



ORIGINAL ARTICLE

Developing a South African Helicopter Emergency Medical Service Activation Screen (SAHAS): A Delphi study

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ABSTRACT

Introduction: 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. We aimed 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. Through collation of these results and international literature, we present an initial concept for a South African HEMS Activation Screen (SAHAS), favouring inquiry on a case-by-case basis.

Discussion: 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. The initial concept of our SAHAS should be investigated further.

African relevance

- HEMS is a costly resource with unproven benefits in the LMIC setting.
- No published evidence-based HEMS call-out criteria have been developed for South Africa.
- Appropriate call-out criteria can improve the cost-effectiveness of the service.
- Identifying patients that are most likely to benefit from HEMS can ensure optimal patient outcome.

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

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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]. Thus highlighting the 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 an appropriate facility and the geographical accessibility of the incident [10]. This model is not practical for the low-to middle-income country (LMIC) setting, as it results in high over-triage, and reducing 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. It is our experience that this process is highly subjective. Furthermore, no recently accepted or evidence-based criteria exist to guide CMO's decision. This seems to rather be guided by non-standardised interrogation and information gathered during consultation with ground crews.

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 a HEMS call-out criteria, which is contextual to the South African setting. We further aimed to create a screening tool based on these data to guide HEMS activations locally.

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. 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. Purposive, snowball sampling was used to identify an appropriate sample of physicians and paramedics locally and internationally. 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 – participants were asked to express agreement or disagreement with criteria listed. 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 insight into the reasoning behind answers.

After each round, content analysis was performed, 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.

Consensus data, free text responses and international literature was then collated and categorised to develop a first concept of a South African HEMS Activation Screen (SAHAS) that might guide dispatch decision-making.

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. Results are presented in accordance with the proposed Conducting and REporting DELphi Studies (CREDES) checklist [16].

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 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.

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 are contained in the [online appendix](#).

Free text responses from the first two rounds were subject to content

Table 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
Medical 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

NDip: National Diploma; BTech: Bachelor of Technology; HEMS: Helicopter Emergency Medical Service.

Table 2
Summary of round three statements.

Statements
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.

*Statements with > 75% consensus.

analysis, which were used to generate a list of statements (see Table 2) that were sent out to participants in the third round of the study. Consensus was met in 71% (10/14) of these statements (Fig. 1). These results were used to gain further insight into the factors participants felt were important when dispatching HEMS in the South African setting.

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, most 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".

Discussion

Our aim was to systematically utilise expert opinions in order to develop a more specific HEMS call-out criteria for the South African environment. Despite reaching consensus on the majority of criteria presented, our panel emphasised the importance of a more generalised screening tool, which can be adapted to individual cases. Participants believed 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, should the patient's clinical need be investigated through interrogation by the CMO.

From the responses obtained in this Delphi study, we present a possible screening tool that could be used to guide dispatch in Fig. 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 [20,21]. We combined criteria identified as appropriate for HEMS activation, with the views of the participants. 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.

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 [22]. Therefore, by combining clinical and logistical components, patient risk stratification can be performed, identifying patients that will benefit maximally from HEMS.

Our proposed screening tool (South African HEMS Activation Screen, SAHAS), interrogates three aspects to HEMS activation namely, logistic eligibility, clinical eligibility and other restrictions. We discuss each of these in turn.

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.

