Exploring and describing the functions and responsibilities of Emergency Medical Communication Centres in South Africa

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DECLARATION

I, Riekert Dewald van Schalkwyk, hereby declare that the work on which this thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university. I authorise the University to reproduce for the purpose of research either the whole or any portion of the contents in any manner whatsoever.

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List of Abbreviations

ALS: Advanced Life Support

BLS: Basic Life Support

EMCC: Emergency Medical Communications Center

EMD: Emergency Medical Dispatch

EMS: Emergency Medical Service

HIC: High Income Country

HICs: High Income Countries

HPCSA: Health Professions Council of South Africa

LMIC: Low- Middle-Income Country

LMICs: Low- Middle Income Countries

NECET: National Emergency Care Education and Training

WHO: World Health Organization

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PART A: LITERATURE REVIEW

Definitions

Emergency Medical Communications Centre (EMCC): A dedicated facility for emergency call handling and dispatch personnel, contactable through publicised access telephone numbers (1, 2).

EMCC Function: Within the context of emergency medical care systems, a function can be defined as a specific purpose or role that promotes the effectiveness of the care delivery system during emergency cases. Functions are activities and responsibilities assigned to specific components or stakeholders within the system, each performing their purpose to address the needs of patients in emergency situations. Functions range from planning and preparedness to response, retrieval and ongoing systems improvement. Adapted from Rosen (3).

EMCC Responsibility: Within the context of emergency medical care systems, a responsibility can be defined as a duty or obligation allocated to an individual, organisation or component within the care delivery system. Responsibilities outline the actions or tasks that should be undertaken to achieve a desired outcome within the context of emergency management. Responsibilities often relate to emergency preparedness, response, and retrieval efforts. Adapted from Rosen (3).

Emergency Medical Service (EMS): describes the system that delivers patient care through an organised structure in both the prehospital and out-of-hospital environments (4), and is facilitated in modern EMS systems by the Emergency Medical Communication Center (5). Call takers and dispatchers perform their duties within Emergency Medical Communication Centers, sustaining Emergency Medical Services (EMS) operations across the world (6). Furthermore, EMS is the basis for effective mass casualty incident management and disaster response (4).

Emergency Medical Dispatch (EMD): A process which facilitates the prioritisation of, and emergency medical service resource allocation for managing medical emergencies by call handling and EMS dispatch personnel, through structured information gathering, processing and guided decision making (7).

Literature Review Objectives

The objectives of this literature review:

- Highlight the focus areas of research conducted on Emergency Medical Dispatch (EMD) and Emergency Medical Communications Center functions and responsibilities since the professionalisation of EMD in High-Income Countries.
- Describe the need for effective EMS and EMD in South Africa, informed by the unique burden of disease.
- Establish an overview of current EMS availability in South Africa, and the available scientific literature on EMD in South Africa, alluding to possible future EMD research focus areas already identified.
- Summarise an appropriate framework and research methodology which are most appropriate for addressing the knowledge gap identified.

Search Strategy

The literature search utilised several databases. These were, PubMed, Scopus and Ebscohost (Africa-wide and CINAHL) accessed through the UCT Health Science Library. In conducting the literature search, Medical Subject Headings (MeSH) terms were utilised to conduct the literature search. These MeSH terms included “emergency dispatch centre”, “call-centre”, and keywords included “emergency communication centre, operations, dispatch, call, roles, functions,

components, elements", and variations of "Low- and Middle-Income Countries". These terms were used in various combinations to yield results. The search period was set between January 1970 and December 2023 due to the low number of studies from LMIC. After selecting for English language, the search yielded 470 results. Titles and abstracts were screened by the first author for relevance, meaning EMCC functions or responsibilities were described. Literature which only tangentially described EMCC functions, or where the full text was not available were excluded. The resulting 34 relevant articles were included for review.

Table 1: Literature search

Databases searched	Pubmed, Ebscohost (Africa-Wide & CINAHL), Scopus
MeSH Terms	"Emergency Dispatch Center" and "Emergency call center"
Key Words	emergency communication centre, operations, dispatch, call, roles, functions, components, elements with Low- Middle Income Countries variations
Date Range	1970 – December 2023
Results	470 Articles
Articles included after screening for relevance by first author	34

Introduction

In the event of a medical emergency in South Africa, a caller will ideally contact the Emergency Medical Communications Center (EMCC) via a universal access number (8-10). A call taker will gather the necessary information to sort the emergency according to urgency, since a tiered response system is used most often, and pre-emptively identify expertise likely required at the scene. In systems where call taking and dispatch duties are performed by a separate person, referred to as a dispatcher, an organised summary of the gathered information will be handed over, eliciting dispatch and control of the required EMS resources (2). In some EMCCs, call taking and dispatch duties are performed by the same staff member.

Although a wide range of functions and responsibilities are performed in various EMCCs, ranging from basic telecommunications in a small local service to advanced demand prediction in international systems, the dispatch function is shared by most EMCCs (4). Sound training and the use of protocols or guidelines are vital, as the call taker or dispatcher fulfils the role of first responder by providing telephonic guidance to bystanders, probing and identifying crucial clinical information, prioritizing the call and resources required, and relaying this to responding EMS personnel (11). In essence, an opportunity for triage exists at this point of emergency care, since calls for service can be sorted according to a calculated level of urgency, based on developed algorithms (12). In addition, the EMD system often provides the link between components of the EMS, such as rescue, inter-hospital transfers, and aeromedical support (2). Time taken from the first call to the EMCC until emergency care is delivered is shortened when EMCC call takers are able to recognise time-sensitive emergencies early on (13). Furthermore, EMCCs function as the control and data hub of the EMS (14).

Burden of Disease and Emergency Care in South Africa

South Africa is classified as an upper-middle-income country (15). Despite this classification, high levels of poverty, inequalities, and unemployment remain for large proportions of the population (16, 17). Although the country made some progress in reducing poverty levels from 1994 to 2011, this reduction of poverty has not continued, with the Covid-19 pandemic predicted to further exacerbate fiscal constraints, amongst other economic growth inhibitors (17-19). The health system of South Africa is fragmented, with most of the population served by the poorly resourced,

government-funded, public health sector, and the minority of the population served by the well-resourced, voluntary medical insurance or out-of-pocket funded private sector (18).

In the past 60 years, the global life expectancy increased with an average of 20 years, while South Africa experienced a decrease in life expectancy in the early 2000s. This reduction could be attributed to the significant burden of disease in South Africa, termed the quadruple burden of disease (17). The quadruple burden of disease includes the HIV and tuberculosis pandemic, violence and traumatic injuries, maternal and child mortality, and noncommunicable diseases such as cardiovascular diseases, diabetes and cancer (18). This disproportionate burden of disease brought about comparatively high levels of preventable and excess deaths occurring even before patients arrive at health care facilities (20). Despite South Africa being the biggest spender of budget per capita on health care in Africa, the improvement in health outcomes does not appear to be proportional, made evident by the lack of increases in life expectancy and other WHO markers (18).

In 2007 the World Health Assembly called for the development of an integrated, emergency care systems in Africa to help address the significant burden of disease (21). Emergency care can be defined as, "the subset of emergency services focused on delivery of curative interventions targeting severe clinical cases" (22). Acute care includes a broader range of clinical health care functions, including prehospital emergency care, acute surgery, and urgent care, among others (22). Acute care is often interchangeably used with emergency care. Emergency Medical Service (EMS) systems have been advocated as a cost effective, sustainable public health intervention appropriate for resource-constrained environments (23).

EMS Accessibility Across South Africa

Nielsen *et al.* attempted to establish the status of prehospital care in South Africa (24). They reported that South Africa has a formal EMS system, with 60% of the population having access to Basic Life Support Services, however, the lack of reliable data was cited as a limitation in assessing the availability and utilization of these services on a national level. In a further attempt to describe the state of EMS in South Africa, Govender *et al.* performed a review of literature in 2023 which found significant shortages in staff and operational ambulances to address the emergency care needs of an estimated 60 million South Africans (25). Although the national standard for attending to high acuity (Priority 1) calls have been defined for EMS, none of the urban provincial EMSs reviewed were meeting the standard of attending to 90% of cases within 15minutes in 2015 (26). Furthermore, a response time of 60 minutes or less is set as the national standard for lower acuity calls within urban settings (26).

For many ill and injured, the EMS is the primary means of accessing health services in South Africa (27). The poorest often have no other means of transportation to health care facilities, other than costly public transportation services which are often not available 24/7, nor equipped to safely transport the ill or injured. In order to achieve the best possible standard of health, access to essential health care, specifically emergency care, are required (22). This necessitates the rational and equitable distribution of limited resources, where failure in the provision of these services increases preventable mortality and morbidity (28). According to a 2015 study aimed at achieving improvements in response times for high acuity cases, none of the three most populated provinces (Gauteng, Kwazulu-Natal and Western Cape) reviewed were achieving the predefined acceptable response times for both urban and rural calls (26). Although some provinces were making improvements toward meeting the national standards, others were regressing (29). It is important to note that while EMS response times aren't a reliable indicator of quality of care , it is a widely accepted norm as a metric for service delivery (29).

Establishing EMD and initial Research in High Income Countries

The development of modern-day EMS in the United States of America (USA) was largely driven by the release of the report titled, "Accidental Death and Disability: The Neglected Disease of Modern Society" in 1966 (30). The report

identified the disjuncture between the needs of the general population and the disorganised emergency services available. With the introduction of organised EMS, emergency dispatch centres were created to facilitate the allocation of EMS resources, such as ambulances, first responders and external role players, including police and fire departments (31), with emergency dispatchers developing into a point of triage (32). Furthermore, the need for the ability to provide emergency instructions to callers who could assist the ill or injured prior to EMS arrival was identified and basic systems were developed to begin with this service. By the mid-1970s, the Emergency Medical Technician (EMT) and EMT-paramedic designations were created following the publication of the Emergency Medical Service Systems Act of 1973 (33). The practice of providing prearrival aid instructions are largely attributed to a paramedic in Arizona, who guided the mother of an apnoeic baby to provide life-saving interventions (34). This practice was further developed when the university of Washington implemented 9-1-1 dispatcher training, which included the provision of detailed telephone instructions on providing Cardio-Pulmonary Resuscitation (CPR) to laypersons (31).

During the establishment period, advances in EMD standards were largely driven by policy developers and position statements, since very little peer-reviewed research was undertaken (32). The need for professionalisation and consistency in dispatching became evident during the early '80s. Protocolised algorithms and training certification soon followed in the USA (35). Prior to instituting recognised training and protocols, untrained dispatchers determined the nature and severity of the incident being reported based on intuition and no guidance (32).

Triage systems are ways of systematically prioritizing care according to the patient's healthcare needs, and influence the order and priority of emergency medical care, transportation and hospital destination (36). This principle implies that when two patients require emergency medical care simultaneously, finite resources will be allocated to the patient with the most urgent need for care, typically determined by a standardised triage tool that classifies intervention priority. Although field triage will only occur once formally trained help arrives, some dispatchers are able to make use of protocols to sort caller symptoms according to priority classifications and activate the appropriate EMS response (36). Accurate dispatch prioritisation is vital, since it represents the match between the patient's medical needs and the allocation of prehospital resources (37). The main objective of the EMCC is to achieve the most efficient use of often limited resources. Inaccurate dispatch priority results in either under- or over-triage. Over-triage is the allocation of highly trained and equipped prehospital resources to low-acuity patients, while under-triage is a delayed response with basic trained and equipped prehospital resources to high-acuity patients (38). Although over-triage is unfavourable, a higher degree of over-triage is tolerated to avoid under-triage as far as possible (39). Under-triage can result in avoidable morbidity and mortality, exposing the EMS to litigious risk (40).

