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Review

A resuscitation systems analysis for South Africa: A narrative review



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Abstract

With a growing incidence in cardiovascular diseases in Africa, including South Africa, and with it a greater incidence of out-of-hospital cardiac arrest (OHCA) there is a need to understand the readiness of these emergency care systems to support a response. Yet, OHCA is expensive and requires comprehensive development across an entire chain of survival in order to gain any benefit in mortality or morbidity. In this narrative review, we provide a resuscitation systems analysis using the Global Resuscitation Alliance's Frame of Survival. We provide evidence or commentary on the elements of the outer frame and inner frame, and make an assessment of the South African system's readiness to support OHCA care, and provide suggestions for priority areas that need to be developed. The South African resuscitation system demonstrates reasonable readiness to respond to OHCA but is characterised by considerable variation and fragmentation. Given the cost ineffectiveness of many interventions and the anticipated rise in OHCA incidence, there is a pressing need for context-specific strategies in South Africa. These strategies should focus on enhancing both outcomes and resource efficiency, while respecting community ethics and sociocultural dynamics.

Keywords: Out-of-Hospital Cardiac Arrest, Emergency Care Systems, South Africa

Introduction

Following out-of-hospital cardiac arrest (OHCA), immediate medical intervention, arranged across a system of care, is necessary to restore circulation, and improve the prospects of survival without neurological sequelae. This system of care, or the "Chain of survival" comprises six domains of care that ought to seamlessly integrate, and they are: 1) recognition of cardiac arrest and activation of the emergency response system, 2) early cardiopulmonary resuscitation, 3) rapid defibrillation, 4) advanced resuscitation by Emergency Medical Services (EMS) and other healthcare providers, 5) post-cardiac arrest care, and 6) recovery (including rehabilitation).¹ As such, it is clear that the management of OHCA requires a systems-wide approach.

Yet, despite considerable investment in these systems of care in high-income countries, the survival rate from OHCA ranges from 4.3% to 11%.^{2,3} In low-resource settings with immature or underfunded chains of survival, survival rates have been found to be as low as 0%.⁴ In South Africa, OHCA return of spontaneous circulation

(ROSC) rates are between 1.3%⁵ and 18%.⁶ To our knowledge, there is no data on long-term outcomes. The OHCA prevalence in South Africa is also similar to that of other countries at 23.2 per 100 000 persons,⁵ but this is likely to increase due to an accelerated epidemiologic transition towards a greater incidence of cardiovascular diseases currently underway.^{7,8}

With a limited fiscus, low- to middle-income countries (LMICs), such as South Africa, need to strategically consider in which health services and systems to invest. The upfront and sustained investment in strengthening the chain of survival might not be cost-effective, given low survival rates.^{9–12} As such, the Global Resuscitation Alliance recommends a graded approach to emergency care and chain of survival system strengthening in these contexts, developing a framework by which nascent Emergency Care System (ECS) can assess and build their emergency capabilities to respond to OHCA.¹³ In this narrative review, we use this framework, the Frame of Survival, to analyse the South African resuscitation system and comment on its readiness and development priorities to appropriately respond to the anticipated increase in OHCA and CVD incidence.

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<https://doi.org/10.1016/j.resplu.2024.100655>

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Methods

Design

A resuscitation systems analysis in the form of a narrative review, was performed using the frame of survival as a conceptual framework.¹³ In order to describe the South African system and its readiness for the management of OHCA, we gathered data from multiple different data sources and deductively mapped it to the different components of the frame of survival.¹³ For the most part, we will emphasise the initial phases of the system, as argued by Deakin.¹⁴

Setting

South Africa is a higher middle-income country on the Southern-most tip of the African continent. It is home to 62 million people that are resident in nine provinces. There is considerable variation in the resources, wealth, and rurality distribution between provinces, but also within provinces.¹⁵ South Africa is considered to be one of the most unequal nations in the world,¹⁶ and this is certainly the case for access to healthcare.