Most participants agreed that distance to the appropriate hospital is

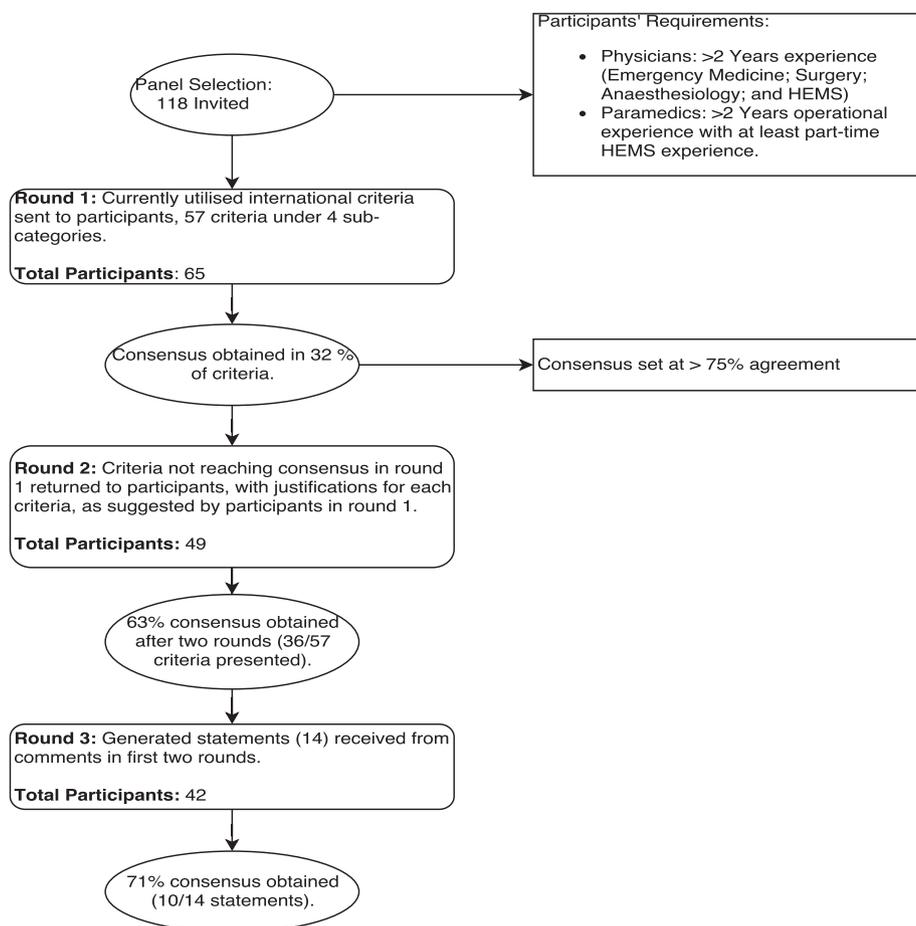


Fig. 1. Delphi Participant Flow Diagram.

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 [23,24].

Direct transportation to a specialist trauma facility has been associated with a 25% reduction in mortality of critically injured patients [25]. 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 a specialist facility is determined by the patients' geographic locale, HEMS could 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 can manage critically injured patients, 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 > 73 km as well as inaccessible or difficult-to-reach locations [23]. However, these specific distances and transport times have not been established in the South African setting. We therefore utilise data from other settings within the screening tool.

After logistical factors have deemed appropriate for HEMS, the CMO will then perform a thorough clinical investigation 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

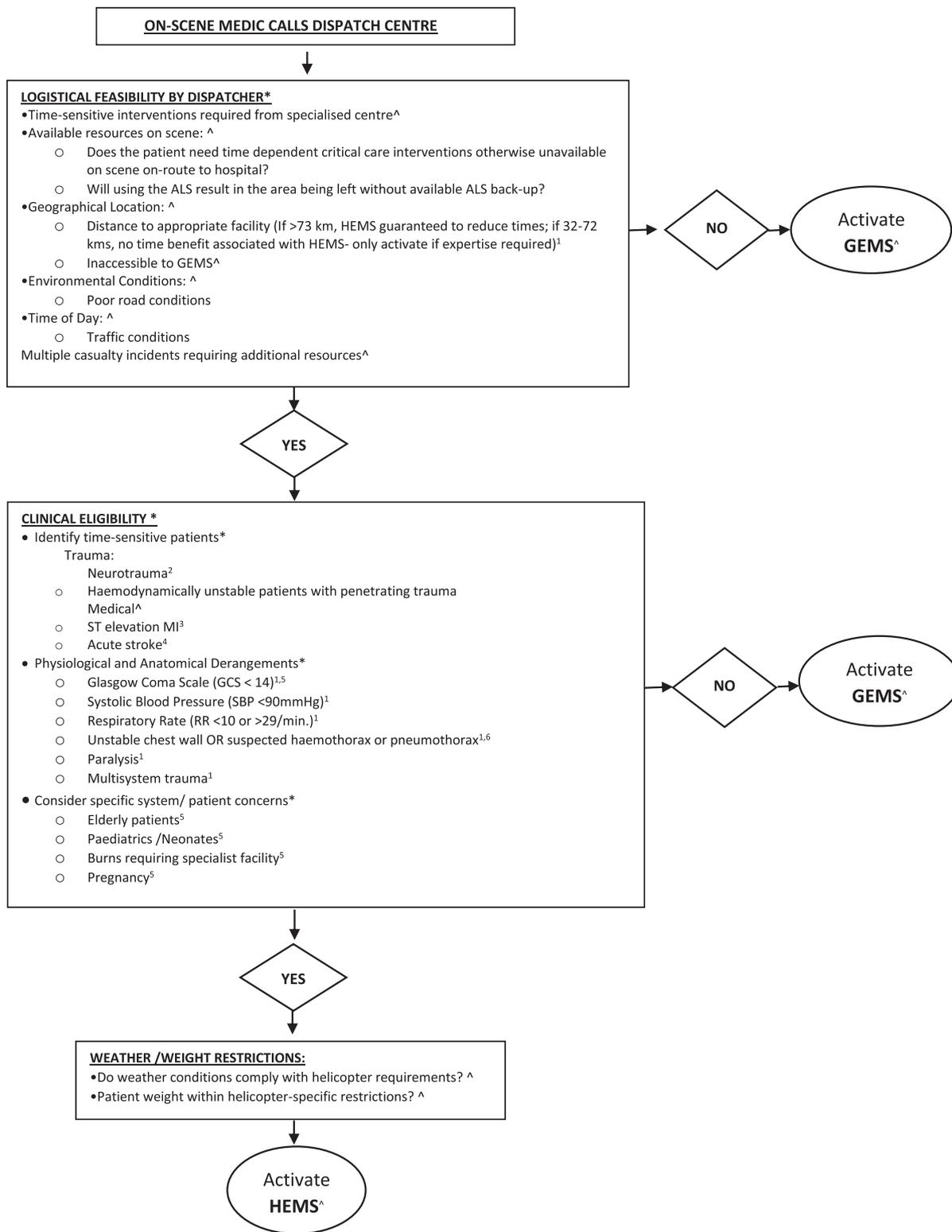
benefit from HEMS [26]. This reinforces the need for a detailed clinical investigation in order to improve patient selection.

