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CLINICAL QUALITY AND PERFORMANCE MEASUREMENT IN THE PREHOSPITAL EMERGENCY MEDICAL SERVICES IN THE LOW-TO-MIDDLE INCOME COUNTRY SETTING

Developing clinical quality and performance indicators as a measure of care in South Africa

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Clinical Quality and Performance Measurement in the Prehospital Emergency Medical Services in the Low-to-Middle-Income setting: Developing Clinical Quality and Performance Indicators as a measure of care in South Africa

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By

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For Louisa, Mia, Layla, Amina, Brodie and Winston

"Every system is perfectly designed to get the results it gets…

If we want better outcomes, we must change something in the system. To do this we need to understand our systems."

-W Edwards Deming/Paul Batalden

ABSTRACT

BACKGROUND

Measuring quality and safety in any healthcare setting however is highly contextual, and depends on the manner in which quality is defined or viewed within that setting. It is this contextual nature that has provoked significant debate and hindered efforts at developing formal standards or criteria for measuring quality and safety in healthcare, regardless of setting. Historically, performance within the Emergency Medical Services (EMS) delivering prehospital emergency care has been assessed primarily based on response times. While easy to measure and valued by the public, overall, response time targets are a poor predictor of quality of care and clinical outcomes.

AIM

The overall aim of the research was to develop a framework for clinical quality and performance-based assessment of prehospital emergency care for use in the South African EMS.

METHOD

The research was divided amongst four studies, with each study constituting one of the overall research objectives. **Study I** was a sequential explanatory mixed methods study with the aim of understanding the knowledge, attitudes and practices of clinical quality and performance assessment amongst South African EMS personnel. Part 1 consisted of a web-based cross-sectional survey, and Part 2 consisted of semi-structured telephonic interviews of select participants from Part 1 to explore the results of the survey. Descriptive statistics were carried out to summarise and present all survey items, and conventional content analysis employed to analyse the interview data. **Study II** utilised a three round modified Delphi study to identify, refine and review a list of appropriate quality indicators for potential use in the South African EMS setting. For **Study III** a novel quality indicator appraisal protocol was developed consisting of two categorical-based appraisal methods, combined with the qualitative analysis of their consensus application, and tested against the outcomes of Study II. Descriptive statistics were utilised to describe and summarize the categorical based appraisal data. Inter-rater reliability was calculated using percentage agreement and Gwet's AC1. Correlation between the individual methods and the protocol was calculated using Spearman's rank Correlation and z-test. Conventional content analysis was utilised to analyse the group discussions. **Study IV** utilised a multiple exploratory case study design to evaluate the current state of quality systems in the South African EMS. A formative assessment was conducted on the quality systems of four provincial EMS and one national private EMS, following which semi-structured interviews were conducted to further explore the results obtained from the formative assessment, supported by multiple secondary data sources. Descriptive statistics were utilised to describe and summarize the formative assessment. Conventional content analysis was utilised to analyse the interview data and document analysis utilised to sort and analyse the supporting data.

RESULTS

Despite relatively poor knowledge of organisational-specific quality systems, understanding of the core components and importance of quality systems was demonstrated. The role of these systems in the Low to Middle Income Country setting (LMICs) was supported by participants, where the importance of context, system transparency, reliability and validity were essential towards achieving ongoing success and utilisation. The role of leadership and communication towards the effective facilitation of such a system was equally identified. Participating services generally scored higher for structure and planning. Measurement and improvement were found to be more dependent on utilisation and perceived mandate. There was a relatively strong focus on clinical quality assessment within the private service, whereas in the provincial systems, measures were exclusively restricted to call times with little focus on clinical care. Staff engagement and programme evaluation were generally among the lowest scores. A multitude of contextual factors were identified that affected the effectiveness of quality systems, centred around leadership, vision and mission, and quality system infrastructure and capacity, guided by the need for comprehensive yet pragmatic strategic policies and standards. A total, 104 quality indicators reached consensus agreement including, 90 clinical QIs, across 15 subcategories, and 14 non-clinical QIs across two subcategories. Amongst the clinical category, airway management (n=13 QIs; 14%); out-of-hospital cardiac arrest (n=13 QIs; 14%); and acute coronary syndromes (n=11 QIs; 12%) made up the majority. Within the non-clinical category, adverse events made up the significant majority with nine QIs (64%). There was mixed inter-rater reliability of the individual methods. There was similarly poor to moderate correlation of the results obtained between the individual methods (Spearman's rank correlation=0.42,$p<0.001$). From a series of 104 QIs, 11 were identified that were shared between the individual methods. A further 19 QIs were identified and not shared by each method, highlighting the benefits of a multimethod approach.

CONCLUSION

For the purposes of this study we focused on the technical competence aspect of quality, in developing our measurement framework. Towards this, we identified a significant number of QIs assessed to be valid and feasible for the South African prehospital emergency care setting. The majority of which are centred around clinically focused processes of care, measures that are lacking in current performance assessment in EMS in South Africa. However, we also discovered the importance and influencing role of the individual practitioners and quality system in which the QIs will be implemented, a point highlighted across all the methodologies and studies. Given the potential magnitude of this influence, it is of the utmost importance that any measurement framework examining technical quality, have equal in-depth understanding of these factors in order to be successful.

LIST OF SCIENTIFIC PAPERS

I. **Howard I**, Cameron P, Castrén M, Wallis L, Lindström V.
Knowledge, attitudes and practices of clinical quality and performance assessment among emergency medical services personnel in South Africa: A mixed methods study. Emergency Medicine Australasia. 2019; 31(6): 1024-1036

II. **Howard I**, Cameron P, Wallis L, Castrén M, Lindström V.
Identifying quality indicators for prehospital emergency care services in the low to middle income setting: The South African perspective. African Journal of Emergency Medicine. 2019; 9(4): 185-192

III. **Howard I**, Cameron P, Castrén M, Wallis L, Lindström V.
Multi-method appraisal of clinical quality indicators for the Emergency Medical Services in the low-and-Middle-Income Setting: The South African Perspective. (unpublished manuscript)

IV. **Howard I**, Cameron P, Wallis L, Castrén M, Lindström V.
Understanding quality systems in the South African prehospital emergency medical services: A multiple exploratory case study. BMJ Open Quality. 2020;9:e000946. doi:10.1136/bmjoq-2020-000946

RELATED PUBLICATION

I. **Howard I**, Cameron P, Wallis L, Castrén M, Lindström V.
Quality Indicators for evaluating prehospital emergency care: A scoping review. Prehospital and Disaster Medicine. 2019; 33(1): 43 – 52

CONTENTS

LIST OF ABBREVIATIONS

ALS	Advanced Life Support
CPG	Clinical Practice Guideline
CQI	Continuous Quality Improvement
ECP	Emergency Care Practitioner
EMS	Emergency Medical Services
EMSOP	Emergency Medical Service Outcomes Projects
HPCSA	Health Professions Council of South Africa
GDP	Gross domestic product
IHI	Institute for Healthcare Improvement
IRR	Inter-rater reliability
JCAHO	Joint Commission on Accreditation of Healthcare Organizations
KAP	Knowledge, Attitude and Practices
KZN	KwaZulu Natal
LMICs	Low to middle income country setting
LP	Limpopo province
NHTSA	National Association of EMS Physicians, and the National Highway Traffic Safety Administration
NW	North West province
PBEC	Professional Board for Emergency Care
PEC	Prehospital Emergency Care
QI	Quality indicator
SA	South Africa
SAQA	South African Qualifications Authority
UK	United Kingdom
UN	United Nations
VAS	Visual analogue scale
VF	Ventricular fibrillation
WC	Western Cape
WHO	World Health Organisation

1 INTRODUCTION

Over the last three decades, the release of several landmark reports has brought the issue of patient safety and quality of care to the forefront of healthcare. The latent nature of poor quality and safety, along with the growing body of evidence that suggests when mismanaged, costs hundreds of thousands of lives and billions of dollars, has dictated that these concepts become top priorities within healthcare[1–6]. Measuring quality and safety in any healthcare setting, however, is highly contextual, and depends on the manner in which quality is defined or viewed within that setting[3,4,7,8]. It is this contextual nature that has provoked significant debate and hindered efforts at developing formal standards or criteria for measuring quality and safety in healthcare, regardless of setting[5–11].

Traditionally, quality and performance within the Emergency Medical Services (EMS) delivering prehospital emergency care (PEC) has been measured primarily on response times. The roots of this can be traced back to research conducted during the late 1970's that highlighted the benefits offered by reduced response time in cardiac arrest management[12]. The significance of these observed benefits was subsequently extrapolated to all aspects of PEC, and as a result, response time targets became the predominant measure of performance in EMS. However, response time targets address only one single aspect of the concept of patient access and fail to take into account other important time intervals, such as scene time. Furthermore, such a measure fails completely to gauge the concept of effectiveness of patient care and patient safety.

2 BACKGROUND

The field of PEC has seen considerable growth over the last two decades. The scope of practice within EMS is continuously expanding, with these services adopting new roles amongst the community[13–17]. The utilisation of EMS for patients not historically viewed as "traditional" emergencies, such as mental health, primary health care or planned patient care has increased significantly over the last two decades[13–17]. This rapid development has dictated that novel, more appropriate measures of quality and safety be implemented to compliment this growth, and ultimately improve these services overall. Internationally, significant steps have been made towards defining appropriate quality measures for PEC. However, the majority of this research remains restricted to measures of service access[18–20].

While some effort has been made towards clinical-based measures of care, this research has occurred largely within the confines of the developed systems of North America, Europe and Australia[18–22]. Little progress has been made within the low to middle income country setting (LMICs). Furthermore, healthcare expenditure and availability, service access, resource utilisation, and healthcare education within the LMICs are significantly varied in comparison to the high-income-country context[23,24]. Much of the early progress achieved in developing quality measures for PEC cannot be routinely applied or extrapolated to the LMICs. Circumstances unique to these environments need to be considered in order for appropriate measures to be defined and implemented. Understanding practitioner and system-focused factors are primary examples of how components of a particular setting or circumstance can be incorporated into the development of a bespoke quality system or framework of measurement.

2.1 EMERGENCY CARE SYSTEMS IN THE LOW TO MIDDLE INCOME COUNTRY SETTING

Within healthcare, the expanded field of emergency care (inhospital and prehospital) has a core focus on reducing preventable mortality, morbidity and disability from time-sensitive disease processes[25–28]. These are ultimately achieved through integrated systems for accessing emergency care, providing emergency care in the community, care during transportation, and care on arrival at receiving facilities[25–28]. Historically, within the LMICs however, emergency care has been prioritized lower than primary prevention-focused strategies, due to the perception that the implementation and delivery of emergency care systems are costly and benefit relatively few patients. This has been reinforced by the burden of diseases prevalent throughout these regions which have traditionally been controlled through the primary healthcare system i.e.: communicable/infectious diseases[29].

Despite this historical focus on primary care and communicable diseases, the burden has begun to shift towards an increasing prevalence of acute illness, non-communicable diseases and injuries in the LMIC setting[25–28]. The scope for improvement is therefore substantial. However, if improvements to emergency care in the LMICs can be achieved,

the outcomes are likely to be equally as significant. Approximately 45% of deaths and 36% of all disability-adjusted life years in the LMICs are amenable to secondary prevention via inhospital and prehospital emergency services[30,31]. It is estimated that strengthening trauma and emergency care in the LMICs could result in a decreased injury mortality rate of 8% (more than 400,000 lives) and cost less than $100 per disability-adjusted life year averted[32–34].

Unfortunately, this is hampered by the fact that the LMICs have consistently maintained the worst levels of healthcare access and quality indices for the last three decades[35,36]. While gains have been made regarding the historical burden felt in these regions, there has been little progress regarding the emerging threat from acute illness, non-communicable diseases and injuries[35,36]. In order to achieve improvements in the outcomes of emergency care in the LMICs, advances in quality and performance are needed over and above progress in patient access alone. Towards this, the World Health Organization (WHO) has proposed six recommendations to improve the measurement of quality of care and its impact on improving health outcomes the LMICs[37] (Table 1).