A concept which has received attention from the introduction of protocols and guidelines on an ongoing basis is that of the predictive value of the EMD system employed. Many retrospective evaluations and some pre/post implementation studies have been conducted to establish and improve on the status quo (11, 41, 42). The continuous efforts aim to optimise the ability of EMD systems to accurately determine the urgency and level of care required at the scene of an emergency.

Other international research focussed on the optimisation of dispatch practices. Standards of practice and regulations were proposed, which sought to standardise EMCC practices across the USA, however, no national standard has been adopted, nor national legislation implemented to achieve standardisation (43, 44). Dr Jeff Clawson (45) authored and co-authored many publications throughout this period detailing position statements and introductory descriptive studies on the establishment of emergency medical dispatch to manage calls received by EMCCs. Reviewing EMCC systems in its entirety and individual dispatchers' performance were introduced as quality assurance practices (46).

Development of Criteria Based Dispatch

Most European countries adopted a guideline-based EMD system, entitled Criteria Based Dispatch (CBD), relying on dispatchers' interpretation of guidelines and information provided by the caller to assign a priority level to calls for service (47). The CBD system does not strictly enforce adherence to algorithms, as stipulated by the Medical Priority Dispatch System (MPDS) employed in much of the USA (48). This system was developed in King County, Washington,

United States of America. The CBD system does not strictly enforce adherence to algorithms, as stipulated by the Medical Priority Dispatch System (MPDS) employed in much of the USA (49). The CBD system was developed in King County, Washington, United States of America. It was introduced into the United Kingdom's (UK) EMS by a task team named 'ORCON' which aimed to identify improvements possible to the UK's EMS (49). Since its introduction and further development, the CBD has been shown to be effective in minimising over- and under-triage ,comparing well to the MPDS system used in most of Northern America (38). Nursing staff have been increasingly introduced to EMCCs, particularly in Sweden where the CBD system is used (37). A four-year nursing degree coupled with the adaptability of the CBD system allows the dispatcher to make a tailored EMS response. This improves the EMS ability to cater to the patient's needs compared to a rigid protocol based EMD system (37). The CBD provides more flexibility, due to the guideline nature of the system, whereas the MPDS has been critiqued for its rigid protocols, making adaptations to unique emergency cases difficult.

EMS & Emergency Medical Communication Centers in South Africa

The South African EMS functions according to the Anglo-American system (minimising on-scene times) and consists of a government-run ambulance service and multiple private EMS organisations. Government and private EMS function independently (27).

In South Africa, the development of emergency medical dispatch and EMCCs occurred rapidly after the 1990s (50). In the past, the responsibility for providing ambulance services were assigned to municipal government. This led to fire departments providing basic emergency care and ambulance services within the municipal boundaries. Large areas of South Africa outside of municipal boundaries were without any emergency services. Although the legislation was promulgated in 1977 to assign this responsibility to provincial legislature with the aim of improving funding and EMS coverage across South Africa, the implementation was not driven successfully until the early '90s (51). The newly established EMS inherited many resources and practices from the fire departments, including staff and institutional knowledge and dispatch communications practices.

According to the 2014 African Federation for Emergency Medicine conference consensus, emergency care systems can be described on a continuum and consist of out-of-hospital and in-hospital components (52). Out-of-hospital emergency care systems include emergency care system activation, tier one (lay person rescuers/first aiders) and tier two response (trained emergency care personnel) and care, as well as emergency transportation. The emergency medical dispatch (EMD) system plays a pivotal role in facilitating out-of-hospital emergency care, actively involved in all four stages thereof (2). In-hospital emergency care systems include basic in-hospital emergency care, and advanced/definitive emergency care (2).

One barrier identified by Nielsen et al. to the provision of effective EMS were the lack of standards-setting legislation (24). Although the National Health Act of 2003 made some provisions for EMS guidance in South Africa, basic legislation for standards of service have only recently been introduced, with the EMS regulations gazetted in 2017 (53), and the EMS standards of care in 2021 (1). Although limited, introductory standards regarding the Emergency Medical Communication Center and EMD have been defined in the 2021 National Health Act amendment (1). Facilitating the development and implementation of legislation relating to EMS and Emergency Medical Communication Centers, it is vital that quality research is done on an ongoing basis. Summarising these challenges, Govender *et al.* recommend that a national framework and policy is developed to guide the standardisation of technology, training and daily operations of EMCCs operating across South Africa (25).

The EMCC landscape varies significantly across South Africa. According to personal experience, there are several provincial EMCCs which make use of basic paper-based EMD managing techniques, such as handwritten calls for service requests, type of incident, and time intervals from time of call received until closure of the call. A 2020 description of the Western Cape Government EMCCs showed significant development. A computerised EMCC call system was

developed in-house, which facilitates electronic recording of call details, priorities, vehicle tracking and other important details, enabling analysis of accurate retrospective data for continuous quality improvement.

Currently no emergency medical dispatch register exists with the Professional Board of Emergency Care (PBEC) at the Health Professions Council of South Africa, the statutory body which regulates the emergency care personnel registrations (54). Further, in some EMCCs, the majority of call takers do not have any medical training, nor protocolised call taking procedures, however, some in-service training is provided (27).

Considering the following case as an example of barriers to the improvements of EMCC systems nationwide, some themes emerge. Recently, Flemming, Hodkinson and McAlpine evaluated the rates and contributing factors to over-triage by EMCCs in Cape Town, South Africa (27). Although specific complaint categories could be identified which were prone to over-triage, local systems improvement would only benefit the population served by the EMCCs in Cape Town and a few other municipalities which make use of the same dispatch system. Replicating these improvements in EMD systems across South Africa would require similar studies to be undertaken in each setting (an enormous undertaking), or the standardisation of operations across South African EMCCs. Identifying the contributing factors to over-triage present in EMCCs across South Africa would be an impossible task, due to the fact that multiple governmental EMCCs are still using handwritten dispatch sheets, hampering data reliability and analysability. Furthermore, there is no national standard for EMCC operations in private EMSs, further hampering a nationwide improvement of EMD systems. The lack of national standards of practices informed by protocols or guidelines would make generalised improvements to country-wide dispatch systems near impossible.

EMD Training

Jacobson et al. identified the need for tailor-made training for dispatchers in Low- and Middle-Income Countries (LMIC) like Nepal, which would entail designing a curriculum that enables efficient coordination and communication between the different entities involved in the delivery of EMS (55). This need was identified based on the limited nature of EMS resources in the country, which required an improved efficiency in utilization, a need shared by South Africa. To facilitate such curriculum design relevant to South Africa, the functional roles and responsibilities of EMCCs would first need to be established.

The unmet need for efficient, effective, standardised EMD practices, relevant to the LMIC setting has been identified previously (7, 8). The MPDS system is a popular dispatch system implemented in developed countries, however the cost, resource intensity and setting appropriateness have been cited as barriers to its implementation in South Africa (56). In November 2014, the African Federation of Emergency Medicine together with the International Academies of Emergency Dispatch formed a work group with among others, the purpose of establishing recommendations to guide developing EMD systems (2). In their paper, Mould-Millman et al. propose that once these systems are established, future studies should determine essential functions and responsibilities of EMCCs (2).

The National Emergency Care Education and Training (NECET) policy brought about significant changes to the emergency care realm in South Africa from 2017 onwards. This policy outlined the transition from short-course vocational training to higher education level education for all tiers of emergency care personnel in South Africa (50). A lack of standardised EMD training has been described by EMCC personnel as a barrier to effective EMCC operations previously (7). Although the need for professionalisation of clinical EMS personnel education was addressed in the NECET policy, EMD training has not been standardised, nor have academic standards been identified and set at the South African Qualifications Authority (SAQA) (57).

Literature describing the historic development of EMS in South Africa is scarce, and barriers to efficient service delivery is mostly restricted to specific cities or regions, very few national descriptions exist. There is, therefore, uncertainty regarding the implementation and developmental status of systems implemented in EMCCs across South Africa in both

the private and government sectors. Furthermore, the level of evidence underpinning the implemented functions and responsibilities in EMCCs across South Africa remains unclear.

Knowledge Gap in the Literature

It is clear from evaluating historical literature that the development of EMD systems and practices in the USA were based on weak empirical research in the early 1970s. Although the need for EMD was clearly identified, the introduction of a protocol-based EMD model, with non-tertiary training and certification pinned as the required level of education, should be re-evaluated with the modern evolution of scientific research. Gardett *et al* (32) describes the situation best, stating with regards to the implemented best practices in EMD, "…more research work in these areas is also needed to confirm the findings of early researchers and standards setters." Subsequent evaluation of singular functions, responsibilities and technology introduced into EMCCs have been studied more thoroughly than systems and their fundamental principles, and its applicability to LMIC settings should be evaluated for contextual appropriateness.

Addressing the Knowledge Gap

In 2005, the World Health Organisation used a framework for establishing and prioritising EMS responsibilities which should be developed in LMIC settings. Four classifications were defined, namely "essential", "desirable", "irrelevant" and "sometimes relevant" (e.g. country at war). These classifications were determined according to the impact of the action on patient survival, the cost and resource intensiveness of implementing this responsibility, and the managerial implications of adding this function to existing EMS structures (8). This framework was also refined and used by Mehmood *et al*. (4) in 2018 to evaluate existing EMS organisations. Given the financial constraints endured by the health sector in South Africa, this framework is most suited in determining the largest return on investment in terms of achieving the greatest benefits to patient care, for the greatest number of patients, given the available resources. This framework could be further expanded to determine the priority and appropriateness of functions and responsibilities of EMCCs in South Africa.

Due to the limited amount of EMCC systems research available for the South African setting, determining the priority functions and responsibilities through means of research methods higher on the hierarchy of evidence pyramid would be problematic (58). Rather, the modified E-Delphi lends itself well to the situation as a consensus-finding technique, with knowledgeable local experts available, who are both familiar with the management and development of local EMCCs as well as the available research-driving development within the sector (59).

Conclusion

There are many ill and injured South Africans who rely on government and private EMS for access to emergency care. Given the very limited amount of research undertaken in South Africa to establish the foundation for implemented EMCC training, functions, and responsibilities, it is crucial to re-evaluate whether key EMCC functions and responsibilities currently employed are relevant and appropriate for the local setting, and what the priority functions and responsibilities are which should be implemented in the short term to optimise the delivery of emergency care to those in need. This re-evaluation should be performed according to an established framework, which delineates relevance and appropriateness for reliable results.

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PART B: SUBMISSION-READY ARTICLE

Article in the format required by the African Journal of Emergency Medicine as per https://www.sciencedirect.com/journal/african-journal-of-emergency-medicine/publish/guide-for-authors

Exploring and describing the responsibilities and functions of Emergency Medical Communication Centers in South Africa: A modified E-Delphi study

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Abstract

Introduction: A significant number of South Africans are reliant on Emergency Medical Services (EMS) for access to Emergency Care, a need compounded by the current quadruple burden of disease. Efficient allocation of EMS resources ensures optimal use in time-critical emergencies. Development and improvement of Emergency Medical Dispatch practices implemented in Emergency Medical Communication Centers (EMCC) have been proposed as a means to improve EMS effectiveness. Establishing priority EMCC functions and responsibilities relevant to South African EMCCs could provide insight into practices requiring further strengthening and development. The aim of this study was to identify and categorise the functions and responsibilities of EMCCs in the South African setting.

Methods: A three-round modified E-Delphi was undertaken to establish priority EMCC functions and responsibilities relevant to the South African setting. Fifty-seven statements related to EMCC functions and responsibilities retrieved from the literature review, across six categories, were sent out to 25 EMCC experts from government and private EMSs using LimeSurvey™ software.