South Africa has a pluralist health system. As such, health is provided for by public, private for profit, private not for profit, and traditional health services. Access to private healthcare is reserved for those that possess medical insurance (approximately 16% of the population)¹⁷ or who can pay out-of-pocket for services. The public sector provides care for the balance, and this is free of charge or carries a marginal co-payment, depending on level of income or the service requirements. This is also the case for out-of-hospital and facility-based emergency services. Additionally, up to 80% of the South African population makes use of traditional or indigenous health services.¹⁸ A more comprehensive description of the emergency services use and resources available will be provided in each of the relevant domains of the frame of survival.

Data sources

A directed and deliberate search of the published, peer reviewed literature was conducted to gather evidence to complete the resuscitation systems analysis. The primary data sources were MEDLINE, via PubMed, Google Scholar and Google. The following terms were used to guide the search strategy: "Emergency Medical Services," "Out-of-Hospital Cardiac Arrest," "Cardiopulmonary Resuscitation," "Resuscitation" and "South Africa." Further, we composed other directed searches through queries on the Google search engine.

The searches were conducted between December 2023 and January 2024 for each of the domains of the frame of survival. No date restrictions were placed on the search. Where necessary, public policy or state reports were also consulted to inform the analysis of the state of each domain within South Africa. Where policies or reports were cited, the latest reports were selected. Lastly, where no published evidence or reports were found, this is indicated and may be supplemented by the views of the authors.

Analysis

Following a series of web and database searches, data sources were interrogated for data or evidence related to each of the frame of survival domains. These results were then deductively matched to the frame of survival and are reported narratively. Furthermore, the extent to which the fundamental elements and frame of survival for OHCA care are developed are presented. One of four categories were allocated to each of the elements, namely: 1) Developed (the

element is fully established), 2) Partially Developed/Variable (element is in place but does not fully meet the necessary standards across all areas or at all times), 3) Not Developed (element is either non-existent or so inadequately developed that it is not effective), 4) No Data (insufficient or no information available to assess the state element).

Results

In this section, brief commentary on each of the different components of the Frame of Survival will be provided and where possible, will be supported by evidence from published literature or public policy and reports. The extent to which the fundamental elements and frame of survival for OHCA care are developed, are contained in [Table 1](#) and [Fig. 1](#).

Outer frame

The outer frame of the Frame of Survival encompasses those factors that are outside of the direct control of the ECS.¹³

Political commitment

The South African healthcare system has gone through tremendous reform since becoming a democracy at the end of Apartheid. This has led to the restructuring of emergency medical services through political commitment, to redress historical inequities due to discriminatory laws pre-democracy.¹⁹ Such a commitment is also, at least principally, espoused in South Africa's membership to the World Health Assembly and its adoption then, of resolutions related to emergency care systems strengthening.²⁰ Yet, this political commitment is somewhat undermined with concerning reports of ongoing corruption in the public health service,²¹ and practices of financial medicine in EMS.^{22,23}

Healthcare expenditure

South Africa spends 8.58% of its GDP on healthcare, which is lower than the world average of approximately 10%^{24,25}. Healthcare expenditure in South Africa is divided between the public and the private sector. In 2019, 48.7% of the GDP expenditure was spent in the public sector (which provides healthcare services to 84% of the population)¹⁷ while 51.3% of the expenditure was in the private sector^{26,27} (which provides healthcare to only 16% of the population).¹⁷ In fact, healthcare expenditure in the private sector has been reported to be up to ten times higher than in the public sector.²⁸ This drives inequity to healthcare access,²⁹ including for EMS and coronary care.^{5,30} As such, there is a drive to implementing a national health insurance scheme for South Africa, but this has been met with some resistance.³¹ To our knowledge, there is no specific public health programme that ringfences funding for OHCA systems development.

Legislative environment

As it relates to the legislative environment of South Africa, there are some important constitutional protections for health and emergency care access in South Africa. Firstly, access to emergency care is constitutionally protected in South Africa,²⁰ and reiterated in the National Health Act which decentralises regulatory responsibility to provincial Departments of Health.²⁰ Yet, legislation is not clear on what constitutes an emergency, nor on when emergency starts or

Table 1 – State of development of the fundamental element in South Africa.

