEMS services within South Africa. Rural and urban areas are differentiated according to their population density, their economic or social status and the agricultural or industrialisation of the area. An urban area has a population of 2500-50000 people, with a centre smaller than two square miles and 1000 people/square mile. Adjoining areas may surround them with 500 people/square mile. Rural areas encompass all areas not encompassed in the urban regions.(94) Rural areas are also defined according to geographic location in combination with their population or provider characteristics. Rural areas are far from health care facilities and also often lack adequate transport to get to these facilities.(94)

By identifying international criteria, the participants will be able to decide whether or not they think that the South African environment will benefit from the various criteria. By taking these settings into consideration, a more specific set of criteria can be developed in order to best service these areas. The last round of the Delphi process will have specific comment-boxes for participants to justify how they believe the criteria they have listed as important for South Africa will benefit both the rural and urban environments.

Participants will be required to select a 'YES' or 'NO' opinion in response to each criterion. This binary data will help us distinguish the percentage of agreement or disagreement for each criterion listed. Participants will be encouraged to substantiate their opinion by adding comments after each criteria.

We will determine the percentage of respondent's views and opinions regarding each criterion currently used by identified services. These percentages and collated comments will be sent back to participants in the second round, allowing

them to change their opinion after reflecting on others' statements. This will continue until a 75% consensus is achieved or stabilization of opinions is apparent.

These will be used to develop a more specific list of indications for healthcare providers to use HEMS in the South African setting.

Setting

Analysis of HEMS call out criteria will be conducted for the South African environment specifically. This will include both the rural and urban environment serviced by private HEMS throughout Southern Africa. It will include all primary call out criteria for the adult and paediatric/neonatal population.

Sample Population

The study population or participants will be reflective of sound experts within the pre-hospital and in-hospital emergency care providers within the South African context as well as internationally identified experts. These experts will be identified utilizing a snowball sampling methodology as this uses identified experts in the field to identify other key role-players who would otherwise be inaccessible or unidentified. The initial experts will be identified by approaching the HEMS providers and asking them for referrals for potential participants. These experts will then be contacted and invited to participate in the research project, as well as finding out if they can recommend other medical practitioners involved in any decision making within HEMS. This method is appropriate as participants are selected according to their exposure and involvement in the field of study making them experts in this field rather than individuals representing a general population.⁽⁹³⁾ Expertise will be classified according to qualification and experience within the emergency medical care environment. Two years post-graduate experience will be the minimal accepted criteria as participants will be required to draw on personal experience and knowledge to develop their opinions for the study. Two years is an adequate amount of time allowing for adequate exposure and experience in order to have a good understanding on the dynamics involved in dispatching HEMS. According to ER24 (PTY) Ltd, they have a policy regarding the minimum crew requirements required for HEMS personnel. They state that a minimum of two years post-graduate experience is the minimum requirement for staff to have sufficient experience to work on their HEMS services.⁽⁹⁵⁾ Currently, in South Africa, the available Emergency Care Practitioners or Emergency Physicians being closely involved with HEMS operations are recently qualified, limiting the number of years experience within the available cohort.

A combination of purposeful sampling and snowball sampling will be used to identify international experts. Large, recognised international services such as London HEMS, Sydney Careflight, Medstar Washington and Rega in Switzerland will be contacted in order to identify role-players within the service. Once identified, contact will be made and snowball sample will be utilised to gain more international participants.

The Delphi methodology requires between 6 to 1685 participants for this type of study.(96) Due to our context, we have selected a sample size of twenty experts to make up the panel, as attrition is anticipated. A minimum cut off of six respondents will be required for each criterion or round in order to maintain a representative sample size.

➤ Inclusion criteria:

- A practicing medical practitioner who is registered with their local statutory professional council.
- **AND;**
- More than two years' experience in the pre-hospital environment, aero-medical environment or the emergency department **AND;**
- Involved in the field of emergency medicine, including specialist emergency physicians, surgeons or medical practitioners registered in an emergency medicine teaching programme **OR;**
- Involved in HEMS services, either providing care in the environment or being part of the authorising team for dispatching HEMS

➤ Exclusion criteria:

- No longer involved in the HEMS field for more than 10 years
- Significant conflicts of interest such as individuals directly involved in or indirectly connected (i.e. family members) to the business side of the HEMS organisation or its affiliates.
- Respondents not replying to invitation e-mail after two attempts

Method

Experts will be selected using a snow ball method together with purposeful sampling for specific international experts.(97) The aim is to include as many individuals that fulfil the selection criteria as there is an anticipated decline between participants invited and those willing to partake. Invitation to prospective participants or experts

will be sent electronically or done telephonically (Annexure A). A compliance checklist will be attached to the invitation letter, which the invitees will complete. Should they not meet stipulated criteria, the invitee will be excluded from the study and informed of this via e-mail.

Any participant who fails to respond within a week of being invited will then be contacted again, after two attempts (two weeks) to get the individual to participate in the study they will be excluded.

Should individuals agree to participate in the study and then not provide their opinions to the questionnaire, they will be reminded that their response is outstanding via e-mail.