Table 1: WHO recommendations to improve quality of care in the low to middle income country setting

Recommendations for improving data collection methods and instruments	1. Redouble efforts to improve and institutionalize civil registration and vital statistics systems
	2. Reform facility surveys and strengthen routine health information systems. Routine information systems can be used to track quality over time and to evaluate improvement efforts
	3. Innovate new quality-of-care measures for low-resource contexts. Development and validation of new measures and new measurement technologies are needed
Recommendation for expanding the scope of measurements	4. Get the patient perspective on quality
Recommendations for translating the data for policy impact	5. Invest in national quality-of-care data. Rigorous collection of quality-of-care data must move beyond individual projects and facilities to the entire health system
	6. Translate quality evidence for policy impact. Robust and meaningful data presented in intuitive ways will greatly improve policy uptake of quality data

2.2 SOUTH AFRICAN EMS CONTEXT

South Africa (SA) is a country that lies at the southern tip of Africa with a population of approximately 60 million people and is considered a developing economy by the United Nations (UN), and upper middle-income country by the World Bank[38–40] (Figure 1). Total healthcare expenditure is approximately 9% of the national growth domestic product (GDP) and is primary delivered and administered regionally by one of the nine provincial governments that make up the next administrative level of government[38–40].

PEC in SA is primarily delivered by government- and private-run EMS and is based on a three-tiered system of Basic, Intermediate and Advanced Life Support levels of qualification[41–43]. Each level is licenced for independent practice and governed by a national

registration board, the Professional Board for Emergency Care (PBEC) of the Health Professions Council of South Africa (HPCSA)[41–43]. There is an increasing scope of practice between each level with Advanced Life Support (ALS) practitioners, the highest level, employing a multitude of skills analogous to Advanced Trauma Life Support and Advanced Cardiac Life Support[41–43].

Recent efforts by the PBEC have signified a desire to professionalise training and qualification within EMS in SA, following the introduction of two university based and South African Qualifications Authority (SAQA) accredited qualifications[44]. Furthermore, recent Department of Health policy reviews have highlighted the importance of systems for developing, implementing and monitoring the quality of healthcare in the country[45,46]. While significant advances have been made in improving the scope of practice of EMS, and training and education of PEC clinicians, little has been done towards ensuring the delivery of high-quality clinical care beyond the traditional response time access targets currently in use. In order to transition to a consistent high-quality, high-performance system, it is essential that measures aimed at monitoring and guiding quality improvement in EMS, are developed and implemented for the local context.

Figure 1: South African context

2.3 DEFINING AND MEASURING QUALITY IN HEALTHCARE

2.3.1 Defining Quality in Healthcare

Defining quality lies at the heart of, and guides, every initiative aimed at measuring and improving it[7,10,47]. The challenge to this, however, is in encompassing the multitude of characteristics that make up such an abstract concept like healthcare quality. Furthermore, multiple definitions of quality are possible, depending on the perspective from which it is viewed[7,48–51]. It is this contextual nature that is primarily responsible for the difficulties in outlining a single unified definition of healthcare quality, a topic that has been the focus of much debate[52]. Three overarching perspectives have been described in the literature in an attempt to define quality:

- The Provider perspective: Donabedian defined two primary components within the provider perspective that dictate how quality is perceived, namely, technical performance and interpersonal relationships. Technical performance is the requisite skills and knowledge used by a provider in order to deliver appropriate care. The interpersonal relationship component, however, lies at the patient-provider interface and encompasses the providers ability to communicate with a patient and the general manner in which information is exchanged[48,49]. McGlynns' interpretation expanded on this by contending that providers face three, often competing, influences on their view of quality that include: clinical judgement, patient values and the need to limit costs[53]. Appropriate infrastructure in the form of clinical information systems, and adequately skilled staff resources to facilitate high quality care have been described as important factors that influence the provider-based perspective[54,55].
- The Patient (and Population) perspective: Understanding the patient's perspective is arguably the most complex to define and understand. There are a multitude of potential societal and cultural factors that could influence an individual's perception of healthcare quality[56]. Of most importance is the perception that the care they seek is responsive to their individual needs[53]. Whereas technical performance is favoured by providers, patients often lack the knowledge to evaluate their own care and are possibly ambivalent towards these technical aspects[57,58]. Patients instead value the manner in which care is provided, or the competence with which it is delivered, concepts shared with the provider perspective in the form of "interpersonal relationship" [47–49,59]. This is arguably based on the assumption that high quality care is assumed and expected to be provided without limitation of cost or resource[60,61]
- The "Purchaser" perspective: Encompassing provider and patient perspectives, is the impact of economic cost, and the notion that cost and quality are confounded. Donabedian proposed two competing views – a "Maximalist" approach seeks the highest quality of care that can be achieved, represented by the greatest improvements in health, while ignoring cost[48,49]. The "Optimalist" approach alternatively considers the impact of cost and will evaluate the cost vs. benefit ratio of maximizing healthcare and the corresponding impact on quality and improvement this will bring about[48,49]

No literature could be identified that specifically defines PEC quality. However, it is arguable that defining quality care in this setting should be no different to the core components of traditional definitions of healthcare quality, and that empowerment, process, service and organizational culture are essential attributes towards maintaining high quality of PEC delivery[62,63]. Examination of the broader quality-orientated literature in the PEC context, however, reveals several themes that can be aggregated into two overarching concepts that aid in defining PEC quality – that of access and effectiveness/effective care[47].

2.3.2 Measuring Quality in Healthcare

The measurement of healthcare quality involves the review of healthcare data against defined criteria (both implicit and explicit) with the aim of assessing the quality of care provided[64]. As with defining healthcare quality, there are multiple "users" or "audiences" for the measurement and aggregation of healthcare data, including similarly, providers, patients, purchasers, managers, regulatory bodies etc.[65,66]. The healthcare data used, should therefore be selected primarily based on availability, the criteria to employed for assessment, and the audience. Similarly, for any measurement system to be successful, it is fundamental that it be comprehensive in its approach, yet simple in its design, and contextually relevant in order to provide an appropriate measure of quality.

While Donabedian attempted to define the "scope" of what one should consider when conceptually defining quality, he at the same time understood the need for a pragmatic approach towards its definition as well. It was based on this need that Donabedian proposed his seminal classification of healthcare information/data, from which inferences on quality and safety could be drawn regarding a specific healthcare system or context. He classified information into one of three categories of measures, each of which offer a distinct yet relational assessment of a healthcare system, namely: structure measures, process measures and outcome measures[48,49]:

- Structure measures denote the attributes of the setting in which health care occurs, and primarily include material resources e.g., facilities, equipment, and financing), human resources, and organizational structure
- Process measures denote the steps in the actual delivery of health care i.e., what the health care provider does to maintain or improve health e.g. making a diagnosis or recommending/implementing treatment
- Outcome measures denote the effects or impact of care on the health status of patients and/or populations i.e., changes in a patient's health status that could be attributed to antecedent care

Alternatives to Donabedian's approach towards measuring quality have been described in the literature. Sheps proposed a system of measurement based around four "areas" of healthcare system appraisal[67]:

- Set standards of care: Prerequisite standards of care minimum or optimum levels of facilities, equipment, professional training, and organization

- Elements of performance: Indices intended to reflect one or more elements of performance, e.g.: Utilization rates of certain laboratory and other diagnostic procedures, by category
- Effects of care: Indices intended to measure the effects of quality of care on patient health, analogous to outcome measures such as mortality etc.
- Clinical evaluation: Scoring system assigned to patient care records based on the completeness of records, diagnostic management, treatment, and reporting, measured against prepared standards

Roemer too, described four focus points of healthcare data for quality assessment, and included[68]:

- Patient health status outcomes, e.g.: death or disability
- Estimated quality of services: A measure he equates to Donabedian's Process measure
- Quantity of Services provided: A measure of service utilization rates
- Attitude of recipients: An early surrogate of patient reported measures

Rutstein et al. took a somewhat contrasting view in attempting to define quality, one that would align more with the contemporary approach towards measuring and assessing patient safety. In his view, because there were no easily measured quantitative definitions of bad, average or good health, he proposed an alternative system focused on measuring negative indices of healthcare, such as unnecessary disabilities, diseases and untimely deaths. Such occurrences are adverse health events that justify the careful and scientifically controlled search for underlying causes, the basis of which offer the best opportunity for improvement[69].

Despite the existence of the alternatives highlighted above, Donabedian's model has been widely accepted as the model of choice for measuring quality across healthcare in general[47,70,71]. Beyond its simplicity, one of the benefits of Donabedian's model is that while each measure classification can be viewed as independent, they inform and strengthen each other - effective structure gives rise to effective processes of care, which lead to improved patient outcomes. This has benefits from an EMS point of view, where the Donabedian approach lends itself to use for assessing PEC quality, as the care delivered in this context is largely symptomatic and/or based around specific interventions. For example, there is a significant volume of evidence that early defibrillation in patients with ventricular fibrillation (VF) (a process-based measure) improves survival (an outcome measure). Furthermore, while the availability of a defibrillator (a structural based measure) does not ensure its use, the act of delivering the process (i.e. defibrillation) would not be possible without one.

2.4 QUALITY ASSESSMENT IN EMS

Historically, several methods aimed at the formal monitoring and assessment of quality and performance within EMS have been described. These have generally fallen into one of two

distinct categories – direct observation and/or the retrospective audit of patient care records[72].

Direct observation employs the use of trained observers to monitor and assess quality and performance in real time. It allows for the on-site consultation and feedback between clinician and assessor to reinforce good practice, remediate poor practice when it occurs, and to set education goals based on these assessments[73,74]. Furthermore, it has been argued that direct observation can act as a potential safeguard against poor practice thus preserving patient safety[75]. Direct observation has been employed with multiple endpoints, including as part of new employee/trainee induction; ongoing training; and more importantly, as part of continued quality assurance processes[73–75]. Direct observation has the added benefit of offering multiple points of view as part of the observation, including peer clinicians; supervisory clinicians; receiving hospital staff; patients and patient family members[76]. Despite these described benefits, direct observation has been widely acknowledged to be significantly resource intensive, the reason often cited as the primary limitation to the widespread use of this approach[73–76].

Retrospective audit encompasses a multitude of methodologies that involve the use of objective explicit and/or subjective implicit criteria to review and assess quality of care. This is primarily conducted using patient care records and/or documents produced following patient care such complaint reports, incidents reports, and root cause analyses etc.[75,77]. As with direct observation, the possibility of multiple viewpoints can be introduced into retrospective audit through either the criteria used for assessment and/or based on the individual conducting the audit, which could similarly include peer clinicians; supervisory clinicians; and receiving hospital staff. Assessment of patient reported outcomes offer equal advantage in providing a patient and/or family-centred view of the care received. Records may be manual or electronic and likewise be assessed manually or electronically. As a small subset of retrospective audit, evaluation of audio and/or visual footage for the purpose of quality assessment has too been described[78].