| Fundamental Elements for Improving OHCA Survival in Developing Emergency Care Systems | |
|---|--------------------------------|
| Fundamental Element (13) | State in South Africa |
| 1 – Standards of care | Developed, but not implemented |
| 2 – Functional emergency units | Developed |
| 3 – Data are available | Partially Developed/Variable |
| 4 – Good continuity of care | Partially Developed/Variable |
| 5 – Universal access number | Developed, but fragmented |
| 6 – Political environment | Partially Developed/Variable |
| 7 – Supportive legislation | Not Developed |
| 8 – Community is engaged | Partially Developed/Variable |
| 9 – Investment in infrastructure | Partially Developed/Variable |
| 10 – Timely response | Partially Developed/Variable |
| 11 – Good communication network | Developed, but volatile |

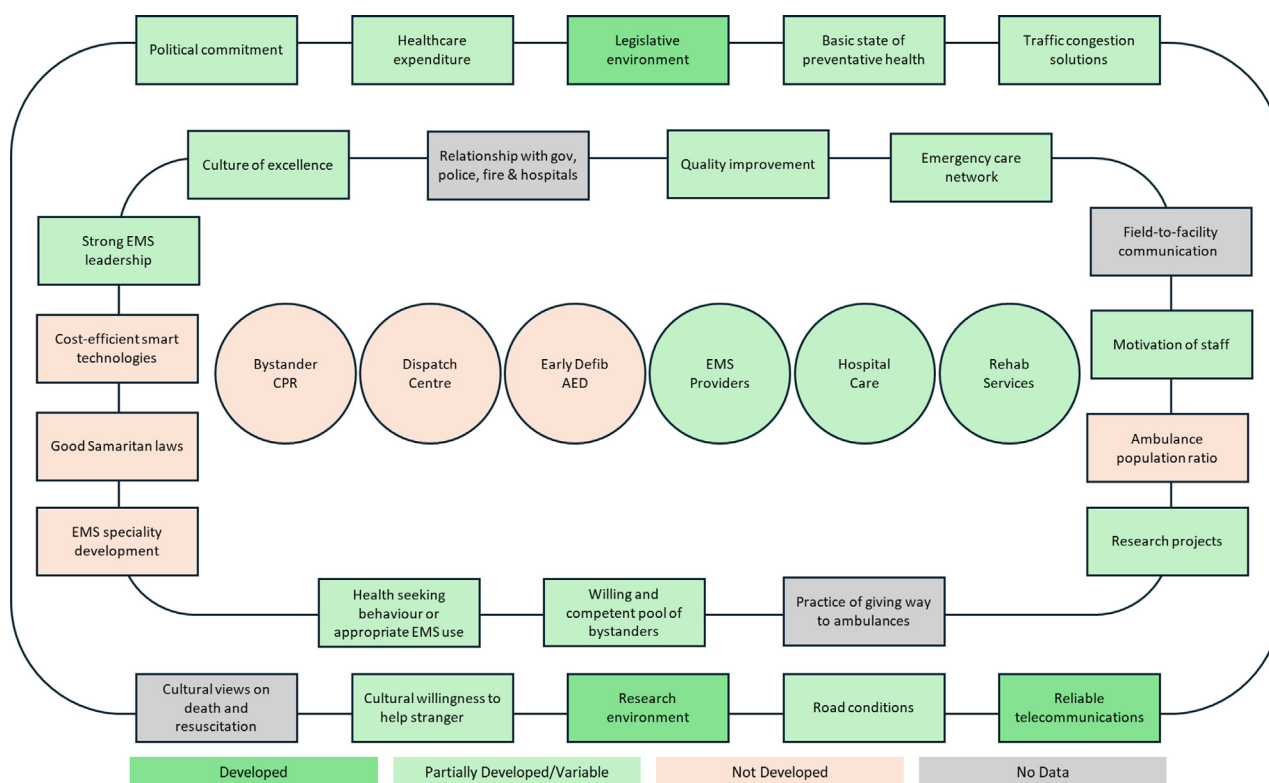


Fig. 1 – State of development of the South African frame of survival.

ends, or what emergency care entails.²⁰ This has been problematic in the application of the legislation.³² Emergency medical services in South Africa, are also regulated under the National EMS Regulations which requires licensing of EMS and provides for norms and standards to which EMS should comply.²⁰