Results: A total of 68 (88%) out of 77 functions and responsibilities' statements reached consensus (70% agreement) as "essential" to South African EMCCs. Most of the statements related to Systems, Dispatch and Continuous Quality Improvement categories. The remaining 9 (12%) statements did not achieve consensus as essential, desirable or non-applicable, however a clear tendency toward a higher or lower rating of contextual applicability was evident.

Conclusion: The majority of EMCC functions and responsibilities described in High-Income Country studies were found to be applicable and were classified by the expert panel as essential for South African EMCC. The methods used as well as the contextualized results could be applied in similar settings to identify developmental priorities.

African Relevance

Formal EMS systems are in varying stages of development across the African continent. This study sought to establish the important South African relevant Emergency Medical Dispatch elements to address the need for efficient Emergency Medical Services. Although South Africa has had a well-established formal EMS system for the past few decades, the development and functioning of Emergency Medical Call Centres may have been neglected. Understanding and prioritising the functions and responsibilities of such call centres can be extrapolated to other African countries in the early stages of establishing formal EMS systems.

Introduction

Globally, the Emergency Medical Service (EMS) is a key first point of access to emergency and non-emergency medical care. EMS refers to the system that delivers emergency medical care to patients through an organised structure, by emergency care professionals in both the prehospital and out-of-hospital environments (1, 2). Formal EMS – although different from region to region – typically comprise an Emergency Medical Communications Centre (EMCC), station/s, vehicles and personnel (1). The nomenclature for the EMCC changes depending on the region, with some areas referring to them as Emergency Operation Centres or Emergency Medical Dispatch Centres (EMDCs) (3, 4). Internationally, EMCCs range from basic telephone-answering services to highly sophisticated, technologically advanced communications centres, which, in some settings, co-ordinate all emergency services. In South Africa, communication centers for fire and rescue services, the South African Police Service, and the EMS function independently. Furthermore, private EMS organisations' EMCCs function independently from the State EMS. Many functions and responsibilities fulfilled by EMCCs in South Africa were adopted from organisations such as fire and rescue services due to the historical combination of these services under local governments until the late 1970s and onwards, when the responsibility of EMS was shifted from local to provincial government level (5).

Although emergency dispatch is a role shared by all, an array of different functions and responsibilities are performed in EMCCs across the world. Since the early 1970s, the practice of Emergency Medical Dispatch (EMD) and the role of the EMCC has evolved considerably, initially through telecommunicators who, without any recognised training, answered incoming calls and dispatched EMS resources on a first come, first served basis. Later, as some degree of formalised training and certification as well as protocols and guidelines around call-triage systems had developed, allocation of EMS resources became more judicious (6-8). However, adoption of these developments in EMCCs varied significantly between regions (9). In the '90s, the practice of EMDs relaying prearrival aid instructions (PAI) became more widespread in high-income countries (HIC), with the potential impact of telephone cardio pulmonary resuscitation (t-CPR) on improving cardiac arrest outcomes driving further development and implementation (10), including bystanders initiating CPR and EMS response times becoming widely accepted as quality indicators (10). The extent to which these practices have been adopted in South Africa's EMCCs and their relevance to the local setting remain, however, unclear.

In 2007, and in subsequent meetings, the World Health Assembly's resolutions 60.22, 72.16, and A74/39 called for the development of integrated emergency care systems on the continent of Africa to help address the significant burden of disease and improve access and availability of emergency care (11, 12). An integrated emergency care system refers to the coordinated delivery of care across different disciplines and phases of care, from out-of-hospital to definitive care as opposed to a fragmented (siloed) care delivery model (11, 12). The African Federation for Emergency Medicine (AFEM) highlighted the role of effective EMCCs in 2015, driven by formalised Emergency Medical Dispatch (EMD) processes and systems, in delivering efficient EMC by the respective EMSs (13).

The World Bank and WHO encourage that the inclusion of health interventions, which includes EMCC functions and responsibilities, be founded on principles which promote the maximisation of general population health (14, 15). Services provided are recommended to be evidence based, cost effective, equitable and targeted towards relieving a burden of disease, which requires each implemented and implementable EMCC function and responsibility to be weighed (16, 17). Currently, in the event of a medical emergency, a caller will ideally contact the EMCC via a universal access number (18, 19) where a call taker gathers the necessary information to sort the emergency according to urgency and identify expertise and resources likely required at the scene. In systems where dispatch duties are performed by a separate person, referred to as a dispatcher, an organised summary of the gathered information will be handed over, eliciting dispatch and control of the required EMS resources (13). In some EMCCs, call-taking and dispatch duties are performed by the same staff member.

South Africa has a tiered EMS workforce with a spectrum of providers from basic to advanced life support personnel, and practice principles based on the Anglo-American model of EMS operations. Legislation guiding EMS practice is developing, with specified standards for EMS organisations, such as the Emergency Services Regulations in 2017, and

the Standards for Emergency Medical Services promulgated in 2021, defining quality EMS operations (17, 20). Limited EMS resources necessitate the triage of incoming calls according to urgency and level of care required (20). It is unclear whether a call triage standard has been implemented in EMCCs across South Africa. Although some organisations provide in-house EMD training, no EMD course is registered with the South African Qualifications Authority, nor does a professional register exist for EMDs with the Health Professions Council of South Africa (21, 22). The development of standards of critical components and functions fulfilled by the EMCC to optimise EMS resource use has been identified for future research (23). The aim of this study was to identify and categorise the functions and responsibilities of EMCCs in the South African setting.

Methods

Setting

South Africa has an approximate population of 60.6 million (24). Despite the country's classification as an upper-middle-income country, high levels of poverty, inequalities, and unemployment remain for large proportions of the population (25, 26). The quadruple burden of disease places severe strain on the health system of South Africa (27). This health system is fragmented, with most of the population served by a poorly resourced, government funded public health sector, and the minority of the population served by the well-resourced, voluntary medical insurance or out-of-pocket funded private sector (27).

Design

A modified E-Delphi study was selected as the most appropriate study design, since little scientific evidence is available for the topic, yet local experts with practical knowledge and experience are available to combine scientific evidence with practical knowledge to create consensual standards (28, 29). Obtaining input from experts across government and private sectors while remaining cost effective is achieved through this method, since the surveys are completed online. A further beneficial characteristic of the Delphi design is that participants remain anonymous to their peers, thereby preventing undue influence potentially brought about by rank or perception of superiority (30).

Expert Panel

A combination of purposive and snowball sampling techniques was used to identify potential expert panel members. Experts were identified based on their expertise through EMCC managerial positions held or EMD systems development experience, and were defined as those "familiar with EMD systems, and EMCC operations and their development in South Africa". As there is no EMD-specific training qualification registered with the South African Qualifications Authority, it was not possible to identify experts based on formal qualifications. Professional staff from non-emergency care backgrounds that are involved in EMCC function and development, such as Information Technology (IT) specialists, financial managers, and communications technology specialists were also included. To maximise participation, potential expert panel members working abroad were included if they had gained SA EMCC managerial experience within the past 5 years.

EMCC managers and EMD systems developers known to the researchers were invited by email to participate in the study (purposive) and further asked to recommend other industry experts who could be eligible for inclusion (snowball). Recruitment was managed through the automated email and records function on LimeSurvey™. The panel size was projected to include a minimum of thirty members, based on a list of experts in the field known to the researchers, with normal attrition rates expected as seen with similar Delphi studies (31, 32).

Initial Framework and Statements and Consensus Process

A literature review was performed searching in PubMed, Ebscohost (Africa-wide and CINAHL) and Scopus databases to establish a list of possible EMCC functions and responsibilities. Keywords included "emergency communication centre, operations, dispatch, call, roles, functions, components, elements", and variations of "Low- and Middle-Income

Countries". Literature describing EMCC functions or responsibilities, publishing in English, were included. Literature which only tangentially described EMCC functions, or where the full text was not available, were excluded. Thirty-four articles were identified for inclusion. Literature statements around EMCC functions or responsibilities were identified by the first researcher and compiled into a list. After statements were extracted from the literature, the second and third authors grouped similarities and reduced duplications, culminating in fifty-seven statements in six categories. The six categories included EMCC systems, incoming calls, dispatch, prehospital care, continuous quality improvement, and financial management. The literature-review informed list of statements was sent to two external reviewers, with the aim of checking for correctness and to minimise author bias, and was piloted by five reviewers and refined around clarification of instructions and flow (pilot responses not included in results). The external reviewers had both expertise in academia and EMCC operations. These statements formed the first framework for the expert panel for consensus and further input.

Round one allowed for free-text additions by the expert panel. Round two and three allowed experts to categorize statements from prior rounds as either essential, desirable, or irrelevant. This was based on an adaptation of the framework used by the World Health Organisation in 2005 and Mehmood et al in 2018, such that the importance of resources for the implementation of EMS in LMICs were classified (1, 33). Each statement was judged by the expert panel members using a 7-point Likert scale reflecting not applicable (0-2/7), desirable (3-4/7) or critical (5-7/7) to the operations of an EMCC in South Africa. Questionnaires and feedback on the results of each round were communicated via the LimeSurvey™ platform, which also enabled participants to give consent to participate.

Process Regulation and Analysis

Data collection occurred from November 2021 until May 2022. Invitations to rounds were sent via email to potential expert panel members, regardless of non-participation in prior rounds, with a four-week period reserved for questionnaire completion. Expert panel consensus was predetermined as 70% agreement (a midrange compared to similar Delphi studies (29), which allowed categorising a statement as critical (5-7/7), desirable (3-4/7) or not applicable (0-2/7), according to a predefined 7-point Likert scale. Data analysis was performed on Microsoft Excel for all three rounds (34). After round one, thematic analysis of additions generated by the expert panel in round one was performed (35) and these themes were added as statements to the literature-review generated list. Thematic analysis consisted of grouping similar statements, removing duplicates, and categorising statements according to the 6 categories established during the literature review. Round two comprised categorising the importance of each function or responsibility to the EMCCs' ability to serve patients in South Africa, as well as allowing for alterations of statements for clarity from round one. Statements from round two which did not reach the 70% consensus threshold were carried over to round three, with feedback describing the average score and number of indications according to the three categories for reconsideration in round three. If statements in round three did not reach consensus, it was reported as such, and no subsequent round for iteration was held. Rounds two and three were extended for four weeks (eight weeks in total each), to allow for more participation, and closed when a minimum of twenty expert panel members had participated.

Ethical Considerations

Ethical clearance for this study was obtained from the Human Research Ethics Committee of the University of Cape Town, HREC ref: 241/2021, as well as from the Gauteng, Western Cape, Eastern Cape and Free State provincial departments of health. Participation in this study was voluntary, and participants remained anonymous in their input as the survey did not obtain any identifiable details.

Results

Expert Panel Demographics

A total of 48 individuals were invited to participate as expert panel members, and twenty-five experts agreed to participate in the study. Experts were from a variety of sectors and provinces participated (see Table 2).