The development of formal systems aimed at monitoring and improving quality within PEC has been ad hoc and slow. Much of the early development on measuring quality and safety originated in the United States, through the efforts of several professional and accreditation bodies[20,79–81]. The Joint Commission on Accreditation of Healthcare Organizations (JCAHO), American College of Emergency Physicians, National Association of EMS Physicians, and the National Highway Traffic Safety Administration (NHTSA) were all early adopters who advocated for the adaptation of Continuous Quality Improvement (CQI) to the EMS context in the early 1990s, when the concept started to gain traction and popularity within healthcare in the United States[75,79]. By the mid 1990s, to capitalize on this growing momentum towards measuring and improving PEC, the NHTSA funded a 5-year project to develop a foundation and framework for use in EMS[18,19,82,83]. The primary objective of the Emergency Medical Service Outcomes Projects (EMSOP) were to identify[18,19,82,83]:

1) Conditions that should take precedence in EMS outcomes research

2) Risk adjustment measures for these priority conditions
3) Outcome measures for these priority conditions

In EMSOP I, Maio et al. argued for the use of "tracer" conditions – those with high frequency and high potential to benefit from emergency care as a measure of EMS "effectiveness" and to guide improvement activities. Towards this, the authors identified "relief of discomfort" as the measure with the greatest potential benefit for improvement in the EMS context[18]. In EMSOP II, Spaite et al. further developed the "Episodes of Care" methodological framework for developing risk adjusted outcome measures based on severity and therapeutic time dependency for a particular condition[19]. The Out of Hospital Unit of Service framework was further developed for outcome analysis in less time critical conditions, which are better modelled by defining and measuring delivery of discrete "units of service," such as pain relief and patient satisfaction. EMSOP III further expanded on risk adjustment measures and outcome measures for potential use, with EMOP IV focusing specifically on prehospital specific measures for pain assessment and relief[82,83]. Keim et al. later used the frameworks and methodologies developed throughout the EMSOPs to develop a range of risk adjustment measures and outcome measures for out-of-hospital respiratory distress[84].

Greenberg et al. opted for a different stance to the EMSOPs and focused on the perspective of emergency care practitioners in the development of EMS specific measures of quality. These included a range of structural indicators such as the quality of training, timeliness of care and availability of resources; and a range of outcome measures such as change in complaint activity, patient outcome, and symptomatic improvement. In contrast to the EMSOP outcomes, few process-based measures of care were included in Greenberg's framework[85].

The International Association of Fire Fighters/Chiefs, based in the United States, continued the strong involvement of professional bodies in driving change through their development of a series of performance indicators for fire-based prehospital care systems. These included structural indicators such as staffing, road structure coverage, the availability of defibrillation and extrication capability and the presence of a multi-casualty plan. Process indicators such as compliance with patient care protocols were additionally included (dichotomous compliant/non-compliant with written protocol), as were outcome measures such as patient outcome at the end of EMS transportation (simple categorization of improved, remained unchanged, worsened), and user satisfaction were included[81].

There is limited evidence regarding the development of systems for the assessment of prehospital care quality outside of the United States[86]. Furthermore, the appropriateness of research conducted in one setting and its applicability to another is somewhat unclear. While research has shown that quality measures developed for one setting were useful when developing new measures for a separate setting, international variation in clinical practice and health system organization may mean that direct transfer of indicators will not always be appropriate[87].

Krafft et al. and Fisher et al. reported on their attempts at comparing the performance of multiple European EMS systems[88–90]. However, the scope of these projects was limited to a few structure based measures of care in attempt to ensure comparability across systems[88–90]. In the United Kingdom (UK), Siriwardena successfully developed and pilot-tested a series of structure- and process-based measures of clinical quality for use in English EMS, centred on five common clinical presentations including Stroke, Myocardial Infarction, Cardiac Arrest, Asthma and Hypoglycaemia[22]. He went on to further demonstrate significant improvements in quality of care delivered across twelve publicly funded ambulance service trusts in the UK, following implementation and improvement initiatives centred on the Stroke and Myocardial Infarction measures of quality previously developed[91]. In Australia, O 'Meara highlighted the need for further development and expansion beyond the eight indicators suggested by the Steering Committee for the Review of Commonwealth/State EMS Provision[92]. Of these measures, three focused on cost and expenditure, three on resource use and response times, a single generic "patient satisfaction: measure, and one outcome based, clinically focused measure on survival rate of out of hospital cardiac arrest[92].

There is an inherent lack of reporting on quality assessment in EMS in the LMICs. A single study by Rahman et al. was found that compared EMS across several Asian cities, albeit including both the High-Income Country setting and LMICs[93]. They compared and reported on a total of 14 structure-based measures, seven process measures, and five outcome measures (all of which pertained to cardiac arrest)[93]. No English language published scientific literature focused on the assessment of EMS quality in Africa could be identified[86].

3 AIMS

The overall aim of the research was to develop a framework for clinical quality and performance-based assessment of prehospital emergency care for use in the South African Emergency Medical Services. The research was divided amongst four studies, with each study constituting one of the overall research objectives (Figure 2):

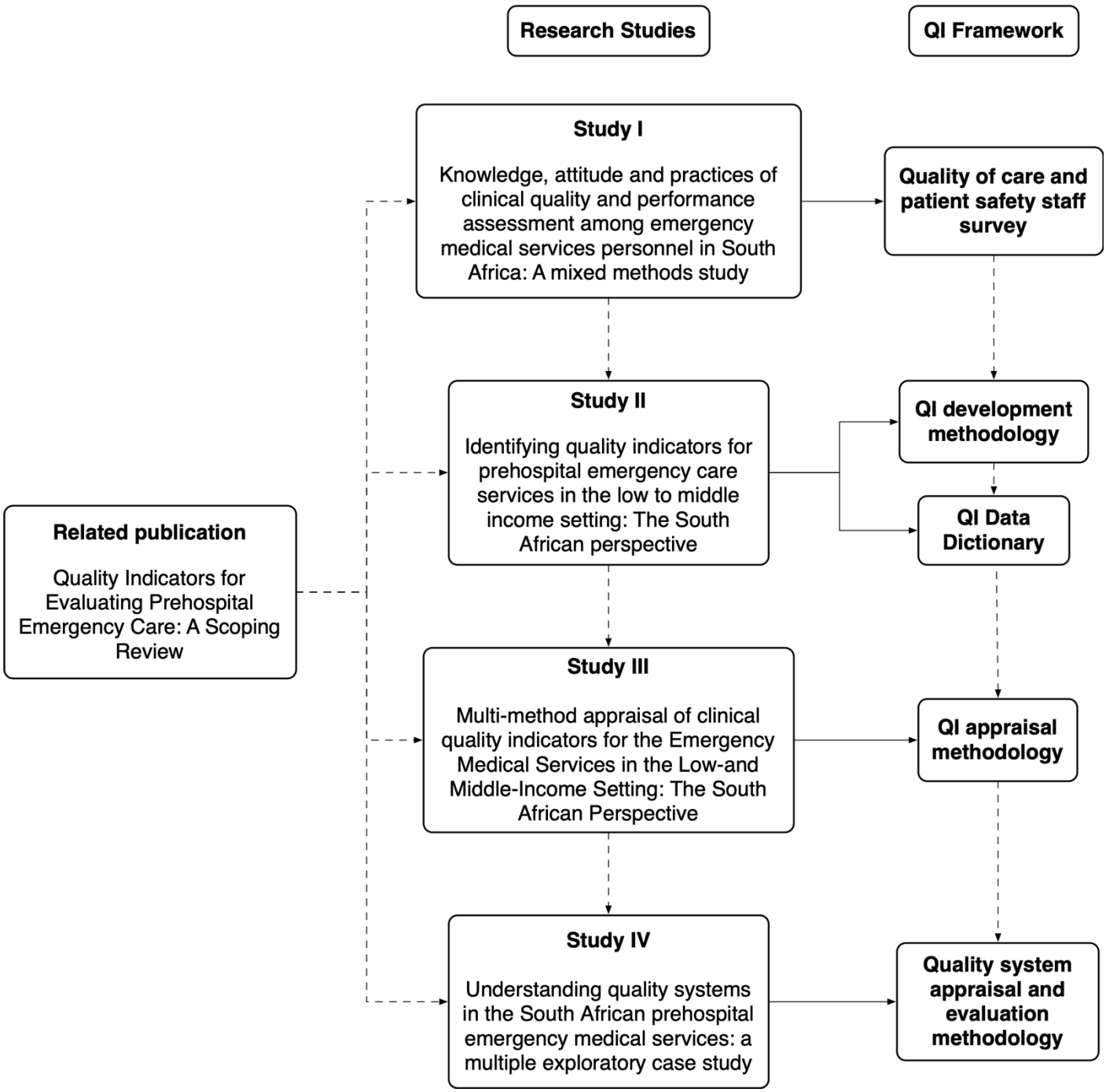
To understand the knowledge, attitudes and practices of clinical quality and performance assessment amongst South African Emergency Medical Services personnel **(Study I)**

To identify appropriate clinical quality and performance-based measures of prehospital care are for use within the South African Emergency Medical Services setting **(Study II)**

To appraise the clinical quality and performance-based measures of prehospital care for use within the South African Emergency Medical Services setting **(Study III)**

To evaluate the current state of quality systems in the South African Emergency Medical Services **(Study IV)**

Figure 2: Research studies and corresponding Quality Indicator (QI) development framework



4 METHODS

A multi-method approach was used to develop the framework for clinical quality and performance-based assessment of PEC for use in the South African EMS. However, due to the lack of literature regarding quality and performance assessment in either the SA or the expanded LMIC setting, a scoping review was conducted prior to the four studies included in the thesis. A general overview of the methodological approach utilised for the included studies is displayed in Table 2.

Table 2: Methodological overview

Study	Design	Population	Data collection
I	Sequential explanatory mixed methods	South African ALS* registered with HPCSA*	Part 1: Online survey
			Part 2: One-on-one interviews
II	Modified Delphi	Emergency physicians, nurses & EMS* staff	3 round online QI* development consensus
III	Combination of multiple methods	South African ALS registered with HPCSA	Part 1: QI appraisal consensus
			Part 2: Literature review and evidence appraisal
			Part 3: Working group discussion and consensus
IV	Multiple exploratory case study	4 provincial EMS and 1 private EMS organisation	Part 1: EMS quality system appraisal
		EMS directors	Part 2: One-on-one interviews
			Part 3: Literature review and evidence appraisal

* **ALS**-Advanced life support; **HPCSA**-Health Professions Council of South Africa; **EMS**-Emergency Medical Services; **QI**-Quality Indicator

4.1 SCOPING REVIEW

Given the relative paucity of scientific literature regarding PEC quality and performance measurement, a systematic scoping review of the literature was conducted, with the aim understanding the development and reporting of PEC specific QIs, and to define the data components and attributes necessary for their development, interpretation and implementation[86]. The scoping review methodology was selected given its primary aim to "map" the extent, range, and nature of a particular topic, summarizing the scope of evidence in order to convey the breadth and depth of a particular field[94,95]. This methodology is of particular use in new and emerging disciplines, where the quality of evidence and methodologies applied in previous research is unknown or varied[94,95].

For the purpose of this review, a QI was defined as any measure that compared actual care against ideal criteria; or a tool used to assess quality and/or performance. Article characteristics extracted included: type of research/methodology, country of origin, year of publication, institutional academic status, source of funding, population/age demographic studied, and description of the QIs within a broader organizational quality framework or structure (defined as demonstration of how and/ or where the QIs developed in the article

reviewed aligned within a larger measurement or assessment structure in the PEC environment). Quality indicator characteristics extracted included: origin of the QI, data source for developing the QI, QI data components, and whether or not a pilot of the QI was reported[86](Appendix 1).

The outcomes from the scoping review become the foundation of the doctoral studies as a whole and served to frame the research problem and how each study contributed towards achieving the overall research aim. The review further assisted specifically to refine the final objectives of each study and formed the basis for which the primary output of the overall study could be developed.

4.2 STUDY I

4.2.1 Design & analysis

A mixed methods sequential explanatory design was used, divided into two parts: Part 1 consisted of a web-based cross-sectional survey, and Part 2 consisted of semi-structured telephonic interviews of select participants from Part 1 to explore the results of the survey (Figure 3).