As it relates to bystander care, the Occupational Health and Safety Act requires that employers where ten or more employees

work, should have a trained and certified first aid provider appointed who can respond to medical emergencies, including requirements for a first aid box³³. This does not include a specific requirement for an automated external defibrillator. First aid training typically includes the provision of cardiopulmonary resuscitation. The utility of this approach however, remains uncertain given low rates (20%) of OHCA in public spaces.⁵

As it relates to EMS professionals, all EMS providers are required to be registered with the Health Professions Council of South Africa following training in an accredited training institution, promulgated under the Health Professions Act.³⁴ This registration provides a legislative framework that governs these providers and is linked to a regulated scope of practice.³⁴ All scopes of practice include cardiopulmonary resuscitation and defibrillation, with advanced scopes including resuscitative pharmacology (adrenaline and amiodarone), advanced airway management (ranging from supraglottic devices to endotracheal intubation), and termination of resuscitation efforts.³⁵

Basic state of preventative health

South Africa is currently facing a high prevalence of infectious diseases such as HIV/AIDS and tuberculosis, as well as a growing burden of non-communicable diseases such as diabetes and cardiovascular diseases (CVD).^{36,37} All of these might increase the risk of OHCA. Furthermore, one could argue that a growing burden of chronic diseases, points to a lack of preventative healthcare in itself.

The South African National Department of Health has made asserted efforts in improving the state of preventative healthcare by reengineering the primary healthcare model to be integrated in the district health system, with greater emphasis on the delivery of community-based services and a focus on the social determinants of health thus improving access to basic healthcare services significantly.³⁸ Notwithstanding this, adherence to treatment regimens is generally low,^{39,40} which complicates chronic healthcare and prevention in the country.

Road conditions and traffic congestion

South Africa has a road network infrastructure of approximately 750 000 km, and only about 21% of these roads were surfaced or paved in 2021.⁴¹ Where roads are surfaced, road maintenance does not meet acceptable standards in either management or physical implementation. The poor condition of the country's road networks is largely attributed to ad hoc, reactive maintenance practices leading to deterioration of the condition of the road system.⁴²

Traffic congestion in the South African metros has been on the increase year on year and this can be attributed to rapid urbanisation, semi-migration and the ailing road infrastructure.^{41,43} This congestion significantly impacts the response times of emergency vehicles, particularly in urban centers. The state of roads and traffic congestion in South Africa thus plays a crucial role in influencing the effectiveness and reliability of emergency medical services and their response time intervals to OHCA, which may be up to 27 min.⁵

Cultural views on death and resuscitation

South Africa is a multi-cultural, multilingual nation highlighting the importance of a tailored, culturally sensitive approach to the development of the resuscitation systems. Views on death in South Africa have been described as a "mature and level-headed acceptance" stemming from constant exposure to death, or seated in a deeply religious foundation where death should not be questioned because one "fate is sealed."⁴⁴ South African views are also based in socially constructed customary laws requiring the performance of rituals and acts to prevent a supernatural "tainted darkness."⁴⁴ There is also a deeply held belief in an afterlife, describing death as a rite of passage

towards the world of the ancestors.⁴⁴ How these belief systems influence decisions on resuscitation has not been studied, but it can be argued that globalisation and popular media may influence this. Further research should seek to determine how these views and beliefs should be incorporated into the development of OHCA systems of care.

Research environment

In South Africa, some prehospital providers and emergency physicians are required to complete research projects for their licensure degrees. In emergency care research there is a research culture marked by ethical complexities^{45,46} and resource challenges.⁴⁷ Barriers to research engagement include lack of funding, training, and time. A key barrier is also lack of a positive research culture and poor access to data.⁴⁷ This is particularly relevant to cardiac arrest research where resource constraints may impede the development and implementation of effective cardiac arrest interventions, perpetuated by a lack of contextual evidence. As such, while there are some established practices of emergency care research in South Africa, systemic issues like resource limitations (including a lack of cardiac arrest registries), ethical challenges in consent processes, and a lack of research capacity negatively affect the research environment.

Willingness to help

The willingness of South Africans to assist in medical emergencies varies based on factors such as individual training, cultural values, education, and access to healthcare.⁴⁸ Those with first aid or medical training, as well as communities fostering a sense of responsibility and mutual support, are more likely to respond positively.⁴⁹ However, concerns about legal consequences, personal safety, and a lack of education may hinder prompt intervention.^{48,50} This may hinder the bystander response in the case of OHCA.