Table 2: Job roles, sector of employment and geographic representation of 25 expert panel members

Expert group job role			
Job role (n = 4)	Total 25	Sector (n=3)	Total 25
EMS[a] Senior Management	9 (36%)	Private	10 (40%)
EMCC[b] Management	12 (48%)	Public & Private	5 (20%)
EMCC[b] Software & Systems Development	4 (16%)	Public	10 (40%)

Geographic Location (n = 6)	Total 25
Eastern Cape	4 (16%)
Free State	3 (12%)
Gauteng	8 (32%)
KwaZulu Natal	1 (4%)
Western Cape	7 (28%)
International	2 (8%)

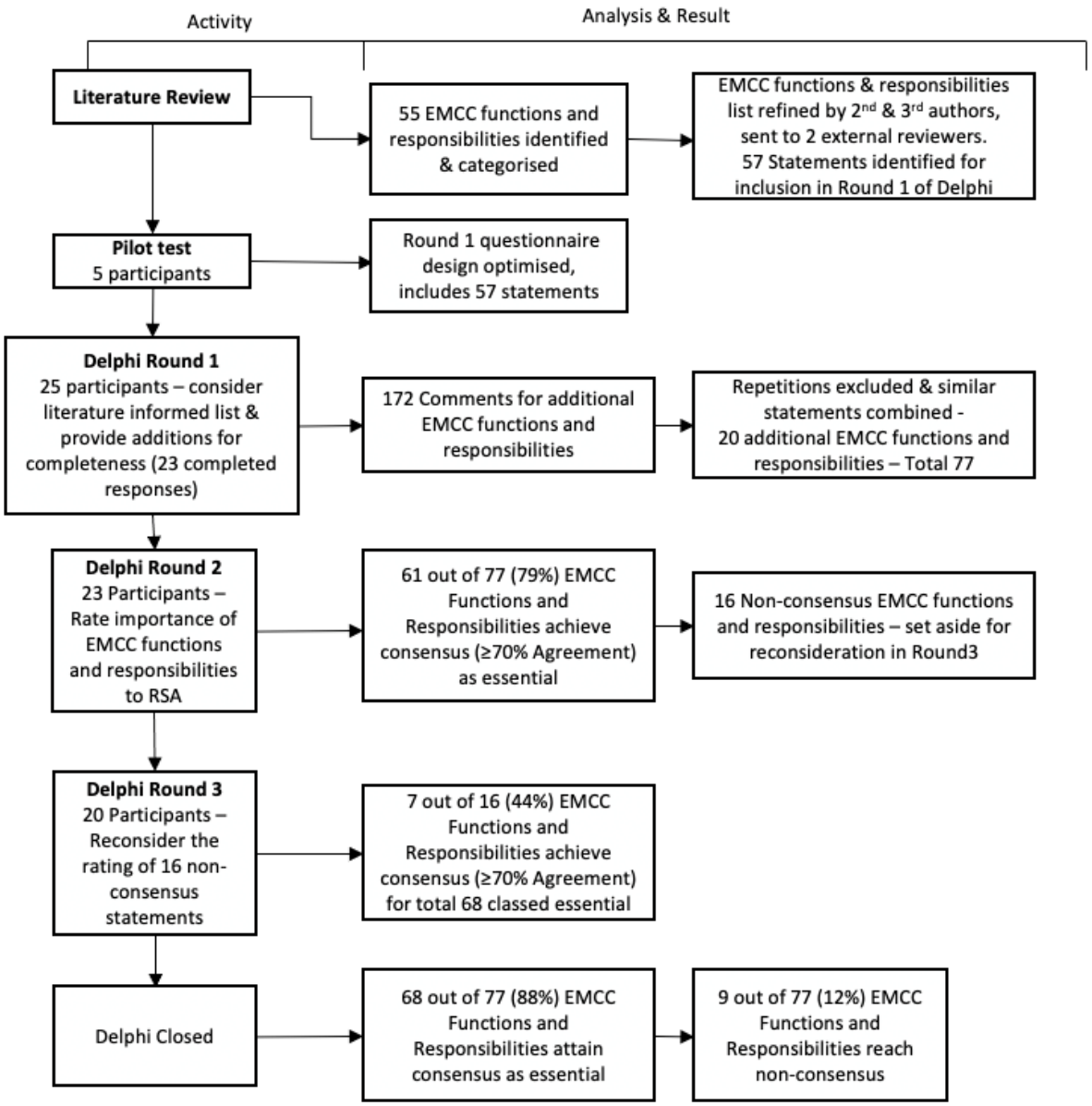
[a] *EMS: Emergency Medical Services*
[b] *EMCC: Emergency Medical Communications Center*

Statements

Fifty-seven literature-informed statements were presented to the expert panel for consideration and additions in round one (Addendum 2). Twenty-three completed surveys were received in round one, which contained 172 suggested additions to the literature-informed list. Thematic analysis of round 1 data produced 20 additional statements.

Seventy-seven statements were presented to the panel in round two. Twenty-three completed questionnaires were received, with consensus reached on 61 (79%) statements and 16 (21%) statements achieving non-consensus.

Sixteen statements were presented in round three, with consensus reached on seven further statements from 20 complete responses. In total, 68 of 77 (88%) statements reached consensus. The expert group was divided on the categorisation of nine (12%) statements after three rounds of iterations, however with clear propensity toward either non-relevant/desirable or toward desirable/critical (see Figure 1, Table 3 and Table 4).



Emergency Medical Communications Center (EMCC); Republic of South Africa (RSA)

Figure 1: Study process flow for the modified e-Delphi study, with three rounds of iterations and resulting consensus and non-consensus statements presented for each round.

Table 3: EMCC functions and responsibilities consensus statements from expert panel after three rounds of iterations

Consensus Statements (≥70% Agreement) as "Essential"

Systems

Core Functions & Responsibilities

1. Emergency Medical Services are a crucial part of Out-of-Hospital Cardiac Arrest (OHCA) survival.
2. EMCCs form the foundation of effective disaster management and response coordination, including mass casualty incidents.
3. The EMCC should organise EMS resources – ensuring coverage of frequent use areas, ensuring that the most effective ways are used to connect the patient to healthcare resources.
4. A Universal Access Number should be available to contact the EMCC.
5. EMCCs should cater for both emergency care and inter-facility transport requests.
6. EMCCs should be available on a 24-hour basis.
7. EMCCs should administrate a planned patient transportation system.
8. The EMCC shares the responsibility for EMS resources' safety. (E.g., Implement ambulance-attack mitigating measures). [1, 2 See expert comments below.]
9. Redundancy should be developed for all EMCC functions. (e.g., IT backup & uninterrupted power supplies)
10. EMCC staff rostering should be aligned with call volume patterns.

Record Keeping

11. Records should be generated of the incoming call, noting time-based metrics and clinical details.
12. All incoming and outgoing communication (telephone, radio & text based) of the EMCC must be recorded and saved as part of the call record (unique incident number).
13. EMS patient report form / Patient Care Record should be linked to the call record.
14. Records should be secured, kept, and made accessible according to the National Health Act, no.61 of 2003.

Software / Tele-Communication System

15. A low-cost dispatching communication software system, which facilitates communication between callers, first responders and dispatchers, is required for LMICs / SA. [3 See expert comments below.]
16. The telecommunication software / system should provide automatic number identification.
17. The telecommunication system should provide automatic caller location identification (mobile handset generated) or nearest cellular site.[4 See expert comments below.]
18. The telecommunication software / system should recommend and enable the dispatcher to dispatch EMS or other services likely required at the scene.
19. Locally developed dispatch systems are preferable in South Africa to expensive brand-name systems (such as the Medical Priority Dispatch System).
20. Dispatch systems must be contextually appropriate, due to the vast differences in EMS infrastructure in LMICs (vs. well-resourced settings where many brand-name systems were developed).
21. Incoming calls should display historic use of EMS and make records available, a unique identifier, such as the caller's telephone number / ID number / street address, could be used to facilitate this function.

Location Display / Tracking

22. GPS trackers and location identifiers should be available for all EMS vehicles.
23. The GPS location information should be integrated into the dispatch system used, generating vehicle movement reports for call records.
24. The GPS location information integrated into the dispatch system used should indicate the status of the vehicle, manually or automatically updatable through geofencing for incident scenes and facilities.
25. An emergency call should be directed to the most appropriate geographic EMCC based on automatic approximate location identification.

Technology

26. EMCC technology needs to keep up with technology used by the public to activate EMS, e.g., text messaging, social media. [5] See expert comments below.
27. Computerised triage tools should be used by call takers.
28. Technology and data should be used to improve EMS services. e.g., real-time electronic run sheets.

Protocols and Guidelines

29. Protocols that indicate resource allocation should adapt according to the number of calls / pressures experienced by the EMCC.
30. Operator deviation and decision escalation should be available for scenarios that exceed the provisions of the protocols or guidelines used, e.g., medical direction. [6] See expert comments below.
31. The EMCC should be functionally laid out to manage specialised tasks, including critical care or aero-medical responses.
32. Guidelines and protocols should be developed for call-taking staff. Examples include: 1) manage complex calls, e.g., very young callers, 2) guide the management of non-medical emergencies e.g., bomb threats or hijacking and 3) deal with prank callers.
33. Guidelines and protocols should be made accessible and call-taking staff should be trained on the content and use of the guidelines and protocols.

Incoming Calls

34. Call takers gather information to establish the nature of the emergency at the scene.
35. Call takers should establish the location of the incident.
36. Call takers should obtain a call-back number or other alternative communication means (e.g., text messaging/social media).
37. The call-taking process should involve scripted questions, based on clinical algorithms, to identify time-critical emergencies and limit over- and under triage.
38. EMCCs should be able to match the caller's linguistic and cultural needs with an appropriate call taker / dispatcher and strategies developed for assisting language-discordant callers.
39. Scripted questions and protocols should be able to identify low acuity callers and be able to institute a low-acuity response or deferral, e.g., primary health care referral, trauma debrief.
40. The EMCC should be equipped and prepared to provide information on local healthcare resources to callers.
41. All unanswered calls to the EMCC should trigger an automated response for call resolution (call forwarding / call-back queue with notification sent to caller)

Dispatch

42. Before dispatch, the right (closest available / correct level of care) EMS resources need to be matched with the need at the scene of an emergency.
43. Different modes of response, such as level of care or urgency of response, should be predefined and algorithm based.
44. Notifications of EMS vehicle's estimated time of arrival should be communicated to callers requesting EMS assistance.
45. The priority of specific conditions and predetermined modes of response should be developed locally and appropriate to the regional setting, according to medical, social, and political considerations.
46. EMCCs should check that the receiving facility is the correct facility according to the needs of the patient. [7] See expert comments below.
47. The dispatcher should coordinate with other emergency services required at the incident scene, including police and fire departments and stand-down services no longer required.
48. The number of fully functional and equipped vehicles, staffed according to a predefined tiered level, should be clear to the dispatcher.

Prehospital Care

49. Telephone advice should be made available for callers reporting a nonacute condition.
50. Time-critical interventions, such as AED defibrillation, CPR, and basic scene safety functions, can be performed by layperson responders at the scene through prearrival instructions by the dispatcher.

51. When possible, constant contact in the form of telephone-based care should be provided from the time of call until EMS resources arrive at the scene of a critical emergency, unless prolonged response times render such contact impractical.
52. Notifications of an ambulance's estimated time of arrival should be communicated to patient-receiving facilities.
53. Dispatch software should have the functionality to enable the communication of essential patient information to the receiving facility while the ambulance is en-route.[8] See expert comments below.

Continuous Quality Improvement

54. EMCC call takers and dispatchers should receive context specific, standardised training and certification.
55. A continuous learning system is required for dispatchers, e.g., recertification or refresher training (CPD).
56. A systemic assessment tool that measures the EMCC's performance should be identified for use.
57. The systemic assessment tool implemented should assist policymakers and planners to identify gaps and set priorities for further systems development.
58. Over- and under-triage rates should be measured and evaluated at regular intervals to monitor the appropriateness of prioritisation decisions made during the call taking process.
59. An ongoing quality improvement program within the EMCC is required for telephonic CPR instructions and cardiac arrest identification by call takers.
60. Dispatch records which reflect call-taking, call-processing and dispatch data should be reviewed for quality assurance, quality improvement, and research purposes.
61. EMCCs should define and track quality indicators for the EMS.
62. Standardised performance indicator measurement should be used to compare the performance between EMCCs in the country.
63. Governance and regulatory bodies with legal and policy frameworks should be established to regulate EMCC operations.
64. Working conditions of EMCC staff should comply with local labour legislation.
65. Epidemiological data should be analysed in the EMCC and shared with interdisciplinary teams for awareness and preventative measure implementation.
66. EMCCs should have a complaints management system (complaints register; resolution procedure & SOP updates).
67. Non-clinical components, e.g., technology uptime, failures, and lag time, should be included in the continuous quality improvement assessment.