Part 1

The survey tool used was developed for the purposes of this study, utilising a knowledge-attitude and practices (KAP) survey framework to guide development[96,97]. Following two rounds of development, refinement and testing, a final 60 item survey was developed, composed of closed-ended, multiple choice and visual analogue scale questions. All surveys were distributed in English and completed via a web-based survey tool. Descriptive statistics were carried out to summarise and present all survey items.

Part 2

The summarised results from the survey were used to develop a semi-structured interview guide for Part 2. For the interviews, purposeful selection of participants was conducted using a maximal variation sampling strategy to ensure the inclusion of multiple participant perspectives[98]. A combination of self-selected participants from the survey, in conjunction with recruited participants meeting demographic criteria unaccounted for in the self-selected group, were included. All interviews were conducted in English and recorded for transcription and analysis. Reflective notes were maintained during each interview, and immediately after, for verification of the interview results during analysis.

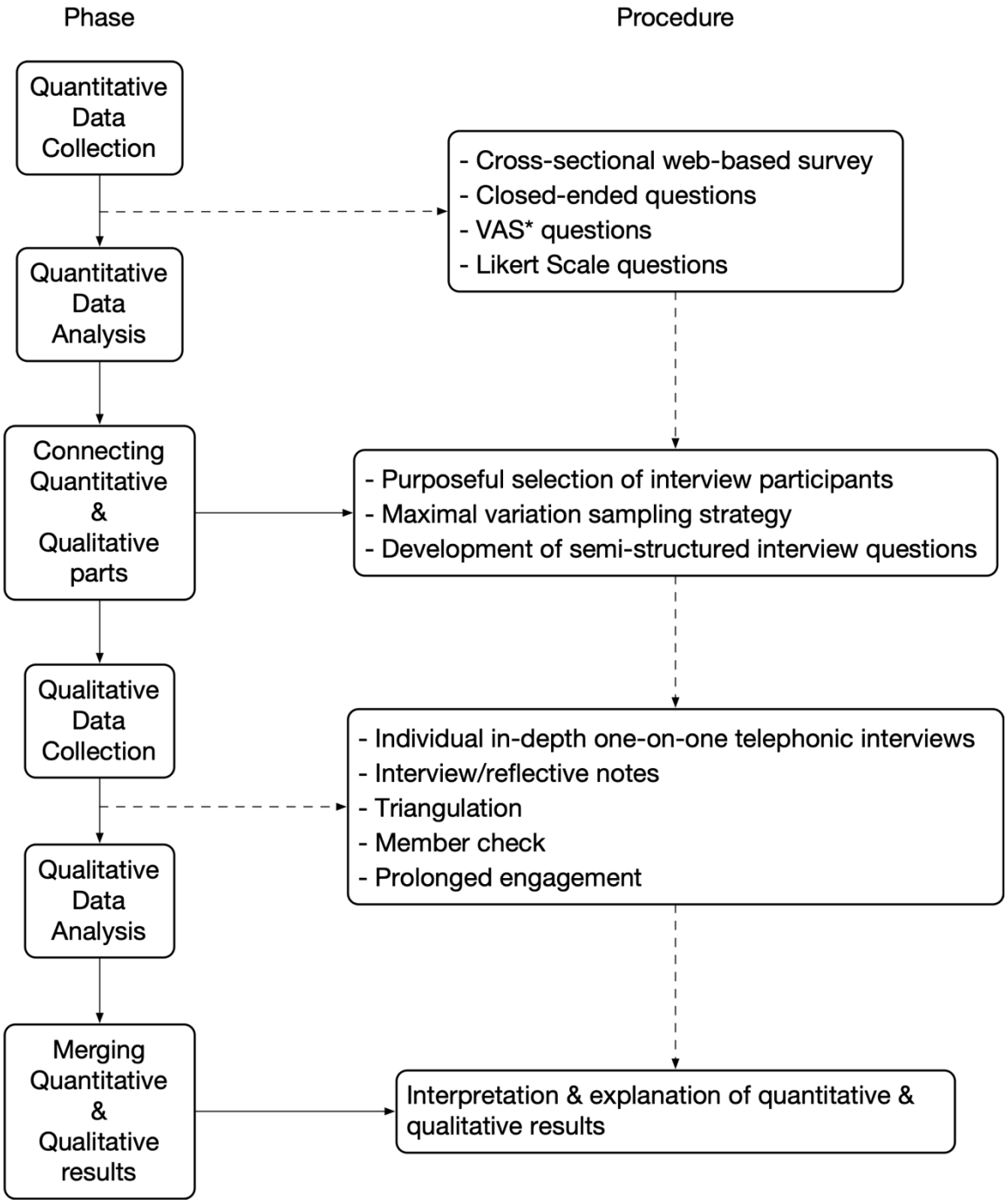
Conventional content analysis as described by Hseih and Shannon, was employed to analyse the interview data using MAXQDA software for data storage; extraction of meaning units and sub-category and category development[99,100] (MAXQDA, 2016; Sozialforschung GmbH, Berlin, Germany). First-level coding was conducted through the extraction of meaning units from each transcript and summarised into codes using open-coding from each interview. Once completed, similar codes across all interviews were combined and organised to

develop clustered sub-categories. Lastly, broad over-arching categories were identified that emerged from similar grouped sub-categories.

4.2.2 Setting & population

The target participants were SA trained EMS practitioners registered at the ALS level with the HPCSA. Practitioners from both private and government EMS and practitioners working in non-conventional EMS roles (i.e. remote site/primary care setting; education) were considered for inclusion.

Figure 3: Sequential explanatory visual model



* **VAS**-Visual analogue scale

4.3 STUDY II

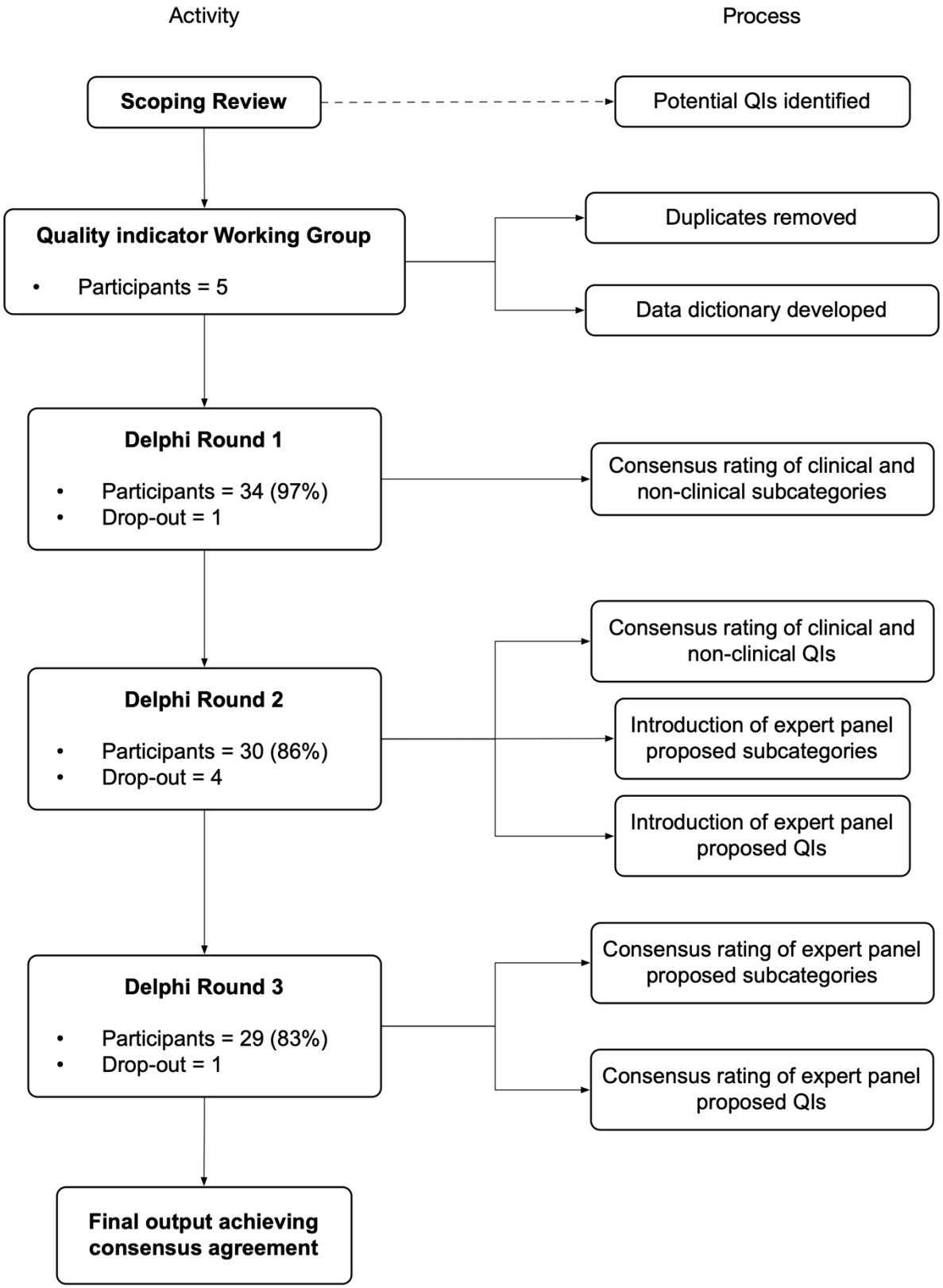
4.3.1 Design & analysis

A three-round modified online Delphi study was conducted to identify, refine and review a list of QIs for potential use in the SA PEC setting[101,102] (Figure 4). This included both the consensus agreement on the appropriateness of QIs identified in the literature, and the development of QIs amongst an expert panel. For each round, participants were required to rate their level of agreement for the respective QI subcategories and QIs based on a 5-point Likert scale, ranging from strongly disagree (1) to strongly agree (5). To achieve consensus agreement, at least 70% of participants had to rate a QI subcategory or individual QI in the "agreement" range of scores (4 or 5). QI subcategories and individual QIs that achieved consensus agreement were not reiterated in subsequent rounds. QI subcategories and individual QIs that did not reach consensus agreement, and participant proposed QIs were refined based on feedback and suggestions, and included in subsequent rounds for consensus rating.

4.3.2 Setting & population

Purposeful sampling was used to ensure appropriate experts were invited to participate due to the focus on both SA PEC and LMICs[101–103]. The range of potential participants invited included emergency medicine physicians, emergency care nurses, and PEC practitioners with a wide variety of primary occupations, including operations and clinical care, education and training, management, and quality assurance. In total, 45 participants were contacted regarding potential participation in the study. Of this group, 35 participants agreed to participate prior to the start of Round 1.

Figure 4: Delphi round progression



4.4 STUDY III

4.4.1 Design & analysis

For the purposes of this study, a QI appraisal protocol was developed consisting of two categorical-based appraisal methods, combined with the qualitative analysis of the consensus application of each method, by a QI Appraisal Working Group (Figure 5). For Round 1, the Qualify QI appraisal tool was selected given its focus on feasibility and consists of four-level Likert scale questions to assess 18 criteria amongst three categories: Relevance; Scientific Soundness and Feasibility[104,105]. For Round 3, the Rand Appropriateness Method was included due to its practical focus, as it combines the best available scientific evidence with the collective judgement of experts to yield a consensus regarding the appropriateness of medical care at the level of patient-specific symptoms, medical history, and test results[87,106,107]. The Rand method rated the indicators by testing the definitions, data components and criteria for use developed for each QI against several clinical vignettes. Four categories (Clarity, Necessity, Acceptability and Technical Feasibility) were rated using a 9-point visual analogue scale, and data extraction assessed using a mock-up of a generic patient report form for the vignettes[79,108]. Both methods consisted of an evidence evaluation component as part of the appraisal process. To achieve this, the QIs were assessed for inclusion within local clinical practice guidelines (CPGs), and against the results of a literature review of the evidence base utilised for the development of PEC focused QIs, in Round 2.