The questionnaire will be designed in a manner preventing any questions from being excluded or remaining unanswered which will force the participant to give an opinion on each point, with the option of providing comments on each criteria. An additional comment box will be open for free-text, allowing experts to add any additional criteria or feedback not listed during the first round. A binary option model (yes/no) has been chosen as this forces participants to either agree or disagree with the applicability of each criteria for the South African setting.

Opinions of all participants will be weighted equally, therefore specific qualification will not affect the results and attrition rates between differing qualifications will not change overall results.

Simple descriptive statistical analysis will be used in order to calculate the percentage of agreement/disagreement obtained for each criterion. This will enable us to highlight which criterion the participants believe to be relevant to South Africa and identify key themes viewed as important to be incorporated into call out criteria.

DATA COLLECTION

The collection and management of data will be done according to the Delphi study design. Due to the nature of the Delphi methodology, the researcher will structure the communication of participants whilst maintaining participant anonymity. This process will facilitate the interaction between participants whilst aiming to reach a consensus amongst the panel of experts.

The study will be conducted using SurveyMonkey® or a printable survey will be emailed to participants requesting non-electronic participation to be printed and completed. For the first round, currently used call out criteria for large services in South Africa, United Kingdom, Europe, Australia and the United States of America will be collated. Each individual criteria will be listed separately, if there are any duplicate or similar criteria, they will be combined. Any overlapping criteria that is unclear or indiscernible will be listed separately.

This collated list will be the questionnaire in round one that is sent to participants (Annexure B) where they will be asked to evaluate the appropriateness of each criterion for the South African setting. This will be done by allowing participants to vote 'yes' or 'no' for each criteria. Participants will be encouraged to give statements or concerns with each listed criteria, substantiating their opinion. Participants will also be able to add additional criteria in a free-text box if there are any criteria missing or not listed that they feel should be included.

Subsequent rounds will be conducted where the received opinions will be calculated as percentages. The percentages obtained for each criteria will be listed, together with received feedback, allowing for participants to re-evaluate their opinions. This process will be repeated until there is consensus amongst participants. Consensus will be defined as 75% agreement amongst participants on each point, or if stabilization of responses has occurred.

Each round will be conducted over two weeks, where participants will be asked to respond. Participants not responding within this time will be excluded from the study. Excluded participants will receive feedback and will be allowed to join the study again if time permits. A maximum of three rounds will be conducted, with a minimum of ten to fifteen respondents, to reach consensus. Consensus on individual dispatch criteria is the aim of the research. However for points not reaching consensus in this time, discussion of participant's comments will be used to identify reasoning behind this. This information will be used in order to list the key themes identified during the study as important or necessary considerations for activating HEMS specifically applicable to the South African context.

Data Analysis

Simple descriptive statistics will be used in order to evaluate percentage of agreement amongst participants. The level of consensus is set to 75% as the accepted value determining whether the criteria should be used in the South African setting specifically.

Statistical analysis of the opinions generated (regardless of consensus or non-consensus of opinions) will be represented graphically. Qualitative data obtained in the form of individual opinions will be kept in the narrative form as well as final consensus or analysis being described in the narrative format.

ETHICAL CONSIDERATIONS

Ethical approval will be sought from the Human Research Ethics Committee at the University of Cape Town. The study is focussed on obtaining expert opinions regarding the current call out criteria within the South African context. Due to the nature of the study the risks and benefits of participants will be evaluated. It is a non-clinical study design, where the collection of participants' opinions will be obtained. Each individual will be required to complete and sign the relevant consent forms, which will be kept anonymous. Participation is on a voluntary basis, where participants are able to withdraw their participation at any point in the process without any consequence (Annexure A).

Risk to participants

Participants will be cognisant that they are subjects participating in a research project. Informed consent will be signed, and participants will be aware that they can withdraw from the project at any stage of the project.

Contact details will be obtained by word-of mouth and will include an option to be excluded from any further communications in line with POPIA and RICA. Participant personal contact details and responses will only be available to the investigator. Opinions shared and results obtained in subsequent rounds of the study will be kept anonymous. This will be done using the SurveyMonkey® program which allows the researcher to keep the individual results anonymous but still be able to track which participants took part in the survey or not. All collected data will be stored on a password protected computer.

Anticipated benefit to participants

Participants are viewed as experts in their field of practice and, therefore, we anticipate that they will be eager to participate in the study. There is potential for individuals to gain insight into the topic from generated opinions as well as the potential to implement new or changes to existing protocol or criteria used within their own organisations.

Participants will be entered into a draw on completion of the study, where the winner will receive a book voucher. This is to encourage participants to continue their

participation in the study up to the end. The value of the prize will not exceed ZAR 1200.

LIMITATIONS

Limitations of this study include the fact that it is an educated assumption that the current criteria are inadequate and that a problem exists anecdotally through common knowledge, however no official statistics are available to support these opinions.

Another limitation is the selection of the sample population, as it is limited to available databases and network systems, which may lead to sampling bias. Due to the nature of the study, there is anticipated reduction in the numbers of participants compared to the numbers contacted to partake.