Financial Management

68. The financing mechanism and sustainability of the EMCC should be assessed on an ongoing basis as part of the greater EMS system assessment.

Expert Group Comments:

[1] EMS resource safety is a shared responsibility between different role-players, e.g., EMS personnel, management, community members, law enforcement.
[2] Surveillance technology may be utilised to enhance EMS resource safety.
[3] The importance of functionality could render cost-containment as controversial.
[4] Some callers may not be at the same location as the patient, the system should allow for operator input in such instances.
[5] Importance of developing prank caller / misuse protocols to keep up with technological advancements and the public's EMS access preferences.
[6] Decision escalation should be instantaneous, with no time delay to consultation.
[7] The EMCC should have updated information on the capabilities of each facility and facilitate consultation with the receiving facility when clarity is sought.
[8] This communication should be automated.

Table 4: Non-consensus statements (with expert categorizations)

Non-consensus Statements
69. The EMCC computer system should display the real-time availability of ICU, hospital ward and trauma beds at hospitals in the region. Essential:13/20, Desirable:7/20, Irrelevant:0/20
70. A dispatcher may use the accurate caller location to alert nearby layperson responders to assist a victim of cardiac arrest until professional help arrives. Essential:12/20, Desirable:8/20, Irrelevant:0/20
71. The location of automated external defibrillators may be pinned to dispatch system maps and used to direct laypersons reporting a potential cardiac arrest incident. Essential:7/20, Desirable:13/20, Irrelevant:0/20
72. The dispatch system used should facilitate text or video transmission between EMS personnel and the dispatcher / receiving facility. Essential:7/20, Desirable:13/20, Irrelevant:0/20
73. Machine learning should be used to develop algorithms to prioritize calls. Essential:10/20, Desirable:10/10, Irrelevant:0/20
74. Bystanders phoning the EMCC to report an emergency could become layperson responders through dispatchers' prearrival instructions, until professional help arrives. Essential:13/20, Desirable:7/20, Irrelevant:0/20
75. Billing and cost per unit calculations should be integrated with the call taking and dispatch functions performed in the EMCC. Essential:8/20, Desirable:8/20, Irrelevant:4/20
76. Odometer readings of EMS vehicles should be monitored by the EMCC to pre-empt routine maintenance by fleet management. Essential:8/20, Desirable:5/20, Irrelevant:7/20
77. The EMCC should ensure that EMS staff assigned to vehicles have active HPCSA registrations. Essential:8/20, Desirable:3/20, Irrelevant:9/20

Discussion

This study identified, through means of consensus, the priority functions and responsibilities applicable to South African EMCCs. Our findings show that the majority of EMCC functions and responsibilities described in scientific literature remain applicable to the local South African EMS setting, even with the fiscal constraints and differing context. Historically, the identification and implementation of new EMCC functions or responsibilities were often based on heuristics, while it is evident from the outcomes of this study that a consensus-finding technique enables valuable input from many experienced leaders in the field, which could better guide such developments (36).

There was overwhelming consensus from our experts as well as overlap in the suggested additions to the list of possible EMCC functions and responsibilities. The diverse employment field of the expert panel implies the relevance of these statements to both private and government EMS organisations across South Africa. There were many statements focusing on systems as the core responsibilities of South African EMCCs, indicating the importance of defining the strategic goals of EMCCs across the country. The basic functions and responsibilities were laid out, even to the level of stipulating that EMCCs should be operational on a 24-hour basis, ranging to more novel specifics on the introduction of computer aided-dispatch and vehicle-tracking technology. Currently, no standardised protocols and guidelines exist for EMD across South Africa, which exacerbates non-standardised practices in a system with no formalised training (37). In contrast, HICs with protocolised EMD found that extensive medical training was shown to be less important, since strong protocols and guidelines have been established (38).

Consensus-statements give detailed strategies around the process of call taking and dispatch, as well as assistance to prearrival aid instructions to bystanders, and EMS care. Appropriate non-ambulance management of low acuity callers is recommended to divert such calls from traditional EMS resources. This is key in the LMIC setting, due to the limited number of EMC resources and overburdened acute health care facilities (39). This finding is in line with international trends, and EMCCs will require someone with medical knowledge to provide telephonic advice, especially in the South African EMS environment where response times are often long (40-42).

Importantly, since we know that patient safety has been neglected in healthcare, the consensus on statements suggesting the need for legislation, standardised and accredited training, and dedicated EMCC personnel to improve this aspect of prehospital care (statements 54, 55 and 63) is key (43).

The statements which did not reach consensus as essential, largely relate to somewhat aspirational and high technology systems that may not be priorities for the South African (and LMIC) contexts at this time. They relate to systems which integrate hospital bed availability, geo-locating around incidents, and specific software and communications. However, there was division in expert opinion for the first seven non-consensus statements (numbers 69-75 in Table 4) between the essential and desirable categories, and these statements should not be neglected despite not reaching consensus. It was evident these issues are relevant to the EMCCs, however, the panel was divided on the importance of implementing these functions (essential vs desirable) perhaps in the short term. The three final statements (numbers 75-77 in Table 4) were the only ones with any categorization as "irrelevant" and, interestingly, they relate to general EMS systems such as billing, vehicle maintenance and employee professional registration, which experts would seem to see as outside of the EMCC function and responsibility.

We believe the findings of this study can guide system developers and EMS organisations looking to scope new dispatch systems catering to the needs of industry. Existing systems can also use the findings to guide further development, while EMS organisations looking to procure EMCC systems and software would benefit from comparing available software and system capabilities to those recommended. There is no reason that this consensus outcome should not be applicable to LMICs developing similar models of EMS, since replicating the study in LMICs in the absence of local EMCC experts would be problematic. These findings could provide guidance on priority areas of systems development, negating wasteful expenditure on developing non-essential capabilities within these systems

The successful implementation of these findings into existing EMS operations is likely to be complex and resource intensive and requires active engagement and support from management and funders. To prioritise implementation, it is recommended that a careful evaluation, such as the Multi Criteria Decision Making approach, be used to enable the evaluation of each individual recommended function and responsibility by establishing the need, cost versus benefit, and equity of each to promote social justice (44). By using this approach, functions and responsibilities yet to be implemented in an EMCC can be identified and ranked from least costly and difficult to implement, seeking greatest patient benefit.

The high level of correlation between literature-informed statements and the expert panel's consensus on most of these statements examined from a triangulation point of view supports the validity of these findings. Expert panel members were able to review their additions made in round one and submit corrections if required, referred to as member checking (45). External reviewers were used to review the questionnaire for round one, to mitigate bias that could be introduced by editorialising. This further enhances the validity of the findings. The descriptive analysis of the quantitative data from round two and round three was checked by the second and third authors for correctness. Furthermore, the three-tiered model used to categorise statements based on the framework used by the WHO in 2005, further refined in 2018 by Mehmood *et al.* (1), also contributes to validity and reliability of the results (18).

Limitations

Delphi studies provide consensus on questions where inadequate information exists, however, stronger empirical study designs are needed to quantify the effects of the recommendations, and to validate the findings of this study, as well as to plot implementation. While the expert panel was representative of six out of nine provinces across South Africa and included both private and government EMS organisations as well as EMD systems developers, minority opinions may have been omitted through non-participation of other invitees, affecting generalisability. Although the response rate of the Delphi study exceeds internationally accepted response rates for such studies, we do accept that participation was not optimal, and some experts' views may not be included.

Conclusion

Through using published but largely HIC evidence as a framework, and then three rounds of consensus from local experts, a framework for essential EMCC functions and responsibilities relevant to the South African setting is presented. Most functions and responsibilities described in international literature were deemed essential to the local context. The implementation of these findings should be approached in a step-by-step manner, with each statement weighed according to decided multi criteria decision making principles.

Dissemination of Results

The results of this study were shared with expert participants, presented at conferences and disseminated to the organizations involved.

Authors' Contribution

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: RvS contributed 70%; WTHB 15%; PH 15%. All authors approved the version to be published and agreed to be accountable for all aspects of the work.

Declaration of Competing Interest

The authors have no other conflict of interest to declare.

Supplementary Materials

Supplementary material associated with this article can be found in Addendum 2.

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PART C: ADDENDA

Addendum 1: Research Proposal

Exploring and describing the responsibilities and functions of Emergency Medical Communication Centers in South Africa

by

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VSCRIE001

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

Supervisors: A/Prof. Peter Hodkinson, University of Cape Town; Dr Wilma ten Ham-Baloyi, Nelson Mandela University

April 2021

Declaration

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

1. I know that plagiarism is a serious form of academic dishonesty.
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3. Where I have used the words of others, I have indicated this by the use of quotation marks.
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6. I declare that this is my own work.
7. I am attaching the summary of the Turnitin match overview.

Signature: ……Date: ……

Contents

Abbreviations

AFEM	African Federation of Emergency Medicine
ECSSA	Emergency Care Society of South Africa
EMD	Emergency Medical Dispatch
EMSSA	Emergency Medicine Society of South Africa
EMS	Emergency Medical Services
LMIC	Low to Middle Income Country

Background

Out-of-Hospital Emergency Care (OHEC) is defined as," acute and emergency care delivered outside the walls of a fixed health facility/hospital", and is facilitated in modern EMS systems by the EMCC (1). Call takers and dispatchers perform their duties within Emergency Medical Communication Centers (EMCCs), sustaining Emergency Medical Services (EMS) operations across the world (2).

In the event of a medical emergency, a caller will ideally contact the EMCC via a universal access number (3, 4). A call taker will gather the necessary information to sort the emergency according to urgency and, if a tiered response system is used, identify expertise likely required at the scene. In systems where call taking and dispatch duties are performed by a separate person, referred to as a dispatcher, an organised summary of the gathered information will be handed over, eliciting dispatch and control of the required EMS resources (5). In some EMCCs, call taking and dispatch duties are performed by the same staff member.

Although a wide range of functions and responsibilities are performed in various EMCCs, ranging from basic telecommunications in a small local service to advanced demand prediction in international systems, the dispatch function is shared by most EMCCs (6). Sound training and the use of protocols are vital, as the call taker or dispatcher fulfils the role of first responder by providing telephonic guidance to bystanders, probing and identifying crucial clinical information, prioritizing the call and resources required, and relaying this to responding EMS personnel (7). In addition, the EMD system often provides the link between components of the EMS, such as rescue, inter-hospital transfers, and aeromedical support (5). Time taken from the first call to the EMCC until emergency care is delivered is shortened when EMCC call takers are able to recognise time-sensitive emergencies early on (8). Furthermore, EMCCs function as the control and data hub of the EMS (9).

Triage systems are ways of systematically prioritizing care according to the patient's healthcare needs, and influence the order and priority of emergency medical care, transportation and hospital destination (10). This principle implies that when two patients require emergency medical care simultaneously, finite resources will be allocated to the patient with the most urgent need for care, typically determined by a standardised triage tool that classifies intervention priority. Although field triage will only occur once formally trained help arrives, some dispatchers are able to make use of protocols to sort caller symptoms according to priority classifications and activate the appropriate dispositions (10). Accurate dispatch prioritisation is vital, since it represents the match between the patient's medical needs and the allocation of prehospital resources (11). The main objective of the EMCC is to achieve the most efficient use of, often limited, resources. Inaccurate dispatch priority results in either under- or over-triage. Over-triage is the allocation of highly trained and equipped prehospital resources to low-acuity patients, while under-triage is a delayed response with basic trained and equipped prehospital resources to high-acuity patients (12). Although over-triage is unfavourable, a higher degree of over-triage is tolerated in order to avoid under-triage as far as possible (13). Under triage can result in avoidable morbidity and mortality, exposing the EMS to litigious risk (14).