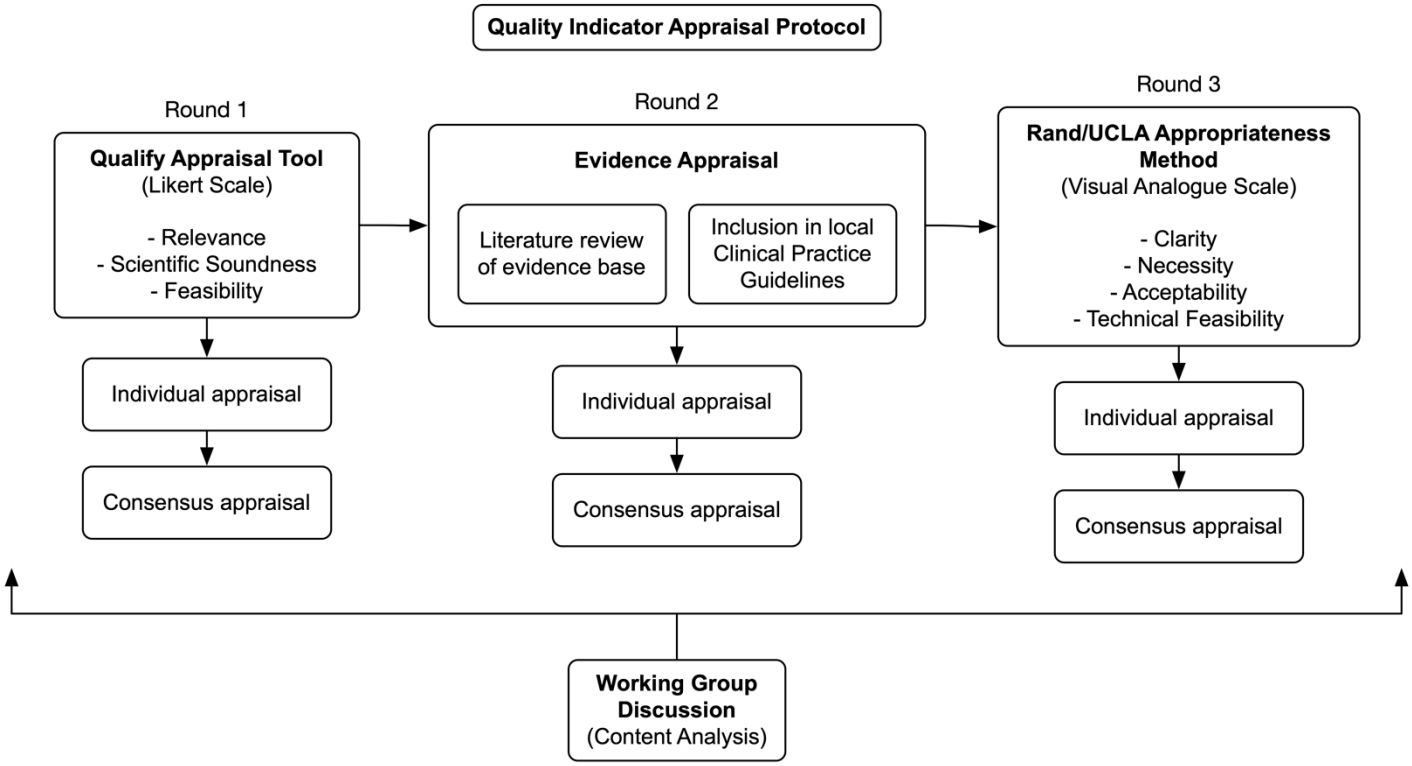
Descriptive statistics were utilised to describe and summarize the categorical based appraisal data. Inter-rater reliability (IRR) for each criterion of both the Qualify tool and Rand method were calculated using percentage agreement and Gwet's AC1 as a measure of IRR[109]. A final composite score was calculated for each QI, for each method to be considered a valid indicator. Correlation between the final composite scores was calculated using Spearman's rank correlation. The consensus derived proportion of non-valid QIs were calculated and assessed against each other using the z-test. 95% confidence intervals were calculated where necessary and a p-value of 0.05 used as a cut-off for strength of evidence. All data were entered and analysed using a combination of Microsoft Excel 2010 (Microsoft Corp., Richmond, WA, USA) and Stata version 16 (StataCorp. College Station, TX: StataCorp LLC).

Conventional content analysis, as described by Hsieh and Shannon, was utilised to analyse the group discussions generated during the three rounds[99,100]. First-level coding was conducted through the extraction of meaning units from each transcript and summarised into codes using open-coding from each interview. Once completed, similar codes were combined and organised to develop clustered sub-categories pertaining to each appraisal tool. Transcripts were analysed using MAXQDA software for data storage; extraction of meaning units and sub-category development (MAXQDA, 2016; Sozialforschung GmbH, Berlin, Germany).

4.4.2 Setting & population

The QI Appraisal Working Group consisted of nine experts chosen for their intricate knowledge of the SA PEC setting and to align with minimum panel size recommendations for each methodology[110,111]. All the participants were SA trained and post-graduate educated Emergency Care Practitioners (ECPs) with > 10 years operational experience each. Six of the participants' primary experience and occupations were in quality governance and improvement within PEC, and the remaining three were primarily involved in clinical operations. The Working Group was given one month between each round with which to work through the information and data collection required for each subsequent round.

Figure 5: Quality indicator appraisal protocol



4.5 STUDY IV

4.5.1 Design & analysis

A multiple exploratory case study design was selected as the most appropriate methodology to achieve the study aim[112,113] (Figure 6). The quality systems of four provincial government EMS and one national private EMS were utilised for the purposes of this study.

Primary data collection

The Institute for Healthcare Improvement's (IHI) Quality Program Assessment Tool was employed as the primary means of data collection (Appendix 2). The tool was used as both a formative assessment for each participating service's quality program, as well as a semi-structured interview guide to further explore the results obtained from the formative assessment. All interviews were conducted in English and recorded for transcription and analysis.

Secondary data collection

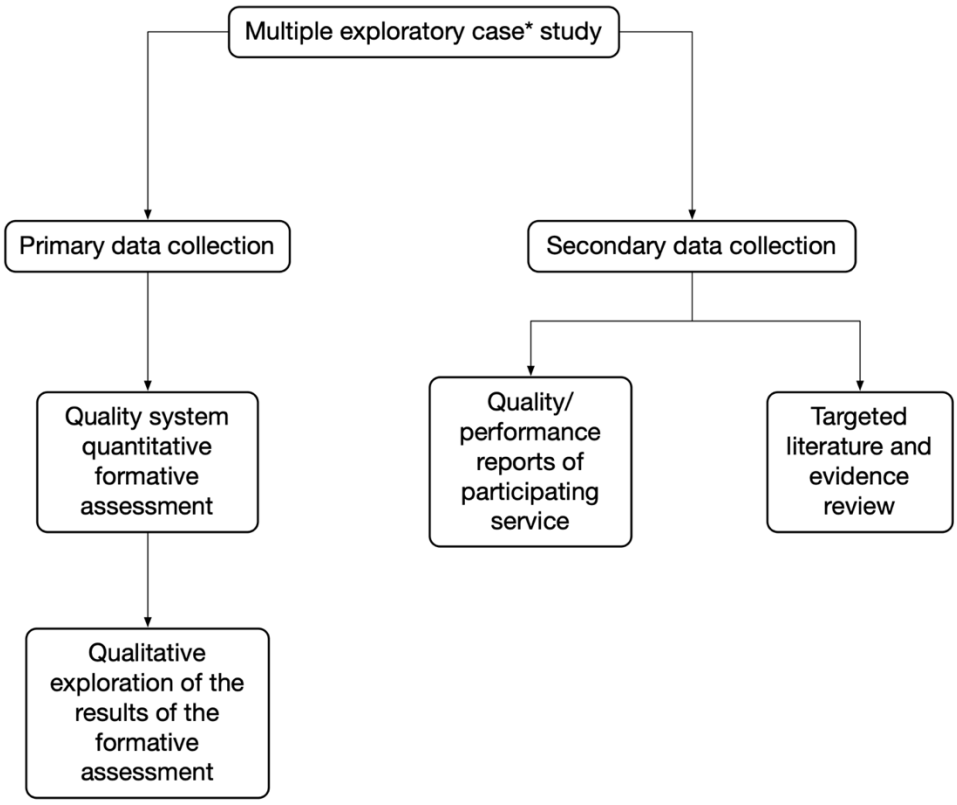
Multiple sources of secondary data were collected to support the primary data, grouped into two categories. Category A secondary data were made up of the results of a targeted literature review to identify policy-focused guidance for EMS organisations in SA regarding the implementation of a quality program; and/or the development, implementation and utilization of methods to assess quality of care. Category B secondary data were made up of publicly accessible quality and/or performance reports published by the participating services.

For the primary data collection, descriptive statistics were utilised to describe and summarize the categorical-based formative assessment. Conventional content analysis, as described by Hsieh and Shannon, was utilised to analyse the interview data[99,100]. For the secondary data collection, document analysis as described by Bowen was utilised to sort and analyse the supporting data[114]. Supporting excerpts, quotations, or passages that made reference to EMS in general or by case example were extracted and synthesized.

4.5 .2 Setting & population

Given the variations in geography and population distribution across SA, the four provincial prehospital emergency medical services of KwaZulu Natal (KZN), Western Cape (WC), Limpopo (LP) and North West (NW) provinces were purposively selected to be as inclusive of this variation as possible (Figure 7). Outcomes from Study I provided evidence to suggest that private EMS in SA are more advanced regarding the utilisation of quality assessment tools and frameworks. As a result, a national private EMS organisation was additionally included as part of the multiple case review.

Figure 6: **Study IV data sources and collection**



*Case definition: Quality program or system of performance measurement of a participating service

Figure 7: Provincial map of South Africa

5 ETHICAL CONSIDERATIONS

The research project conforms with the principles of the Declaration of Helsinki and abides by all the laws and regulations of the Department of Health of South Africa. The research project was approved by the Stellenbosch University Human Research Ethics Committee (HREC), reference no.: S15/09/193.

5.1 PERMISSION AND CONFIDENTIALITY

For Studies I to IV, where applicable, individual approval and written informed consent to participate was sought prior to the start of data collection. Furthermore, for Studies I and II, additional organizational permission was sought from the participating private EMS organisations. Lastly, for Study IV, approval from the participating provincial departments of health and the private EMS organisation was sought prior to data collection. Anonymity was maintained throughout the data collection process and identifying data was removed and not reported on. Further confidentiality was ensured by limiting data access to the research team.

5.2 RISKS

No direct risks were anticipated for enrolled organisations or participants. Furthermore, no participants who were considered vulnerable, or with reduced capacity were included for data collection. Discussion of the assessment of healthcare quality and performance could be considered a sensitive topic, especially when conducted with practitioners on whom such a system would be applied. It requires the acknowledgement that as healthcare workers, we are not infallible, and the potential exists for errors and adverse events to occur that may affect patients. Furthermore, discussion of and the objective assessment of organisational quality systems amongst both senior level managers and frontline workers may too be considered sensitive and potentially distressing content. To allay fears, prior to participation, potential participants were provided with detailed information regarding background to the study, the study process, expectations of the potential participant, confidentiality, ethics and contact information for the researcher and supervisors. In addition, participants were provided the opportunity to further explain and elaborate on their responses, allowing them to address any potential feelings of distress or anxiety in the content of the data collection tools and process.

6 RESULTS

6.1 STUDY I

Part 1: Knowledge, Attitude and Practices baseline cross-sectional survey

The majority of participants (73.4%) were aware that their clinical documentation underwent some form of review for quality of care, however, less than half of respondents (48.5%) were aware that these activities were performed by a dedicated quality department, or what criteria were used to assess their quality (50.9%). There was nonetheless agreement among participants regarding the desire to know: who was responsible for the review of their quality (91.1%); what criteria were used (92.9%); how quality of care was assessed (92.3%); and that these should both be made available to them (91.7%).