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. Muhlbaier 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 [27]. This is in-line with the participants' views, as they emphasised 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 infarction [28,29]. These conditions require time-sensitive interventions only available at specialist facilities. HEMS has the advantage over GEMS by improving access to specialist facilities to patients in rural and urban



* For example, not limited to

^ Participants' suggestions

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Fig. 2. South African Helicopter Emergency Medical Services Activation Screen (SAHAS).

areas [30,31].

HEMS authorisation cannot be restricted to a pre-defined list of clinical conditions or injuries, and an exhaustive list can therefore not be provided within the SAHAS. Other comorbidities should also be considered [32]. In keeping with the views of our panel, the importance of appropriate selection of CMOs cannot be over-emphasised.

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 [23]. We suggest creating and implementing a similar list for the South African setting in order to assist with the correct patient selection.

Once the logistical and clinical indications are confirmed, 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 minima for each aircraft type and safe landing zones are to be prioritised. By abiding to this, the HEMS crews are protected from being pressured into flying patients [6]. 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 operation [6,33].

We sampled a small cohort of international participants, which could bias results however, this may be mitigated by a larger local response bringing specific contextual views. This does consequently limit the external validity of the study.

We utilised expert opinion in this study which is the lowest level of evidence, and can only yield results identifying ‘first principles’ [34]. Further development, validation and refinement of this screening tool is recommended.

Consensus was not reached in all criteria, yet we expressly aimed at closing the study after three rounds in order to maintain opinions without forcing participants into consensus [35,36].

HEMS justification needs to be continuously assessed. This could be done by implementing regular audits on HEMS in South Africa and their impact on mortality and morbidity. We further suggest additional health economics studies on HEMS in LMICs to determine the cost to benefit ratio.

HEMS are a costly resource that should be dispatched to patients who would maximally benefit from its expedited transport and increased skillset. By appropriately selecting patients who will maximally benefit from HEMS, its utilisation can be optimised towards a more favourable cost-benefit ratio. There is a paucity of literature to highlight which patients could benefit from HEMS in LMICs like South Africa. We propose an initial concept for screening HEMS eligibility based on systemic utilisation of expert opinion and dispatch criteria found in the literature. Further research and validation of this SAHAS is required.

Conflicts of interest

The authors have no conflicts of interest to declare.

Authors' contributions

Authors contributed as follows to the conception or design of the work; the acquisition, analysis, or interpretation of data for the work; and drafting the work or revising it critically for important intellectual content: DL contributed 60%, WS contributed 25%, and TW contributed 15%. All authors approved the version to be published and agreed to be

accountable for all aspects of the work.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.afjem.2018.09.001>.

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