The unmet need for efficient, effective, standardised EMD practices, relevant to the Low to Middle Income Country (LMIC) setting has been identified previously (3). In November 2014, the African Federation of Emergency Medicine together with the International Academies of Emergency Dispatch formed a work group with, among others, the purpose of establishing recommendations to guide developing EMD systems (5). In their paper, Mould-Millman *et al.* propose that once these systems are established, future studies should determine essential functions and responsibilities of EMCCs (5).

Problem Statement

A descriptive list of priority functions and responsibilities that should be performed by EMCCs in LMICs is yet to be developed. By defining the essential functions and responsibilities of the EMCC, a uniform and structured approach could be described that would enable the identification of financial and operational inefficiencies within EMCCs across South Africa.

Throughout the literature search for this proposed study, no studies could be found that aimed to identify essential and desirable functions and responsibilities of EMCCs for LMICs, as would be appropriate for the South African setting.

Research Purpose

The purpose of this study is to establish and describe the functions and responsibilities of EMCCs in South Africa, and grade them as essential or desirable. A descriptive list of EMCC functions relevant to the LMIC setting that have been classified as essential or desirable could be used to focus development efforts to areas that will most benefit EMS service delivery. This information is necessary to ultimately inform the development of an assessment tool that can be applied to EMCCs, including EMCC components, systems, processes, equipment, human resources and others to be identified in future studies. Provincial EMS directors, District Managers, and other midlevel managers responsible for EMCC operations could use the findings of this study for planning and budgetary purposes. Private EMS directors and managers could also use the findings to identify areas of excellence or shortcomings of new and existing EMCCs in private EMSs. Finally, the findings of this study could be used to inform new policies and guide regulations that govern the minimum standards of EMCC operations, given the infancy of the 2017 promulgated national ambulance regulations and its deficiency of EMCC regulation (15) and the envision standards of service for EMS in South Africa (16).

Aim

The aim of this study is to identify and categorise by degree of importance, the essential and desirable functions and responsibilities of EMCCs in the South African setting.

Objectives

1. Obtain institutional permission for expert group members to participate in Delphi rounds.
2. Compile a literature-based list of possible EMCC functions and responsibilities.
3. Establish an expert group for Delphi study participation.
4. Circulate list of EMCC functions and responsibilities to the expert group for further additions identified.
5. Categorise the generated list of functions as either essential, desirable or not applicable to the South African setting by means of consensus.

Methodology

Study Design

A modified E-Delphi study design will be used to generate qualitative and quantitative data through a consensus development technique. Delphi designs are well suited to generate answers for complex questions with little or conflicting existing evidence, and advantage could be gained in the combined subjective findings of experts (17).

Study Setting and Population

The study will be conducted by assembling a group of experts via electronic communication, who are able to remain at their respective geographic locations.

Experts will be identified from disciplines that include Emergency Medicine, Information and Technology, Radio and Wireless telecommunications specialists, and finance.

Possible experts will include:

1. ICT Specialists – IT Infrastructure, communications infrastructure, metrics, statistics & reports, EMD system software.
2. EMCC management / public funds administration (chartered accountants & business analysts) – building infrastructure & layout, EMD system functionality, metrics, statistics & reports, financial management mechanisms & transparency (cost effectiveness).
3. Emergency Care – EMD system functionality, professional body registration, required training & CPD (education program development), metrics, statistics & reports.

Sampling

A combination of purposive and snowball sampling will be used. In order for a participant to be included in the expert group, the following minimum criteria will have to be met:

- Well-informed familiarity with EMD systems development and EMCC operations development in South African EMCCs. (Including professionals that are employed abroad but are well versed with South African EMD systems).
- Postgraduate qualifications in respective fields of expertise or occupation, or direct responsibility for the development of a functional EMD system / EMCC.

Exclusion criteria would include unfamiliarity with EMD system development or EMCC operations development in South Africa. Casual acquaintance with the researcher would also form part of the exclusionary criteria, as this could possibly influence the results of the study.

The expert group is projected to include 30 members in order to provide an encompassing set of opinions on the posed questions.

Recruitment and Enrolment

The African Federation of Emergency Medicine (AFEM) will be contacted and requested to populate a list of suitable professionals to participate in the expert group. The National Director of EMS, Dr R. Naidoo, and each provincial EMS manager will be requested to provide contact details for suitable experts. An external reviewer familiar with the EMCC scene in South Africa will be requested to identify additional experts not identified in the previous processes.

Professionals identified as possible expert group members will be contacted via email and invited to participate in the study by the study facilitator. Please see Appendix A.

The sample size will be determined by the number of experts recommended by the AFEM and EMS management that agree to be included on the expert group. Since the study is largely qualitative, the end goal is to achieve saturation of the themes rather than a generalisability through power calculations used in quantitative studies (17).

Research Procedures and Data Collection Methods

The advocated frameworks for delivering and monitoring emergency medical services in LMICs developed by the World Health Organisation will be used to populate the list of required functions and responsibilities of the EMCC in South Africa (3, 18, 19). These frameworks were further refined in a 2018 study by Mehmood *et al*. which identified the core elements of pre-hospital EMS from the emergency systems and health systems frameworks described (6). The identified core elements are applicable to the LMIC setting, and probable EMCC functions and responsibilities identified will be used to generate the Delphi's first round list that the expert group will make additions to. Please see Appendix B.

The participants will then respond to rounds of questions where communication is facilitated by making use of the LimeSurvey™ software via internet communication using four (or more) rounds as follows:

- Round 1: Expert group members will be requested to add more options to the list of answers generated by the literature review to the question, "Which functions and responsibilities should be ascribed to the EMCC?"
- Round 2: Participants will receive feedback from round 1, listing possible EMCC functions and responsibilities. Expert group members will subsequently be requested to review the list, comment and revise statements, and if changes are recommended, they will be requested to provide rationales for the proposed changes. Functions and components will then be categorised using a 7-point Likert scale to score these functions and responsibilities according to importance and relevance to the South African setting.
- Round 3: Iterations will commence that will seek consensus between the expert group members.

The typical consensus rate of 70% will be regarded as having achieved the required level of agreement (17). A Likert scale will facilitate the judgement of the expert group, allowing functions to be judged as not applicable (0-2/7), desirable (3-4/7) or critical (5-7/7) to the operations of an EMCC in South Africa. Iterations will be repeated until consensus is achieved. Expert group members who refrained from participating in one round of iterations will still be invited to participate in subsequent rounds.

Data Analysis

Thematic analysis will be performed by utilizing Excel 365® software (20) to categorise additions made by expert group members for the list of possible EMCC functions and responsibilities. Categories are defined according to the framework used in the 2005 study by the World Health Organisation on Prehospital Trauma Care Systems (3). Please see Appendix C. The focus is to group similar free text responses and avoid duplication after each round. Responses will be analysed between each round and the themes will be returned to expert group members as statements for subsequent iterations.

For iterations, 70% agreement on the category of the function and responsibility as essential, desirable or not applicable will be regarded as having attained consensus (as outlined under 'Research procedures and data collection methods), rather than calculating the mean of Likert scores.

Please see Appendix D for the data management plan.

Ethical Considerations

Ethical clearance will be obtained from the University of Cape Town Human Research Ethics Committee prior to commencement of the Delphi Iterations. Furthermore, facility approval will be sought from AFEM and the National Health Research Database (NHRD), since National EMS and AFEM will be requested to provide contact details of content experts in their employ.

This study will adhere to the Protection of Personal Information Act 4 of 2013 in that no personal information will be gathered during the study (21).

Description of Risks and Benefits

Since the proposed study will make use of an E-Delphi technique, and is regarded as a consensus development technique, the overall anticipated risk of the study is minimal as opposed to experimental study designs.

However, a small amount of risk is associated with this study. Expert group members will be asked to answer questions and rate statements in their own time, without remuneration. This could be seen as a financial inconvenience. Participants will furthermore be required to use their own resources in terms of communication devices and internet access to participate in the study.

No risk of physical harm should exist, as this study does not require any physical interventions from participants.

No vulnerable populations in terms of minors or people with diminished mental capacity will be included in the study.

In an attempt to limit psychological and legal risk exposure to participants, participation in the study will be voluntary, and no members will be requested to provide input based on any means of coercion. The exclusion of all personal information and identity during feedback to the expert group members would further contribute to minimising the risks of social harm.

The benefit of this study would be a compiled descriptive list of South African EMCC functions and responsibilities, based on scientific evidence. This could be used toward standardising the service delivery levels amongst the different EMCCs across South Africa. It enables future research possibilities, such as the compilation of an EMCC assessment tool, with a uniform and structured approach made possible to identify areas of cost and operational inefficiencies within EMCCs across South Africa.

The results of this study should encourage further research and refinement of the content. Any improvement to the effectiveness and efficiency of EMSs in South Africa translates to improved access, quality, and cost effectiveness of OHEC to the South African society.

Informed Consent Process

Informed consent will be obtained from each expert group member prior to the commencement of the Delphi rounds. This process will be facilitated by the researcher. An information letter that clearly describes the following will be emailed to each potential participant: a clear indication that this is a research study, elaboration on the purpose and duration of the study, research procedures, potential risks and its mitigation efforts, anticipated benefits, confidentiality of records, access to records, remuneration for participation, contact information for anticipated queries, nature of voluntary participation, consequences of

cessation of participation (22). The potential participant will be requested to clearly mark their choice and return a dated and signed form for record keeping purposes. Please see Appendix E.
This process is designed to provide potential participants with sufficient information regarding the nature of the study in order to make an informed decision to participate or refrain therefrom.

Privacy and Confidentiality

Access to identifying information of participants will be restricted to the researcher and supervisors only. Expert group members will not be informed of the identity of other members. Free text data returned to the researcher will be analysed in between Delphi rounds. Data will be anonymised when entered into the data analysis software, and feedback provided to the expert group members will not include any identifying information.

Electronic data will be stored in a password-protected folder, stored on a password-protected computer in possession of the researcher. The computer used during the study is equipped with commercial anti-virus software that is updated automatically. A backup electronic copy will be stored on a password-protected hard disk, which will be stored in a locked safe. Hard copies of consent forms will be stored in a wall-mounted, locked safe. Electronic data will be destroyed by formatting and overwriting upon completion of the study, projected by end of 2021. The backup copy of data will be stored at the University of Cape Town's department of Emergency Medicine for safekeeping for a period of 5 years after completion of the study, should any questions regarding the integrity of data or analysis be made subsequent to the study. All hard copies will be destroyed by shredding upon completion of the study.

Reimbursement for Participation

Participants will receive no reimbursement or remuneration for participation.

Strengths and Limitations

Strengths

It is expected that a wide spectrum of different experts will be identified as participants in this study. The results will therefore include a broad encompassing overview of EMCC essential and desirable functions and responsibilities that are important and relevant to the South African setting.

The study design is very suitable to areas with little or no scientific studies, and with the paucity of literature identified in this area, the proposed study is well suited to generate a robust departure point for further studies.

Limitations

The proposed study makes use of expert opinion, which is regarded as the lowest level of evidence, and the results should only be used to identify first principles (23). Further development and refinement of EMCC functions and responsibilities and the components required to action these should be recommended for future study.

Bias may be introduced when free text data is interpreted for themes, however the results are distributed back to the expert group for review in an effort to minimise bias.

Dissemination of Findings

The findings of the study will be presented at professional meetings of emergency medicine stakeholders. This will be presented at the research presentation meeting of the Emergency Medicine Cape Town group. Presentation slots will also be sought from professional associations such as the Emergency Medicine Society of South Africa (EMSSA) as well as the Emergency Care Society of South Africa (ECSSA).