There is also no guarantee that consensus will be reached due to participants diverse knowledge and opinions. The study does, however, provide room for recommendations to be made on items not obtaining consensus.

The outcomes of the study are limited to the expertise and opinions of the panel of experts. The participants' opinions may not be representative of their field of expertise, reducing the external validity of the study.

DATA DISSEMINATION PLAN

Data obtained from this research project will be made available to the University of Cape Town and stakeholders. It will also be submitted to a relevant peer reviewed journal for publishing.

PROJECT TIME LINE

EVENT	DATE
Write up of Proposal	February 2015 - September 2015
Submission of proposal	September 2015
Ethics	October 2015
Data collection	October 2015 – February 2015
Data analysis and write up	February 2016 – March 2016
Submission for marking	March 2016

RESOURCES AND BUDGET

BUDGET				
February 2015 – January 2016				
Item	Description	Unit cost	N° of Units	Total cost
Consumables				
1. Office supplies, printing & re-production for reports	Paper, ink, pens, highlighters etc.	R500	1	R500
2. Final report	Printing and binding	R150	2	R300
Research equipment & staff				
1. Equipment	External hard drive	R500	1	R500
Prize				
1. Book Voucher	Book Voucher	R1200	1	R1200
Total				R2500

The project will be funded privately by the researcher.

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ANNEXURE A

Invitation Form:

PARTICIPATION IN DELPHI SURVEY ON THE VIEWS AND OPINIONS REGARDING INCLUSION AND EXCLUSION OF LOCALLY AND INTERNATIONALLY RECOGNISED HELICOPTER CALL OUT CRITERIA WITHIN THE SOUTH AFRICAN CONTEXT

I am enrolled as a student at the University of Cape Town and am currently completing my second year in the MPhil: Emergency Medicine program. I am required to complete a research project as part of this qualification.

The aim of the research is to determine the views and opinions on current international and local helicopter call out criteria from national and international experts. The criteria should be applicable to the South African or low-to-middle income country context in order to develop a more specific call out criteria to be used when dispatching HEMS within this setting. I would like to investigate this topic, as there is a lack of uniformity amongst HEMS organisations with a set consensus regarding which patients would benefit the most from HEMS with the South African setting being the pertinent factor. This lack of consensus often leads to the wrong patients being flown, correcting this will lead to overall improved utilization of the services to improve patient treatment/transport delivery.

I would like to invite you to participate in this Delphi survey, to form part of a panel of experts. If you accept this invitation and give your consent to be part of the panel of experts, you will need to open the following link, which will connect you to the survey.. While completing the questionnaire, you will be required to use your own personal experiences, available data and literature, or any other resources in order to provide an expert opinion.

Once completing the questionnaire you will be required to submit your views and opinions and all the received answers will be reviewed and used to formulate new themes relevant to the South African context. A more specific questionnaire will then be constructed based on the first round of responses and again distributed to all participants. In accordance with the Delphi method, several rounds (maximum of

three) of comments and discussion via e-mail with a link to the SurveyMonkey® program until consensus is achieved.

All communications will be kept anonymous and participants' names will not be disclosed while compiling the different opinions of the participant group. If you agree to participate in this survey, it is requested that you do not discuss your opinions of the questions or any responses with other members of the study who may be identified to you through other interactions. You may withdraw your consent and participation in this survey at any stage.

On completion of the study, all participants will be entered into a draw, where the winner will receive a book voucher valued at R1200 (ZAR).

Yours sincerely ,
Diane Laatz

E-mail: dianelaatz@gmail.com
Cell: +971 56 196 1590

3.4 HREC APPROVAL LETTER



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



Room E52-24 Old Main Building
Groote Schuur Hospital
Observatory 7925
Telephone [021] 406 6338 • Facsimile [021] 406 6411
Email: shuretta.thomas@uct.ac.za
Website: www.health.uct.ac.za/fhs/research/humanethics/forms

30 October 2015

HREC REF: 774/2015

Dr T Welzel
Emergency Medicine
J46.56
OMB

Dear Dr Welzel

PROJECT TITLE: DEVELOPING CALL-OUT CRITERIA FOR SOUTH AFRICAN HELICOPTER EMERGENCY MEDICAL SERVICES: A DELPHI STUDY (MPhil-candidate D Laatz)

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

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

- Please add the FHS HREC contact details to the Informed Consent Form.

Approval is granted for one year until the 30th October 2016.

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

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

Please quote the HREC REF in all your correspondence.

We acknowledge that the student, Diane Laatz will also be involved in this study.

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

Yours sincerely

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE

Federal Wide Assurance Number: FWA00001637.

Institutional Review Board (IRB) number: IRB00001938

This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical

HREC 774/2015

Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Convention on Harmonisation Good Clinical Practice (ICH GCP), South African Good Clinical Practice Guidelines (DoH 2006), based on the Association of the British Pharmaceutical Industry Guidelines (ABPI), and Declaration of Helsinki (2013) guidelines.
The Human Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50, 56 and 312.

HREC 774/2015

3.5 TURNITIN REPORT

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