Reliable communications

South Africa has one of the most advanced digital ecosystems on the continent, but despite that the country faces issues such as unequal access to communications infrastructure, with urban areas generally having better connectivity compared to rural regions.¹⁵ Most South Africans have access to a cellular phone (92%) and a television (79%), while only a fifth (21%) of South Africans do not have access to the internet.¹⁵ All of these media of communication may be harnessed to either seek emergency care or for mass media messaging relating to OHCA and resuscitation. However, communications and cell tower signal reliability is influenced by an ongoing unstable power grid and regular, scheduled power outages.

Inner frame

The inner frame is comprised of those elements that are understood to be in the control of the local ECS.

Culture of excellence and quality improvement

In South Africa, quality systems are in their infancy. Common concerns include transparency, reliability, and contextual relevance, which are exacerbated by poor communication and ineffective leadership.⁵¹ Culture of excellence and improvement seem to vary across the public and private sector, with private EMS often investing

more into quality improvement.⁵¹ In contrast, quality in the public sector mostly focus on metrics such as response time targets, versus assessing quality of care.⁵¹ In general, South African EMS lack knowledge of quality management systems, but do acknowledge its importance.⁵² A set of clinical quality indicators for South African EMS has also been developed, including for OHCA⁵³ but the extent to which this has been adopted or implemented is not known. A lack of leadership and quality system infrastructure and capacity have all been cited as barriers to improving clinical care in South African EMS.⁵¹ This is being addressed systematically, as more EMS are implementing digital systems which may support quality improvement.

Relationship with government, police, fire, and hospitals

While we could find no published literature on the relationship and coordination of the ECS with these services, it is our experience that there is largely a lack of integrated communication systems and dispatch. The South African Police Service are also critically under-resourced, eliminating the option of redirecting these services to a OHCA victim.

Emergency care networks

South Africa has one of the most developed emergency care systems on the continent. As it relates to prehospital care, South Africa has a developed tier 2 (professional) EMS system,⁵⁴ with some areas also fully integrating a tier 1 (community-based) EMS system.^{54,55} Formal tier 2 systems are staffed by prehospital emergency care providers at the basic (BLS), intermediate (ILS) and advanced level (ALS).⁵⁶ Each ambulance is staffed by at least two providers, with ALS providers often working on rapid response vehicles. Training for prehospital providers range from a 6-week (BLS) certificate course, to 4-year degree programme (ALS). Emergency call-takers are often non-medically trained and perform their duties without a script or clear protocols on OHCA-recognition and telephonic CPR guidance.⁵⁷

As a pluralist health system, EMS in South Africa are also operated by public, private for-profit, and private not-for-profit services. A national, toll-free universal access number (UAN) is in place, which is managed centrally while dispatch is decentralised nationally.⁵⁸ Private for-profit and private not-for-profit services generally have their own emergency numbers, but in some instances they are also contactable via the UAN.

Physicians may receive specialty or non-specialty emergency care training to improve facility-based emergency care.^{59,60} This is also the case for nursing.⁶¹ South African emergency departments also have established triage areas and dedicated resuscitation rooms. There is considerable variation in the amounts of resources, coordination and quality of emergency care networks between provinces and between the public and private sector.

There are no well-established or universally accepted hospital bypass protocols in South Africa. Only approximately 54% of the South African population live within 60 min of a PCI-capable centre,⁶² which presents a major geographic barrier for timely reperfusion in the unlikely event of ROSC. South Africa also has limited percutaneous coronary intervention (PCI) capable facilities, with one facility for every 887 096 people.³⁰ South Africans also face major socio-economic barriers to accessing timely PCI, as 77% of all PCI-capable centres are owned by the private for-profit sector.³⁰ Thrombolysis, including prehospital thrombolysis,^{63,64} has been

suggested to remedy this however, there are still multiple challenges with its timely implementation, including reperfusion delays.^{63,65,66}

Field to facility communication

No specific literature could be found regarding field to facility communication in South Africa. However, from our experience there are a variety of different policies implemented across provinces and private hospital groups related to prenotification for arrival of critical patients, including those with ROSC. As certain provinces and services are investing in digitization, this has led to some improvement in isolated cases. We believe that field to facility communication is also complicated by the absence of integrated communication systems and fragmentation of the ECS due to the plurality of our health system.