The research writeup will be prepared for publishing in the AfJEM, since this is an authoritative, peer-reviewed African journal, indexed in Pubmed and Emerging Sources Citation (24).

Timeline

Research Proposal submission to the UCT Human Research Ethics Committee (HREC) for approval	March 2021
Expert group member recruitment and consent	June 2021
Data collection and analysis	June to August 2021
Write-up of the final results	September to October 2021
Final submission	November 2021

Budget

Item	Amount
Communication Calls / Internet Data	R1000.00
UCT listed editing Services	R2000.00/20000 Words
Software	Free - UCT library Access
Printing & Binding	R300.00
Total:	R1300.00

This proposed research study will be funded by the researcher.

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Appendices

Appendix A: Invitation Letter to Partake in the Delphi

Dear ….,

You are invited to participate in a Delphi study aiming to identify and categorise by degree of importance, the essential and desirable functions and responsibilities of Emergency Medical Communication Centers (EMCCs) in the South African setting. Based on your expertise in Emergency Medical Dispatch, you have been recommended for participation in this study titled, 'Exploring and describing the responsibilities and functions of Emergency Medical Communication Centers in South Africa'.

You are requested to partake in a minimum of two rounds of feedback. The first round of feedback would include reviewing a previously developed list of emergency medical care service functions for their relevance to the EMCC and suggesting additions for functions and responsibilities. In subsequent iterations, the items identified will then be categorised using a 7-point Likert scale to score them importance and relevance to the South African setting, according to criteria that identifies them as essential, desirable or not applicable.

If you would like to participate, kindly forward me the signed information and consent form as attached to this email.

Thanking you in advance.

May you have any questions, please do not hesitate to contact me.

Best regards,

Riekert van Schalkwyk

Cell no: 0724242887

Email: VSCRIE001@myuct.ac.za

Appendix B: World Health Organisation Prehospital Trauma Care Systems Framework

Definitions

Desired	Represents a function or responsibility of the Emergency Medical Communications Center that improves the probability of a favourable patient outcome but does not meet the criteria as essential. Most desired functions or responsibilities increase the emergency medical dispatch system's cost, with poor cost effectiveness. While these may be implemented in resource rich environments, it may not be justified in areas with limited resources and limited access to emergency medical care, and their acquisition should not hinder the implementation of essential processes.
Essential	Represents a function or responsibility of the Emergency Medical Communications Center that should be available in all regions, including resource limited areas. Their absence would hinder the safety of Emergency Medical Services operations or result in a poorer patient outcome. They require a modest level of expenditure, primarily requiring improvements in organisation and planning.
Irrelevant	This term describes functions or responsibilities that are not desirable or appropriate to the Emergency Medical Communications Center, regardless of the cost or financial resources available.
Possibly Required	This term refers to functions or responsibilities of the Emergency Medical Communications Center that has been classed as Desirable but may be appropriate to implement due to extreme circumstances, such as war, where the institution performs tasks normally reserved for higher level institutions. These are advisable if people will die without this service.

Definitions adapted from (3).

Appendix C: Emergency Medical Care Framework

Health system Building Blocks/ Inputs						Outputs				Goals / outcomes			
Service Delivery	**Health work force**	**Informati-on**	**Medical products**	**Financing**	**Leadership & Governance**	**Access**	**Quality**	**Coverage**	**Safety**	**Improved Health**	**Responsive-ness**	**Social and Financial Risk Protection**	**Efficiency**
EMS delivery model	Workforce demography, experience	Communication system	EMS vehicular equipment and supplies	Work force Compensation structure	Lead agency and legal framework	National or regional toll free number	Vehicular and documentation standards	Population coverage	Clinical protocols/ guidelines	Trends in utiliization of EMS for specific causes	Responsive staff	Affordable or subsidized emergency care	Efficient triage
Number of EMS agencies	EMS crew configuration	Dispatch system	Medications for cardiac arrest, trauma and chest pain	Government spending	Regulatory bodies	Proportion of population with access	EMS crew standards	Geographic coverage	Medical direction	Improved survival of patients using pre-hopsital services	Response times	Emergency care insurance plans	Referral systems
Vehicular distribution	Certified Curriculum	Location identifier	IV fluids, analgesics	Private market share	Liability protection	Alternate emergency transport	Operational Benchmarks	24 hour availability of emergency services	Staff safety programs	Improved outcome of injuries, cardiac emergencies and stroke	Timely Referral	Reduction of out of pockets expenditure	Use of technology and data
Number of functional vehicles	Refresher training programs	Registries	Airway protection and oxygen	Taxation for EMS provision	Political and community support		Clinical benchmarks		Information to receiving facility				Staffing policies to improve efficiency

Fig. 3 Domains of the prehospital framework. This figure outlines potential variables of the assessment tool to evaluate overall EMS system capacity and performance according to a health systems framework. Blue cells in the table represent system inputs, yellow represents system outputs, and green represents goals and outcomes

Appendix D: Data Management Plan

DCC Checklist	DCC Questions
Administrative Data	
ID	HREC ID TBC
Funder	Private
Grant Reference Number	Not Applicable
Project Name	Exploring and describing the responsibilities and functions of Emergency Medical Communication Centers in South Africa
Project Description	A modified E-Delphi study design will be used to generate qualitative and quantitative data. Problem statement: A descriptive list of priority functions and responsibilities that should be performed by EMCCs in South Africa is yet to be developed. Data will be collected for the purpose of conducting an E-Delphi study in order to determine expert consensus on the essential and desirable functions and responsibilities of South African EMCCs.
Researcher	Riekert van Schalkwyk
Researcher ID	VSCRIE001
Project Data Contact	Cell 0724242887 / vscrie001@myuct.ac.za
Date of First Version	19 November 2020
Date of Last Update	19 March 2021
Related Policies	The following University of Cape Town (UCT) Policies will apply: UCT Policy for Responsible Conduct of Research UCT Research Ethics Code for Research Involving Human Participants UCT Policy and Procedures for Breach of Research Ethics Codes and Allegations of Misconduct in Research
Data Collection	
Data to be collected	Data collected will be free text and numerical. The chosen format of data is capable of long-term sharing. No existing data can be used to facilitate the study.
Method of data collection	Electronic survey, facilitated by LimeSurvey™ software. Each round of survey responses will be maintained in a folder named "Survey Responses EMCC", and each file will be named according to the date of completion. Data will be captured by completing a standardised list of responses, in text format, when completed surveys are returned to the researcher.
Documentation and Metadata	
Documentation and Metadata to accompany Data	The data stored in text format may be accessed after gaining permission from the Department of Emergency Medicine of the UCT. Data will be clearly labelled to indicate title, number in round of responses, and date of creation.
Ethics and Legal Compliance	
Management of Ethical Issues	Informed consent details the duration and methods of data preservation, as well as responsible parties for access control. All participants participating in the study will remain anonymous, and no identifying data is returned back to participants between Delphi rounds.
Management of Copyright and Intellectual Property Issues	Data and intellectual property rights are owned by the UCT. Due to the specific data collection method, reuse of the data for additional studies would be highly unlikely.
Storage and Backup	
Methods of Data Storage and Backup	Sufficient storage space for data storage is available. Data will be backed-up by making use of a safe-secured external hard-disk. The researcher is responsible for backup and recovery of data.

Access and Security	No confidential data will be collected throughout the research project. Computers used will be password protected, and all files created to store data will be password protected. Study supervisors will be able to access the data by accessing the password protected files on an external hard disk.
Selection and Preservation	
Data to be Retained, Shared or Preserved	All electronic data collected throughout the study will be destroyed from the researcher's computer by formatting and overwriting upon completion of the study. Hardcopies will be destroyed by means of shredding upon study completion.
Long-term Preservation Plan	Data will be preserved at the Department of Emergency Medicine, UCT. Validation of findings will remain possible according to relevant UCT policies.
Data Sharing	
Methods of Data Sharing	Potential users of data will be informed of the study through presentations of current research at the Department of Emergency Medicine, UCT. Data will be made available for sharing once permission is extended by the department.
Restrictions on Data Sharing	No restrictions apart from the Department of Emergency Medicine, UCT procedure for data sharing is required.
Responsibilities and Resources	
Person Responsible for Data Management	Riekert van Schalkwyk – Researcher
Resources Required for Plan	No additional hardware or software other than those supplied by UCT library services will be required. No data repository services will be utilised.

Adapted from (25).

Appendix E: Informed Consent Letter

UNIVERSITY OF CAPE TOWN
IYUNIVESITHI YASEKAPA • UNIVERSITEIT VAN KAAPSTAD

Dear Sir/Madam

RE: REQUEST FOR YOU TO TAKE PART IN A RESEARCH STUDY

A research study is about to commence, conducted by the Division of Emergency Medicine, University of Cape Town. This will form part of the master's degree of Mr Riekert van Schalkwyk. The research study is titled: 'Exploring and describing the responsibilities and functions of Emergency Medical Communication Centers in South Africa'. The research team also includes A/Prof. Peter Hodkinson (UCT, Cape Town) and Dr. Wilma ten Ham-Baloyi (NMU, Port Elizabeth).

This study has been approved by the Faculty of Health Sciences Human Research Ethics Committee of the University of Cape town, authorisation number: HREC 241/2021. *The University of Cape Town aims to promote high quality research in the interests of South African society and the human condition as a whole. The Human Research Ethics Committee in the Faculty of Health Sciences ensures that research done by the faculty adheres to the ethical principles endorsed by the University of Cape Town*.

Why is this study being done?

A descriptive list of priority functions and responsibilities that should be performed by Emergency Medical Communication Centers (EMCC) in South Africa is yet to be developed. By describing the essential functions and responsibilities of the EMCC, we hope to establish a standard and structured approach that would enable EMS organisations to see the effectiveness of the EMCCs across South Africa.

Why are you being asked to take part?

You have been identified as a possible participant due to your expertise in the development or management of Emergency Medical Dispatch systems in South Africa.

How many people will take part in the study?

It is estimated that thirty people will form part of the expert group and take part in the study.

How long will the study last?

The study should be completed in four months. Each round of questioning will be summarized and returned to you for review within four weeks, and we anticipate consensus after three rounds of questioning.

What other choices do you have?

Participation in this study is voluntary. You have a choice to take part or not. Should your initial choice be to take part in the study, you are free to stop taking part at any point during the study, without any consequence. You will receive the results of the study regardless of the amount of time that you have taken part in the study.

What will happen if you decide to take part in the study?

The researcher will distribute surveys in the form of E-Delphi rounds to the assembled expert group members. All iterations of the Delphi study should be completed within a 3-month period. Each round of iterations will have a 4-week period allocated for completion, with participants encouraged to answer the questions in their own time. The first round of the study would include reviewing a previously developed list of emergency medical care service functions for their relevance to the EMCC and suggesting additions for applicable functions and responsibilities. Subsequently, the results will be categorised using a 7-point Likert scale to score these functions and responsibilities according to importance and relevance to the South African setting.

Should participants consent to the study, cessation of participation at any point of the study would carry no consequences. The outcome of the study will be shared with participants regardless of the duration of participation in the study.

What will happen when the study is over?

The results of the study will be shared with everyone that took part in the study, as well as with people managing emergency medical services in South Africa.

Will the outcome of each questioning round be shared with you?

After you submit your answers to the questions presented, an anonymous summary of all the answers will be compiled (your identity will not be revealed to other participants). This summary will be circulated back to everyone taking part for review.

Who will see the information which is collected about you during the study?

Your answers are sent back to the researcher during each round of questioning. Access to the returned question and answer sheets are restricted to the research team. The researcher will compile a summary of all responses received, anonymise the results, and circulate it back to everyone taking part in the study.