With regards to incentivising the results of a quality review or audit there was variation among participants, with 43.2% in disagreement and 47.9% in agreement. There was similar variation as to whether respondents felt such an incentive scheme would have a positive result on their performance. In contrast, when questioned as to whether they felt the review of a practitioner's quality should be linked to a punitive system, the majority disagreed (56.8%).

In terms of feedback and information sharing, the results of a quality review were made available to participants via a multitude of methods, with email (23.1%) and dedicated presentation days (21.3%) the most common and equally preferred (65.1% and 57.4%, respectively). Nineteen percent of participants indicated that such information was not made available to them. Approximately half (52.5%) of respondents indicated the desire to have at least monthly reporting regarding quality assessment.

Part 2: Semi-structured interviews

Overall, seven categories emerged exploring the participants' understanding of quality assessment within SA EMS and included the following (Table 3) (see Appendix 3 for supporting interview quotes):

- *General understanding of quality assessment*

A general understanding among participants was demonstrated on several levels and extended beyond just a practical focus. From a conceptual point of view, participants understood that quality assessment is a fundamental, albeit complex component of healthcare, not only within SA, but within the broader LMICs.

- *The role of context in quality assessment*

The importance of context continuously emerged as a central component, where there was widespread consensus that quality systems should be specifically designed for or tailored to setting and purpose. In terms of SA EMS, there was significant commentary regarding the variation in current systems between government and private-funded EMS, rural and urban areas and between provinces. Private services were perceived to be more advanced

regarding the utilisation of quality assessment tools and frameworks. However, there was agreement that this was largely based on a financial motivation and to a lesser extent, perceived legal ramifications if not adequately performed.

- *Factors affecting implementation*

Communication as a function of implementation was found to be essential towards achieving buy-in among staff, especially considering the desire for participants to understand the assessment process, and the importance this understanding was felt to bring in terms of participation. The historical connotations and stigma of current systems that were poorly designed and implemented emerged as a factor affecting future systems, and further emphasised the important role effective, early communication has to play.

- *Factors affecting ongoing utilisation*

Ongoing and open sharing of information, and the general inclusion of frontline staff was perceived to be a central driver towards promoting a culture aimed at prioritising quality within an organisation. Similarly, the role of management and leadership were seen as essential towards ensuring this. There was consensus among the participants that the lack of leadership input or involvement largely contributed to the poor culture, motivation and prioritisation regarding quality currently seen in the systems that exist in SA.

- *System validity and reliability*

The demonstration of an objective, transparent quality system that was consistently applied was not only key to ensuring success but was noted to be all too absent regarding systems currently employed in EMS in SA.

- *Advantages of an effective, efficient system*

Effective quality assessment was understood to be a facilitator of a multitude of factors, including training; identifying knowledge gaps; accountability and responsibility; patient safety and overall improvement.

- *Disadvantages of an inappropriate, ineffective system*

There was a general understanding of the disadvantages of an inappropriately designed or utilised quality system. It was highlighted that such systems may potentially be open to corruption, or at a more individual level, demotivate and demoralise staff, and lead to behavioural changes as a result.

Table 3: Qualitative exploration of the Knowledge, Attitude and Practices (KAP) of clinical quality and performance assessment amongst South African trained ALS EMS personnel	
Sub-category	**Category**
An essential component of healthcare (K)	General understanding of quality assessment
Used as a monitoring tool (K, P)	
Should be measured against a standard (K, P)	
Relevant to the Low Resource/Low to Middle Income Country setting (A)	
High quality care should always be expected from staff (A)	
Quality system should be tailored to local setting/take local circumstances into account (K, A)	The role of context in quality assessment
Quality system should take into account private vs. government service organisational variation (K, A)	
Quality system should take into account provincial & rural vs. urban geographical variation (K, A, P)	
Communication an essential component of implementation (A,P)	Factors affecting implementation of quality assessment systems
Historical perceptions of quality systems a barrier to implementation barrier? (A, P)	
Effective leadership has central role to play in quality system (A,P)	Factors affecting on-going utilization of quality assessment systems
Maintain open sharing of information and ideas with staff to ensure success (A, P)	
Awareness & understanding amongst staff key to buy in (A, P)	
Quality assessment should be priority within any organisation (A)	
Quality system important to public perceptions/expectations (A)	
Culture that supports staff is essential (A)	
Results of quality system should be used appropriately (A)	
Quality system should be objective & transparent (A)	Quality assessment system reliability and validity
Quality system should be consistent in its utilization & reporting (A)	
Quality system should encourage peer support (A, P)	
Effective quality system ensures patient safety (A)	Advantages of an effective, efficient quality assessment system
Effective quality system identifies knowledge gaps (A)	
Effective quality system ensures implementation of best care/evidence-based care (A)	
Effective quality system facilitates improvement in delivery & quality of clinical care (A)	
Effective quality system optimises use of available resources (A)	
Effective quality system facilitates staff & organisational responsibility & accountability (K, A)	
Inappropriate quality system open to corruption (A, P)	Disadvantages of an inappropriate, ineffective quality assessment system
Punitive based quality system leads to behavioural change in staff (A, P)	
Punitive based quality system demotivates & demoralises staff (A)	

6.2 STUDY II

The outcomes of the scoping review returned 346 QIs for potential use in the PEC setting. In addition, the review led to the development of 19 definable elements required by each QI to allow for appraisal and/or implementation (Table 4). Following the removal of duplicate and/or similarly focused indicators, a working group developed a data dictionary using these definable criteria for 202 unique QIs for evaluation by the expert panel.

Of the 202 original QIs, 104 individual QIs reached consensus agreement by the end of the Delphi study, 90 clinical QIs across 15 subcategories and 14 nonclinical QIs across two subcategories (Appendix 4). The QIs reaching consensus were broadly applicable across all three tiers of Basic, Intermediate and Advanced Life Support levels of qualification, allowing applicability across multiple settings and service types in SA. In terms of Donabedian's classification of healthcare information and data, within the final list of individual QIs, there were a total of ten (10%) structure-based QIs, 83 (80%) process-based QIs, two (2%) outcome-based QIs, and a further nine (8%) QIs categorised as adverse events, given their specific focus on patient safety.

Table 4: Data dictionary Quality Indicator (QI) components	
Abbreviated Name	Abbreviated QI name
Definition	Basic description/purpose of the QI
Domain	Primary area of focus of the QI
Subdomain	Secondary area, within the Domain that the QI is focused
Clinical Pathway/Service Pathway	Identifies the Domain and Subdomain within which the QI is positioned
Measure Type	Structure, process or outcome
Target Population	Domain level population on whom the quality indicator is measured/applied
Unit of Analysis	Emergency medical service component under study/assessment for quality and performance
Numerator Statement	Description of the subset of the subdomain population on whom the quality indicator is measured/applied
Denominator Statement	Description of the subdomain level of population on whom the quality indicator is measured/applied
Case Mix/Risk Adjustment	Suggested differentiation amongst the denominator population for greater accuracy (i.e.: stratification)
Exclusion Criteria	Denominator cases to be excluded when applying the QI
Measure Calculation	The equation for calculating the QI
Numerical Reporting Format	Suggested format in which the numerical results should be reported
Graphical Reporting Format	Suggested format in which the results should be displayed/visualised
Reported Indicator	Suggested output in which results should be described
Data Source	Suggested data source to obtain the data required for calculating the QI
Suggested Reporting Period	Time frame, number of successive cases or other grouping strategies cases should be aggregated for reporting purposes
Recommended Review Period	Suggested time period at which the QI should be reviewed for validity and feasibility

6.3 STUDY III

Round 1 - QI appraisal tool

There was mixed IRR of the criteria found prior to the group consensus (Table 5). *Validity* and *Understandability & Interpretability for medical personnel* scored perfect agreement by the Working group, while *Data Collection Effort* (% agreement=22%, IRR=0.01) and *Understandability & Interpretability for patients and interested public* (% agreement=28%, IRR=0.09) and scored the lowest. Of the 104 QIs assessed, eight (7.7%) scored less than the validity threshold on the final composite score (≥3). All eight scored relatively high for *Relevance* and *Scientific Soundness* yet scored poorly for *Feasibility*. A further 15 QIs scored on the validity threshold.

Round 2 – Literature and evidence review

The evidence review found an evidence base for 11 of the 15 Clinical subcategories and the two Non-clinical subcategories, plus an additional four subcategories not included in the QI appraisal, covering 311 indicators. In excess of half (59%) were developed through a consensus/expert opinion-based approach, with fewer developed via more robust and higher quality levels of evidence such as systematic reviews and/or cohort and case control-based studies (10% each). There was however considerable representation of the QIs amongst the SA national EMS CPGs. Seventy-nine QIs (76%) were accounted for in the CPGs, of which 76 (73%) had evidence directly supporting their use (see Appendix 5 for breakdown of evidence review).

Round 3 – Rand Method

As with the appraisal tool, there was mixed IRR in the individual rating prior to the consensus rating, with *Acceptability* scoring the highest (% agreement=90%, IRR = 0.9) and *Technical Feasibility* the lowest (% agreement=47%, IRR=0.32). Eleven QIs (10.6%) scored below the validity threshold and a further eight QIs scored on the validity threshold (7.0-7.1). In total, from a series of 104 QIs, eight were identified as non-valid and three identified for which caution was recommended prior to full implementation, that were shared between the appraisal methods. A further 19 QIs were identified as non-valid and not shared by each method.

Comparison of Categorical Appraisal Methods

When final consensus validity scores were compared, there was poor to moderate correlation of the results between the Qualify tool and Rand method (Spearman's rank correlation=0.42, $p<0.001$). Ninety-two of the 104 QIs (88%) (78 clinical and 14 non-clinical) were appraised to be valid and feasible for the SA PEC setting. Of this group, an additional 21 QIs (13 clinical and eight non-clinical) were assessed to be on the threshold of validity, in which caution is recommended prior to full implementation. There was little evidence to support a statistical difference in the proportion of non-valid QIs identified between the Qualify tool and the Rand method [difference=-0.03; (95%CI -0.12:0.05, p=0.47)]; between

the Qualify tool and the protocol [difference=-0.05; (95%CI -0.13:0.03, p=0.25)]; or between the Rand method and the protocol [difference=-0.02; (95%CI -0.11:0.07, p=0.66)]. There was likewise little evidence to support a statistical difference in the proportion of QIs in which caution is recommended, identified between the Qualify tool and the Rand method [difference=0.07; (95%CI -0.02:0.15, p=0.12)]; or between the Qualify tool and the protocol [difference=-0.06; (95%CI -0.16:0.04, p=0.27)]. There was, however, strong evidence to support a statistical difference between the proportion of QIs in which caution is recommended, identified between the Rand method and the protocol [difference= -0.13; (95% CI -0.22:-0.03, p=0.009)].

Group Discussion Content Analysis

Several observations highlighted during the group discussions were found to be important considerations regarding the appraisal protocol and its ability to assess the appropriateness of the QIs. For the Qualify tool, *Relevance* and *Scientific Soundness* were perceived to be characteristics inherent to the QIs (and supporting data components) themselves, and as a result were generally appraised to be highly applicable across all QIs and criteria (Table 6). In contrast, *Feasibility* was judged to be more of a gauge of the system in which the QIs would be implemented and as such, scores were found to be on average lower amongst these criteria. Somewhat related to this, was the broader issue of context and the importance of selecting those indicators that best suited the local setting, prior to full implementation. Despite the focus on the appraisal of the QIs, on several occasions the discussion steered towards the need for EMS organisations in SA to improve their quality systems in general, if such measures are to be implemented. For the Rand method, the importance of having completed the practical data extraction using the case vignettes made a difference in the QI rating.