Motivation of staff

Motivation of EMS staff will be considered in three ways: motivation to remain in South Africa, motivation to remain clinically current through compliance with continuous professional development, and motivation to initiate resuscitation in OHCA.

There is a dire shortage of EMS personnel in South Africa.⁶⁷ While some of this can be ascribed to reduced training and output of qualified personnel, a large contributor of this is brain drain – emigration of South African EMS personnel to high income countries.⁶⁸ Factors affecting South African EMS providers' motivation to emigrate include factors such as working conditions, physical security in South Africa, and economic conditions and quality of life abroad.⁶⁸ Such loss of providers influence not only staffing levels, but affects the leadership of EMS as experienced providers are exiting the services.

Continuous professional development (CPD) is a regulatory requirement for all registered EMS providers in South Africa.⁶⁹ however, compliance with these requirements is rather poor, as over half of prehospital providers in South Africa lack a CPD portfolio. This might not reflect a lack of motivation however, as barriers identified include lack of personal funds, distances to travel to higher level educational institutions and lack of availability or opportunities for CPD.⁶⁹ This affects the system's ability to implement evidence-based practice and hinders continuous quality improvement and the adoption of a culture of evidence.

It has been found that a small proportion (7.4%) of OHCA victims receive resuscitation.⁵ Factors that influence this decision include assessment of a poor prognosis, personal safety in hostile situations, and limited resources within the system.⁷⁰

Ambulance to population ratio

South Africa faces tremendous shortages of ambulances⁷¹ and emergency medical services personnel.⁶⁷ In order to reach an ambulance to population ratio of 1:10 000 population, South Africa would require approximately 6000 ambulances^{15,71} however, only about a third of this is currently in operation.⁷¹ This affects ambulance response time intervals, where some patients have to wait between 3⁷² and up to 12 h for an ambulance to arrive in some parts of the country.⁷³ This is further complicated by a lack of accurate, and standardised emergency call triage and prioritisation processes, and a high proportion of ambulance cases being non-emergent, or do not receive any prehospital interventions.^{74,75} This results in increased EMS utilisation rates, exerting substantial pressure on an already

constrained EMS. This limits the ability of the EMS to divert resources to cases of suspected or confirmed OHCA which may influence outcome. It has not been reported how many ambulances are contained in the private for-profit and not-for-profit sectors, but this is expected to be marginal.

Research projects

South African research projects related to OHCA, or which might inform the development of resuscitation systems within the country are drawn upon and cited throughout this analysis. However, research has been slow and labour intensive, and mostly observational in nature. With the absence of a robust OHCA registry within the country, research is limited especially by non-uniform reporting and high levels of data missingness.⁵ Urgent attention should be given to this to facilitate future research and continuous quality improvement.

Practice of giving way to ambulance

South Africa has specific legislation that requires drivers to give immediate and absolute right of way for emergency vehicles who are displaying emergency lights and/or are sounding a siren. It is an offence to fail to do so. While no specific literature could be found assessing the practice of giving way to emergency vehicles in South Africa, there have been recent media reports describing an “alarming new trend”⁷⁶ that South Africans “have gained notoriety”⁷⁷ for not giving way to ambulances. This is of course, further complicated by traffic congestion and poor road conditions, as noted.

Willing and competent pool of bystanders CPR/AED

Willingness of the South African public to help others and perform CPR has already been described. South Africa does not have sustained, regular and mandated public CPR programmes outside of that required to comply with occupational health and safety regulations. Where training programmes exist, they are generally not offered free of charge. This might explain low rates (36%) of bystander CPR in South African OHCA victims.⁶ The utility and cost-effectiveness of such campaigns in South Africa is likely reduced as most OHCA do not occur in public places, have prolonged response times, and poor resuscitation rates.⁵

In South Africa, CPR knowledge is at a low level (20%).⁷⁸ As in other settings, South Africans are more willing to do CPR if it was hands only compared to CPR with mouth-to-mouth resuscitation, with 66% of those surveyed preferring hands-only CPR).⁷⁸ Telephone-guided (tCPR) is reportedly acceptable to South Africans however CPR quality is suboptimal, and instructions should be simpler and available in a caller’s home language. South Africans report that they would be willing to initiate bystander CPR if they were guided over the telephone.⁷⁹ This may be a cost-effective alternative to public mass CPR campaigns and overcome the limitations of OHCA occurring in private settings.