Will any identifying information be shared with anyone?

You will remain anonymous to other members throughout the study, and no personal information will be collected. All data records will remain confidential, and only the results of the rounds and final outcomes of categorisation will be circulated following the data analysis process. Access to data records will be confined to the researcher, supervisor, and co-supervisor. All data are securely stored, and access control measures are prepared.

Will you receive any reward for taking part in this study?

No remuneration will be provided for participation in the study.

What are the risks and discomforts of this study?

There are minimal risks to you in participating in the study – potentially use of your time, and data, but we believe the potential benefits of the outcomes of the study make this worthwhile. Legal and psychological risks remain minimal since participation in this study is voluntary.

What are the potential benefits of this study?

The benefits of this study would be establishing prioritised EMCC functions and responsibilities in South Africa. Furthermore, the results of this study should encourage further research and refinement of the content. Any improvement to the effectiveness and

efficiency of EMSs in South Africa translates to improved access, quality, and cost effectiveness of OHEC to the South African society.

I would like to encourage you to ask questions about anything that remains unclear after reading this letter, before agreeing to take part in the study. Please feel free to contact me, my supervisor, A/Prof. Peter Hodkinson (UCT, Cape Town) at peter.hodkinson@uct.ac.za or my co-supervisor, Dr. Wilma ten Ham-Baloyi (NMU, Port Elizabeth) at wilma.tenham-baloyi@mandela.ac.za or the researcher on 0724242887 or vscrie001@myuct.ac.za .

Yours sincerely,

Riekert van Schalkwyk (Researcher)

041 435 0911 email: VSCRIE@myuct.ac.za

HREC Queries

Members of the research team will answer any questions you have about this study. But if you have any queries or concerns about the conduct of this study, you may contact the Health Research Ethics Committee of the University of Cape Town:

Human Research Ethics Committee:

Manager: Mrs Lamees Emjedi

lamees.emjedi@uct.ac.za

tel: 021 406 6338

Consent Form

Title: Exploring and describing the responsibilities and functions of Emergency Medical Communication Centers in South Africa

I give consent to complete the questionnaires, and I am willing to participate in the above-mentioned project. I have read the accompanying letter explaining the purpose of the research project and understand that:

- My participation is voluntary.
- I may decide to withdraw at any time without penalty.
- My name will not be identifiable or linked to my inputs and comments, nor used in any written reports.
- A report of the findings will be made available to me.
- I may seek further information on the project from Riekert van Schalkwyk on 0724242887 or from the UCT Health Sciences Research Ethics Committee (HREC) as below.

Cell:

Email:

_____ _____

Name Signature

_____ _____

Date Witness (if applicable)

HREC Queries

Members of the research team will answer any questions you have about this study. But if you have any queries or concerns about the conduct of this study, you may contact the Health Research Ethics Committee of the University of Cape Town:

Human Research Ethics Committee:

Manager: Mrs Lamees Emjedi

lamees.emjedi@uct.ac.za

tel: 021 406 6338

Addendum 2 : Round 1 Survey Questionnaire

Emergency Medical Communication Center Functions and Responsibilities: Literature Informed List

Round 1

The following statements were retrieved from peer-reviewed journal articles. Statements have been categorised according to six subheadings which encompass day-to-day operations of EMCCs in the private and government sectors of South Africa.

This section provides you with the opportunity to make additions to the functions and responsibilities identified elsewhere. You are encouraged to suggest additions to be made according to your experience with Emergency Medical Communication Center functions and responsibilities. Additions are not compulsory.

Please note that you will have an opportunity to vote on each statement's relevance to the South African setting in the next round of questions.

1.1.1 Emergency Medical Dispatch is a crucial part of Out of Hospital Cardiac Arrest (OHCA) survival (1).

1.1.2 EMCCs form the foundation of effective disaster management and response coordination, including mass casualty incidents (2-4).

1.1.3 The EMCC should organise EMS resources – ensuring coverage of frequent use areas, ensuring that the most effective ways are used to connect the patient to healthcare resources (5).

1.1.4 A Universal Access Number should be available to contact the EMCC (2).

1.1.5 EMCCs must cater for both emergency care and inter-facility transport requests (4, 6).

1.1.6 EMCCs should be available on a 24-hour basis (5).

If you have no other additional functions and responsibilities of EMCC systems to add, or this is not your area of expertise, please continue to the next subheading.

Please add any other EMCC systems core functions and responsibilities here: Additions should be concise (1 concept/theme)

Systems

Core Functions & Responsibilities

- Emergency Medical Dispatch is a crucial part of Out of Hospital Cardiac Arrest (OHCA) survival (1).
- EMCCs form the foundation of effective disaster management and response coordination, including mass casualty incidents (2-4).
- The EMCC should organise EMS resources – ensuring coverage of frequent use areas, ensuring that the most effective ways are used to connect the patient to healthcare resources (5).

- A Universal Access Number should be available to contact the EMCC (2).
- EMCCs must cater for both emergency care and inter-facility transport requests (4, 6).
- EMCCs should be available on a 24-hour basis (5).

Record Keeping

- Records should be kept of the incoming call, noting time measures and clinical details.
- EMS patient report form / Patient Care Record should be linked to the call record. (Expert review)

Software / Tele-Communication System

- A low-cost dispatching communication software system which facilitates communication between callers, first responders and dispatchers is required for LMICs / SA (5).
- The telecommunication software / system should provide automatic number identification (1).
- The telecommunication software / system should provide automatic caller location identification / nearest cellular site (1).
- The telecommunication software / system should automatically recommend the dispatch of EMS or other services likely required at the scene (6).
- Brand-name systems such as the Medical Priority Dispatch System are too expensive to use in LMICs and will therefore require development of local systems.
- Brand-name dispatch systems are not contextually appropriate, due to the vast differences in EMS infrastructure in LMICs (5).
- The EMCC computer system should display the real-time availability of ICU, hospital ward and trauma beds at hospitals in the region (4, 6).

Location Display / Tracking

- GPS trackers and location identifiers should be available for all EMS vehicles(2, 5).
- The GPS location information should be integrated into the dispatch system used (2, 5).
- An emergency call should be directed to the most appropriate geographic EMCC based on automatic approximate location identification (1).
- A dispatcher may use the accurate caller location to alert nearby layperson responders to assist a victim of cardiac arrest until professional help arrives (1).

Technology

- EMCC technology needs to keep abreast with technology used by the public to activate EMS (1). e.g. text-messaging, social media.
- Computerised triage tools should be used by call takers (3).
- Technology and data should be used to improve EMS services (2), e.g., real-time electronic run sheets.
- The dispatch system used should facilitate text or video transmission between EMS personnel and the dispatcher / receiving facility (1).
- Machine learning should be used to develop algorithms to prioritize calls (7-9).

Protocols and Guidelines

- Protocols that indicate resource allocation should adapt according to the number of calls / pressure experienced by the EMCC (1).
- Decision escalation should be available for scenarios that exceed the provisions of the protocols or guidelines used (2), e.g., medical direction.

- The EMCC should be functionally laid out to manage specialised tasks, including critical care or aero-medical responses (4).
- **Incoming Calls**
- Call takers gather information to establish the nature of the emergency at the scene (1).
- Call takers should establish the location of the incident (1).
- Call takers should obtain a call-back number or other alternative communication means (e.g. text messaging/social media) (1).
- The call taking process should involve scripted questions, based on clinical algorithms, to identify time critical emergencies and limit over- and under-triage (1, 4, 10-12).
- EMCCs should be able to match the caller's linguistic and cultural needs with an appropriate call taker / dispatcher and strategies developed for assisting language-discordant callers (10, 13).
- Scripted questions and protocols should be able to identify low acuity callers and be able to institute a low-acuity response or deferral (1, 6), e.g., primary health care referral.
- The EMCC should be equipped and prepared to provide information on local healthcare resources to callers (4).

Dispatch

- Before dispatch, the right EMS resources need to be matched with the need at the scene of an emergency (1, 5, 7, 10).
- Different modes of response, such as level of care or urgency of response should be predefined and algorithm based (1).
- The priority of specific conditions and predetermined modes of response should be developed locally and appropriate to the regional setting, according to medical, social and political considerations (4).
- EMCCs should check that the receiving facility is the correct facility according to the needs of the patient. (2, 5)..
- The dispatcher should coordinate with other emergency services required at the incident scene, including police and fire departments (5).
- The number of fully functional and equipped vehicles, staffed according to a predefined tiered level should be clearly evident to the dispatcher (2).

Prehospital Care

- Bystanders phoning the EMCC to report an emergency could become layperson responders through dispatchers' prearrival instructions, until professional help arrives (1).
- Telephone advice should be made available for callers reporting a nonacute condition (4).
- Time critical interventions such as AED defibrillation, CPR, and scene safety can be performed by layperson responders at the scene through prearrival instructions by the dispatcher (1, 3, 5).
- When possible, constant contact in the form of telephone based care should be provided from the time of call, until EMS resources arrive at the scene of a critical emergency, unless prolonged response times renders such contact impractical (4).

Continuous Quality Improvement

- EMCC call takers and dispatchers should receive context specific, standardised training and certification (1, 5, 6).
- A continuous learning system is required for dispatchers (5), e.g., recertification or refresher training (CPD).
- A systemic assessment tool that measures the EMCC's performance should be identified for use (2).

- The systemic assessment tool implemented should assist policy-makers and planners to identify gaps and set priorities for further systems development (2).
- Over- and Under-triage rates should be measured and evaluated at regular intervals to monitor the appropriateness of prioritisation decisions made during the call taking process (3).
- An ongoing quality improvement program within the EMCC is required for telephonic CPR instructions and cardiac arrest identification by call takers (11).
- Dispatch records which reflect call-taking, call-processing and dispatch data should be reviewed for quality assurance, quality improvement, and research purposes (4, 5, 9).
- EMCCs should define and track quality indicators for the EMS (9).
- Standardised performance indicator measurement should be used to compare the performance between EMCCs in the country(9).
- Governance and regulatory bodies with legal and policy frameworks should be established to regulate EMCC operations (2).
- Working conditions of EMCC staff should comply with local labour legislation (2).

Financial Management

- The financing mechanism and sustainability of the EMCC should be assessed on an ongoing basis as part of the greater EMS system assessment (2).
- Billing & Cost per unit calculations should be integrated with the call taking and dispatch functions performed in the EMCC. (Expert review)

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Addendum 3 :UCT HREC Permission Letter

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

Room G50- Old Main Building
Groote Schuur Hospital
Observatory 7925
Telephone [021] 406 6492
Email: hrec-submissions@uct.ac.za
Website: www.health.uct.ac.za/fhs/research/humanethics/forms

17 May 2021

HREC REF: 241/2021

A/Prof P Hodkinson
Division of Emergency Medicine
F-51, OMB
Email: peter.hodkinson@uct.ac.za
Student: vscrie001@myuct.ac.za

Dear A/Prof Hodkinson

PROJECT TITLE: EXPLORING AND DESCRIBING THE RESPONSIBILITIES AND FUNCTIONS OF EMERGENCY MEDICAL COMMUNICATION CENTERS IN SOUTH AFRICA-MASTES CANDIDATE-MR RIEKERT VAN SCHALKWYK

Thank you for your response letter, addressing the issues raised by 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.

This approval is subject to strict adherence to the HREC recommendations regarding research involving human participants during COVID -19, dated 17 March 2020 & 06 July 2020.

Approval is granted for one year until the 30 May 2022.

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)

The HREC acknowledge that the student: - Mr Riekert van Schalkwyk will also be involved in this study.

Please quote the HREC REF 241/2021 in all your correspondence.

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

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

HREC/REF 241/2021sa

Yours sincerely

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

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 Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use: 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/REF 241/2021sa