Table 5: Inter-rater reliability analysis of individual appraisal by the Quality Indicator Appraisal Working Group							
Methodology		% agreement [p value (95% Confidence interval)]			Kappa [p value (95% Confidence interval)]		
Quality Indicator Appraisal Tool							
Relevance							
R1	Significance	90%	[<0.001	(0.8675 – 0.9350)]	0.9	[<0.001	(0.8587 – 0.9334)]
R2	Benefit	83%	[<0.001	(0.7934 – 0.8746)]	0.82	[<0.001	(0.7704 – 0.8669)]
R3	Potential risks/side effects	41%	[<0.001	(0.3887 – 0.4395)]	0.25	[<0.001	(0.2065 – 0.2840)]
Scientific Soundness							
S1	Unambiguity of definitions	81%	[<0.001	(0.7818 – 0.8465)]	0.8	[<0.001	(0.7664 – 0.8390)]
S2	Reliability	49%	[<0.001	(0.4614 – 0.5181)]	0.3	[<0.001	(0.2647 – 0.3434)]
S3	Risk adjustment	71%	[<0.001	(0.6789 – 0.7340)]	0.66	[<0.001	(0.6248 – 0.6975)]
S4	Sensitivity	80%	[<0.001	(0.7695 – 0.8395)]	0.78	[<0.001	(0.7426 – 0.8269)]
S5	Specificity	88%	[<0.001	(0.8502 – 0.9126)]	0.87	[<0.001	(0.8395 – 0.9093)]
S6	Validity	100%		1	1		1
Feasibility							
F1	Understandability and interpretability for patients and interested public	28%	[<0.001	(0.2670 – 0.2959)]	0.09	[<0.001	(0.0646 – 0.1076)]
F2	Understandability and interpretability for medical and nursing personnel	100%		1	1		1
F3	Possibility to influence the indicator manifestation	45%	[<0.001	(0.4286 – 0.4714)]	0.35	[<0.001	(0.3233 – 0.3835)]
F4	Availability of data	65%	[<0.001	(0.6434 – 0.6630)]	0.48	[<0.001	(0.4487 – 0.5134)]
F5	Data collection effort	22%	[<0.001	(0.2104 – 0.2345)]	0.01	[<0.001	(-0.0133 – 0.0235)]
F6	Implementation barriers	49%	[<0.001	(0.4803 – 0.5069)]	0.11	[<0.001	(0.0775 – 0.1503)]
F7	Accuracy	49%	[<0.001	(0.4803 – 0.5069)]	0.11	[<0.001	(0.0775 – 0.1503)]
F8	Data integrity	49%	[<0.001	(0.4765 – 0.5030)]	0.35	[<0.001	(0.3283 – 0.3695)]
F9	Completeness of the data	49%	[<0.001	(0.4765 – 0.5030)]	0.35	[<0.001	(0.3283 – 0.3695)]
RAND method							
Clarity		85%	[<0.001	(0.8079 – 0.8854)]	0.83	[<0.001	(0.7865 – 0.8786)]
Necessity		48%	[<0.001	(0.4663 – 0.5033)]	0.39	[<0.001	(0.3663 – 0.4196)]
Acceptability		90%	[<0.001	(0.8682 – 0.9363)]	0.9	[<0.001	(0.8585 – 0.9347)]
Technical Feasibility		47%	[<0.001	(0.4401 – 0.4958)]	0.32	[<0.001	(0.2735 – 0.3568)]

Table 6: Qualitative analysis of the Working Group discussion		
Appraisal Tool	**Sub-category**	**Supporting Quote**
Qualify appraisal tool	Relevance	"For me, because practically zero clinical indicators are used or reported publicly by EMS [Emergency Medical Services] in South Africa, their relevance wand significance and benefit was naturally going to be scored high"
	Usability	"Whenever I was rating a category that I used or drew information from the data dictionary, there was always sufficient information that left no doubt that it was well planned for or accounted for. The difficult part was knowing how much variation there would be in different EMS organizations in South Africa in how they would be able to extract this information and put it to use"
	Context	"Whatever indicators are used by a service, it's important that they do a feasibility assessment of what's possible for them to achieve. We may be able to say overall, like these will work for South Africa in general, but when it comes to actual implementation, a service is going to have to understand its surroundings and the types of patients it sees"
		"Like, the indicators involving direct transport to a CT [Computed Tomography] scanner for Stroke patients, or to PCI [Percutaneous Coronary Intervention] facilities for STEMI [ST Elevation Myocardial Infarction], those will only be applicable to certain metropolitan areas, and probably only for certain private services as well. It won't be a general indicator for everyone to use"
	Quality system	"This is a complete mind shift from what we currently know and how we measure quality in South Africa. If a service is serious about implementing these, even it's just a few, they're going to have to admit that it's going to take an overhaul in their quality system, and that it's likely going to need more resources than what they dedicate to measuring response times at the moment"
		"Outside of a few of the large private services, the provincial services are going to have to ramp up the effort around measuring quality. As simple and as easy a system that these indicators are, there's probably not many of the provincial services that are ready to implement them"
RAND method	Methodology	"You really get to see how these will be used from a practical point of view. I can see the benefit of how a simple system that's objective can make the world of difference. It's not like how I used to remember it when we checked the case sheets, and it depended on how you felt at the time"
		"Doing the data extraction made a big difference, because I remember, especially for the sentinel event indicators, I scored them quite low with the appraisal tool, but when we went through them and applied them to actual cases, it was much simpler than I thought it would be and so I scored them higher after being able to actual do the extraction"
	Technology	"I think applying these indicators would be way easier with an electronic patient report form. It's going to take way more effort in doing it manually, but I can still see the benefits even if it's done this way"
	Quality system	"I think when you're sitting down and applying the indicators to case sheets, the system does seem simple and straightforward enough to use. But what do you do from there? It's going to be a logistical challenge to get the paperwork together to do the assessment, but I feel like the bigger challenge is using the information we learn, it's just as important as getting the information"
	Transparency	"It seems like it's going to be easy to game the system. Like how I know the guys have done the things that they've written down. What sort of mechanism is there for to check that they've been truthful in their notes, especially if they now know they're being watched"
	Technology	"I think [participant] was right about the electronic record, because we can build checks and balances into that sort of thing to monitor truthfulness I suppose, also like [respondent] mentioned. That also solves the legibility issue and whether or not enough information has been written. Look at when we used the poor documentation examples, it was difficult to apply the indicators to those just because you didn't always have the right information to go on"

6.4 STUDY IV

Participating services generally scored higher for *Structure* and *Planning* (Table 7), whereas *Measurement* and *Improvement*, were found to be more dependent on the services' utilisation and perceived mandate. There was a relatively strong focus on clinical quality assessment and improvement within the private service, whereas in the provincial systems, QIs reported were exclusively restricted to call times and available vehicle resources, with little to no focus on clinical care (see Appendix 6 for supporting interview quotes).

Western Cape

The provincial service's higher points in the formative assessment were largely within *Structure* and *Planning*, where a hybrid centralised/decentralised system at the district level employed EMS staff primarily dedicated to quality assessment and monitoring. Despite this strength, it was acknowledged that a lack of higher-level leadership had had a negative impact on the program. Similarly, while a comprehensive quality plan existed, it was acknowledged to be outdated and inconsistently reviewed and/or updated. Of interest to note was the services' approach towards *Measurement* and *Improvement*, and the understanding of its mandate, where it operated as a logistics and transport service more than a medical service. As a result, it was felt that reporting on time-based measures of performance was wholly appropriate. Much of the focus on improvement activities were therefore centred around transport and improving inter-facility transport booking and operations in particular. The service acknowledged that improvements could be made in terms of staff engagement, however they felt their public engagement had improved significantly in recent years.

KwaZulu Natal

The service scored low for *Structure* in the formative assessment, compared to the other services. The decentralised approach towards measurement and evaluation made coordination difficult, a situation further exacerbated by the perceived rudimentary means with which data was captured and shared. While the service acknowledged the lack of described roles, responsibilities and accountabilities within its quality plan, the content of the plan was otherwise described as comprehensive and underwent regular evaluation and updating. The service scored highest in *Measurement*, where a strong focus was placed on continuous monitoring for trend analysis. The service scored low for staff and public engagement where it was acknowledged that while some effort was made towards this, there was still much to be improved upon.

Limpopo

The Limpopo EMS quality system scored relatively highly within the *Structure* and *Planning* categories of the formative assessment. There was a strong focus on strategic planning, where their quality system and planning were firmly entrenched into the broader provincial health structures. The importance of this relationship with the provincial health system was

emphasised as a driver for potential improvements in service quality monitoring. It was acknowledged that much could be done to improve *Quality Measurement* and *Improvement* within the service, which focused primarily on response time targets and complaints for measuring and reporting of quality and performance. The notion of relationships however was echoed in these sections, where feedback from the facilities the service interacted with were too seen as an important measure of performance. Despite the low scores for *Staff engagement and Evaluation*, these factors were acknowledged as important drivers of general service success and had been earmarked for attention in the services current strategic plan for future improvement. Similarly, technology was also earmarked as a driver of success, both for staff engagement, and community accountability as well.

North West

The NW scored low across all questions and categories in the formative assessment as the provincial government, had been placed under administration. From a managerial perspective, the extreme decentralization in which the service was structured made coordination and oversight complicated, and significantly hindered process and/or plan implementation. Coupled with this, the service found it difficult to retain high-level clinical staff, further hampering the ability to implement and sustain a clinically focused quality program. From an operations point of view, based on a recent audit, it was recognised that the province's non-personnel resources were inappropriately matched towards the needs of their daily activity. The QIs that were reported by the service were limited to time-based measures, and vehicle and staff counts. Furthermore, the service lacked their own standalone committees regarding complaints and patient safety, which were instead incorporated into broader general provincial health service committees and structures.

Private EMS

There was a strong clinical focus within the quality system of the service, with representation up to the Executive level, where much of the strategic planning was conducted within a centralised office. Despite this structural strength, the service acknowledged that there was room for improvement with regards to program *Planning* and *Evaluation* towards its quality plan. While a quality management plan existed, it was acknowledged to be outdated, and not regularly reviewed. Likewise, while several clinically focused indicators were consistently reported and discussed at a high-level, the system was acknowledged to be outdated and rudimentary, largely manually captured, and difficult to change as it was not fit for purpose. This was perceived to have had an impact on both general quality monitoring and monitoring for sustained improvement. There was, however, a relatively strong focus on quality improvement activities within the service where a robust and comprehensive process was consistently followed whenever a project was carried out. Of all the categories, *Staff and Patient engagement* were perceived to be the weakest, and an area for improvement within the service. The strengths the service enjoyed in this area were largely as a result of the services private hospital group parent company.