To our knowledge, there exists no registry of automated external defibrillators (AEDs) in South Africa. Some public spaces (e.g. airports and gymnasias) are required to have AEDs available, but this is not the case for all public spaces.

Health-seeking behaviour and appropriate use of EMS

Great disparities exist with access to health care, and a complex interplay of socio-cultural and economic factors influence health-seeking behaviour in South Africa.⁸⁰ Traditional healing practices, socioeconomic status, and the accessibility and affordability of

healthcare services all contribute to when and how individuals seek medical care. Disparities in access between urban and rural areas, as well as the impact of stigma and discrimination, can create barriers to timely healthcare seeking.^{80,81}

Emergency centres and EMS are often stretched beyond their capacity due to a high number of inappropriate emergencies.^{74,75,82} In a recent study it was found that up to 83% of patients transported by ambulance did not receive any prehospital interventions.⁷⁵ This can be attributed to poor allocation of resources, socioeconomic conditions, and inadequate health-seeking behaviors.

EMS speciality development

There is currently no EMS speciality for physicians in South Africa and all prehospital care and the vast majority of interfacility transport is undertaken by prehospital providers of different cadres.

Bystander protection laws

There is no specific bystander protection law in South Africa for first responders in South Africa.⁸³ This may be why bystanders are concerned for the legal consequences of acting.^{48,50} However, there are some provisions requiring healthcare professionals to act in cases of emergency when it is safe, and they are capable to do so.⁸³ Considering that the majority of OHCA in South Africa do not occur in public spaces,⁸⁴ the utility of these prescriptions to improve early recognition and CPR is not that clear.

Cost-efficient smart technology

Some services (private and public) have migrated, or are migrating to digital technologies for dispatch and clinical record-keeping but this has not been universally adopted. A key barrier to optimally utilising smart technology in South Africa is the fragmented nature of the pluralist health system. Further, while a large number of South Africans have access to cellular phones and the internet,¹⁵ data costs in the country are still prohibitively high.⁸⁵ There is also a lack of data integration and data registries in South Africa, impacting the ability to leverage smart technologies in detecting and managing OHCA.

Strong EMS leadership

Research in South African prehospital settings has developed significantly.⁸⁶ Over the last 20 years, academia has produced short courses, undergraduate degrees, and postgraduate studies. South Africa also has a resuscitation council which is a member of the International Liaison Committee on Resuscitation. The Resuscitation Council of Southern Africa offers standard resuscitation courses and adapted and translated algorithms.

The effects of the “brain drain” and mass exodus of health workers within the South African Health sector are well documented.⁸⁷ The effect of this is felt in the development of any system and more so in the development of effective leadership. The sustainable development of any health sector is determined by the leadership found within. This may affect the continuity of leadership, leading to changing agendas and priority focus areas. This is no different for OHCA. EMS and out-of-hospital emergency care systems development in South Africa are largely led by prehospital providers with a variety of qualifications, including doctoral degrees. As such, while no EMS physician qualifications exist, prehospital providers are uniquely positioned to play a decisive role in strengthening OHCA systems of care. Retention of skilled and experienced leaders will be essential to develop OHCA care.

Chain of survival

In this section, the current state of the chain of survival in South Africa is presented. Challenges in recognising OHCA due to linguistic diversity and varying education levels impact early recognition. However, callers do use consistent descriptors across languages⁸⁸ and sectors,⁸⁹ which is promising for the development of universal OHCA recognition algorithms. To our knowledge there is no data on layperson recognition of OHCA. In South Africa, bystander CPR rates are low,⁶ layperson knowledge is poor.⁷⁸ While tCPR could assist in improving this, it results in suboptimal quality.⁷⁹ tCPR programmes are also not commonly applied in the country and there are multiple barriers to its initiation, resulting in low uptake by callers.⁹⁰ There exists no registry or specific legislation for AED placement, but defibrillation via EMS is likely delayed due to prolonged response times.^{6,84} This also delays access to ALS care, which is further compounded by emigration of these cadres of provider.⁸⁸ South Africa faces tremendous shortages of critical care resources for admission of patients who have obtained ROSC and similarly,^{91,92} access to percutaneous coronary intervention is affected by unequal distribution or barriers to access for socio-economic reasons.³⁰ As it relates to recovery, rehabilitation services in South Africa are severely limited with multiple challenges related to appropriate referral and continuity of care.⁹³

Recommendations and conclusion

This narrative review provides an analysis of the South African resuscitation system. While there is considerable variation in the resources, wealth, and rurality distribution between and within provinces, it is encouraging that there is high level political commitment and legislative guidance that recognises the importance of ECS development.

Resource limitations, in regard to overall health expenditure, infrastructure and equipment and workforce allocation will continue, and demand in the near- and medium-term will continue to outweigh that which the ECS is able to accommodate. These barriers will present challenges for the ECS to improve OHCA survival rates but can be overcome through systematic prioritisation and contextually appropriate solutions.

Key areas to address in support of OHCA care include increased advocacy at a national and provincial level to:

- Address inequities in access to healthcare which prevent affordable, available and acceptable emergency care.
- Reinforce the commitment towards improving basic preventative and curative health services thereby strengthening the capability of the health network to provide high quality, robust continuity of care and effective implementation of the chain of survival.

Research is identified multiple times in the Frame of Survival emphasising the importance of contextually relevant research. To this end, an enabling research environment, robust OHCA data registries and investment in the development of research capacity is essential.

The Chain of Survival for the management of OHCA starts with the community and as such, their contribution to OHCA care, as engaged stakeholders within a complex and resource constrained health system, should not be overlooked or underestimated.

Commitment towards regular engagement with the community and co-creation of community-led approaches should be a core value of the systems development initiatives.

The South African resuscitation system demonstrates a reasonable level of readiness to appropriately respond to anticipated increases in OHCA and CVD incidence. However, it is characterised by considerable variation and fragmentation. To enhance outcomes after OHCA, a whole-systems strengthening approach is essential which encompasses all elements of the frames and chain of survival. Given that community CPR campaigns cost between \$22 539⁹⁴ and \$62 600⁹⁵ per quality-adjusted life year (QALY) gained; and that public access AED programmes cost at \$30 000⁹⁶ to \$1 102 473⁹⁷ per QALY gained, these interventions might not be cost effective in South Africa. The cost effectiveness threshold for South Africa is reported to be between \$3 292 and \$7 941 per QALY averted.⁹⁸ Of note, to our knowledge there have been no cost-effectiveness analyses for OHCA interventions undertaken in South Africa. Regardless, considering an anticipated rise in OHCA incidence, there's a pressing need for context-specific strategies in South Africa.⁹⁹

While many initiatives to improve the OHCA systems of care in South Africa are more long-term focused, it is our view that the following concrete steps can be taken in the short term. 1) Implement targeted bystander CPR training for the family-members of high-risk patients; 2) establish and engage with community forums to determine how best to develop a bespoke OHCA system in South Africa using participatory approaches; 3) perform cost-effectiveness analyses to determine which interventions for OHCA may be acceptable within local thresholds for healthcare expenditure; 4) develop telephonic triage processes that can prioritise not only OHCA patients, but all emergency calls, including OHCA recognition and tCPR systems; 5) develop and disseminate support tools for prehospital providers to guide decision-making on when to initiate, withhold or withdraw resuscitation attempts that are sensitive to local variation and resource constraints. These strategies should focus on enhancing both outcomes and resource efficiency, while respecting community ethics and sociocultural dynamics. All of this should be underpinned by evidence and be inclusive of healthcare providers, policymakers, and community engagement.

CRedit authorship contribution statement

Louis van Rensburg: Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Naqeeb Majiet:** Writing – original draft, Resources, Data curation, Conceptualization. **Amalia Geldenhuys:** Writing – original draft, Resources, Data curation. **Lauren Lai King:** Writing – review & editing, Writing – original draft, Resources, Conceptualization. **Willem Stassen:** Writing – review & editing, Supervision, Resources, Project administration, Methodology, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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