Table 7: Quality Program Formative Assessment						
No.	**Quality Program Assessment Tool Question**	**WC**	**KZN**	**NW**	**LP**	**Private**
Quality Structure						
A.1	Does the organization have an organizational structure in place to plan, assess and improve the quality of care?	2	1	1	3	5
A.2	Have adequate resources been committed to fully support the quality program?	4	2	0	2	4
A.3	Do the leadership support the quality program?	3	1	1	3	5
Subtotal (max = 15)		9	4	2	8	14
Quality Planning						
B.1	Does the organization have a comprehensive quality improvement/management plan?	2	3	1	3	2
B.2	Does the organization have clearly described roles and responsibilities for the quality program?	4	1	0	1	4
B.3	Does the work plan specify timelines and accountabilities for the implementation of the quality program?	4	1	0	3	3
Subtotal (max = 15)		10	5	1	7	9
Quality Measurement						
C.1	Are appropriate outcome and process quality indicators selected in the quality program?	1	3	1	1	2
C.2	Does the organization regularly measure the quality of care?	1	3	0	1	3
C.3	Are processes established to evaluate, assess and follow up on quality data?	3	3	0	2	3
Subtotal (max = 15)		5	9	1	4	8
Quality Improvement Activities						
D.1	Does the organization conduct specific quality activities and projects to improve the quality of care?	3	1	1	2	3
D.2	Are quality improvement teams formed for specific projects?	3	1	0	2	4
D.3	Are systems in place to sustain quality improvements?	3	3	0	2	2
Subtotal (max = 15)		9	5	1	6	9
Staff Involvement						
E.1	Are staff routinely educated about the program's quality program?	2	1	0	2	1
E.2	Does the organization routinely engage all levels of staff in quality program activities?	2	3	0	2	2
E.3	Are patients involved in quality-related activities?	3	0	0	2	3
Subtotal (max = 15)		7	4	0	6	6
Evaluation of Quality Program						
F.1	Is a process in place to evaluate the quality program?	3	3	0	2	1
F.2	Does the quality program integrate findings into future planning?	3	3	0	2	3
F.3	Does the program have an information/data system in place to track patient care and measure quality indicators?	2	3	0	1	3
Subtotal (max = 15)		8	9	0	5	7
Total (max = 90)		48	36	5	36	53

0 – No plan/structure/process
1 – Limited plan/structures/process in place
2 – Early implementation
3 – Full implementation
4 – Developing systematic approach to quality
5 – Full systematic approach to quality

WC – Western Cape**; KZN** – KwaZulu Natal**; NW** – North West**; LP** – Limpopo

7 DISCUSSION

Measuring the quality and performance of any healthcare service in any context, extends beyond the individual measures and indicators used in its assessment. While the framework of a quality system will always be primarily rooted in its system of measurement, there is a multitude of factors that affect the implementation and utilisation of the system of measurement. Beyond the contextual appropriateness and relevance of the indicators themselves, the manner in which they are implemented, and their output is acted upon, are equally important. As a consequence, the individuals whose quality and performance will be assessed, and the service in which such a process will be implemented have a significant role to play towards the success or failure of the quality system as a whole.

In developing our framework, we acknowledged the role and contribution of practitioner and system perspectives towards its success and included their assessment as part of our framework. This allowed us to both highlight the influence these components exert on developing a quality system, as well as gain a deeper understanding of this influence to identify the primary barriers and facilitators of success at play within each component.

7.1 PRACTITIONER PERSPECTIVE

The importance of system structure, and its understanding amongst practitioners has been previously highlighted as a factor supporting the implementation of quality systems in healthcare[115]. In Study I however there was poor knowledge of organisational-specific systems demonstrated among participants surveyed. Despite this lack of knowledge, there was a desire to improve this understanding, a notion supported during the interviews when participants demonstrated an understanding of the core attributes and characteristics of quality assessment in general.

Organisational culture, and the importance of effective and engaged leadership have too been identified as important strategic determinants for success toward efficient quality management[115,116]. In Study I, there was significant commentary that emerged through interview participants' recognition of the historical connotations and stigma surrounding previous failed or ineffective quality systems, and the barrier they represented. This association was often discussed in conjunction with the general perception that these systems were often punitive in nature, with too much focus on assigning individual blame. The notion of a 'blame-culture' has previously been identified as a factor that discourages the reporting of adverse events and near misses both in healthcare in general and EMS specifically[116,117]. Linked to this, was the importance of leadership towards developing the organisational mindset and correcting the negative stigmas. To facilitate this, communication in particular emerged as a recurring feature among several of the categories identified throughout the interviews in Study I.

From a more pragmatic focus, many of the components necessary to ensure success, reported in the literature were also identified in Study 1. Factors surrounding transparency, consistency and reproducibility were initially highlighted in the survey. Validity and reliability similarly emerged during the interviews; all points previously identified as fundamental in EMS performance measurement[81]. The emphasis on context was attributed to not only the disparities seen in private versus government-funded services, but in geographical variation as well. The need to have locally relevant and appropriate measures and standards was perceived to be a facilitator of success not only in SA, but the broader LMICs. The importance of context, both in accounting for local settings when designing systems and measures, and in sustaining their utilisation have becoming increasingly recognised as central to overall success in the LMICs[37,118–120].

7.2 SYSTEM PERSPECTIVE

Much of the organisational associated outcomes from Study I were echoed in Study IV, where it was found that a centralised approach with appropriate and engaged senior/executive level management established responsibility of the system and facilitated greater control over the direction of the system, whereas decentralisation hampered collection and reporting, and as a consequence, accountability. Similarly, the role of leadership re-emerged as a factor present in study IV as both a driver of success when incorporated, and a barrier when inadequate or unaccounted for[121–123].

The lack of a cohesive vision and mission regarding quality, and the role of leadership towards developing and driving these concepts has also been associated with organisations who consistently struggle to improve quality and were similarly lacking or poorly developed within the services assessed in this study[123]. Factors associated with infrastructure, support and capacity have too been identified as key drivers of success of quality systems in healthcare[121–123]. While structure was among the highest scored attributes of the participating services in Study IV, insufficient capacity was often identified as a weak link. The combination of leadership and capacity has been described as primary drivers of a quality culture in healthcare quality systems; another component reported as both an enabler of high-quality systems when present, and a barrier to its success when absent[121–123].

All participating services in Study IV were limited in their measurement of either adverse events, technical quality of care or patient-reported measures, with the primary focus largely centred around time-based measures. This is in contrast to the increasing focus on non-time- based measures of quality evident in the literature[86]. This limitation was widely acknowledged and partially justified around the perceived purpose of EMS and what was understood to be the mandate of these services in SA. Non-time-based measures of safety and quality have previously been used as a strong base with which focused quality improvement programmes have led to meaningful and improved patient outcomes in the

PEC setting. The lack of such measures could in part explain the generally poor results observed regarding quality improvement in Study IV.

There was little to no supporting documentation in the way of national policies and/or guidelines for EMS in either implementing quality systems, measuring quality, or reporting performance found in Study IV. Furthermore, there was a general lack of policy outlining minimum standards for EMS quality systems altogether. This was evident in the variation of the results of the quality programme assessment and further highlights the need for such guidance. To be effective in both implementation and use, it is essential that appropriate high-level guidance and minimum standards regarding quality systems be outlined, as a driver for change[9,124].

7.3 QUALITY INDICATORS FOR MEASURING QUALITY AND PERFORMANCE

Quality assessment promotes accountability to all stakeholders, including both service users and service providers. QIs represent a promising and important component within the assessment process by helping to identify and measure levels of service quality and performance. In and of themselves, QIs cannot improve quality. They effectively act as flags or alerts to identify good practice, provide comparability within and between similar services, identify opportunities for improvement, and provide direction where a more detailed investigation of standards is warranted.

PEC lends itself to assessment by QIs. This was evident in the number, variety and type of QIs reaching consensus agreement in studies III and IV. Given the short amount of time that patients are exposed to these services, outcomes are difficult to measure, making the application of process based QIs ideal for assessing quality and performance. This was evident in the output of Study III, where process-based measures of care made up the majority of QIs reaching consensus agreement. Historically, non-clinical/service-based measures have been the predominant focus for measuring and assessing PEC quality[86]. In contrast however, there was an overwhelming focus on clinical-based QIs reaching consensus in Study III. Furthermore, the majority were focused on patient subsets for which PEC has been shown to have a positive impact, such as cardiac arrest[125,126], acute coronary syndromes[127], airway management/ breathing problems[128–130] and stroke[131].

Despite the findings regarding specific QIs used in Study IV, the outcomes of Study II and III represent a significant shift away from the perceived importance and “appropriateness” of time-based measures. In countries with geographically dispersed populations (i.e., proportionally high rural population) or those with an under-resourced response capability, such as that seen not only SA, but the broader LMIC setting, time-based targets for EMS are often difficult to achieve. Similarly, the majority of the indicators reaching consensus in Study II and III were those that could be readily implemented without the need for complex data and information systems such as electronic patient care records or computer aided

dispatch systems, compared to QIs previously described for more mature, "developed" PEC systems[132].

7.4 TOWARDS APPROPRIATE CONTEXT

The simplicity and practicality of QIs as a system of quality measurement has led to their widespread adoption in healthcare[87,91,133–139]. Importantly, they align with Donabedian's conceptual framework for healthcare evaluation, predicated on the belief that an effective structure gives rise to effective processes of care, which in turn result in improved outcomes[48]. Within the PEC setting, patient exposure times are generally limited, and the delivery of care based largely around processes as opposed to outcomes. The utilisation of QIs as a measure of quality are therefore ideally suited to this environment. Despite these advantages, the implementation of inappropriate or poorly tested QIs - even in well-established quality systems - has been reported to be both time-consuming and costly to correct[87,140]. Consequently, QI appraisal has been identified as an essential step toward understanding the appropriateness of these measures for a particular healthcare field or setting, prior to full implementation. The results of Study III support these notions through the application of QI appraisal protocol against a series of QIs. Further to this, the results support the value in adopting a multi-method approach towards QI appraisal, compared to the single method approach. Our observations found the multi-method approach to be advantageous in that the methods complemented each other's strengths and compensated for each other's weaknesses.

This was additionally evident in the group discussion analysis of Study III, which in and of itself added further input towards understanding and appraising the appropriateness of the QIs that would not have otherwise been captured or understood by the categorical methods alone[141,142]. Despite these advantages, the application of the protocol required a significant investment in time and staff resources. The overall benefits of such an approach are therefore heavily dependent on the availability of these resources. This availability will likely vary significantly, depending on the quality system setting within which the protocol will be applied. As highlighted in Study IV, these "system-focused" factors therefore have the potential to exert as much influence on the validity of the QIs as the setting in which the QIs will be implemented[122,123].

Healthcare quality is an abstract concept. Consequently, there are a multitude of methods, mechanisms and approaches in which it can be measured and assessed, each of which have a number of unique factors that influence their utilisation. For the purposes of this study we focused on the technical competence aspect of quality, in developing our measurement framework. Towards this, we identified a significant number of QIs assessed to be valid and feasible for the SA PEC setting. The majority of which are centred around clinically focused processes of care, measures that are lacking in current performance assessment in EMS in SA. However, we also discovered the importance and influencing role of the individual practitioners and quality system in which the QIs will be implemented, a point highlighted

across all the methodologies and studies. Given the potential magnitude of this influence, it is of the utmost importance that any measurement framework examining technical quality, have equal in-depth understanding of these factors in order to be successful.

8 METHODOLOGICAL CONSIDERATIONS

The research project provided several unique challenges to overcome in order to achieve the overall study aim. First was the lack of scientific literature regarding quality and performance assessment in either the SA or expanded LMIC setting. Therefore, the underlying approach needed to be largely exploratory in nature, with a focus on knowledge generation. Second to this was the difficulty in researching concepts that are largely abstract, or at the very least, highly subjective and contextual.

Consequently, neither a purely quantitative nor qualitative approach was deemed sufficient in order to comprehensively explore the topic. To adequately achieve this, the project relied on the utilisation of a mixed methods approach and the benefits that integrating multiple data types, sources and viewpoints can bring towards overcoming these challenges

8.1 MIXED METHODS RESEARCH

The defining characteristics of mixed methods research are best summed up in the commonly accepted definition proposed by Tashakkori and Creswell: "*Mixed Methods Research is research in which the investigator collects and analyses data, integrates the findings, and draws inferences using both qualitative and quantitative approaches or methods in a single study or program of inquiry*"[143].

Mixed methods research is a paradigm rooted in pragmatism that allows the researcher to tackle a research problem in a more comprehensive manner and from multiple perspectives than if confined within the constraints of any individual methodology[98,143–145]. The qualitative strand allows the researcher to add a narrative and therefore context to numerical data, whereas the quantitative strand offers greater underlying precision to any qualitative narrative[98,143,144]. It essentially allows for and offers researchers the ability to utilise the strengths of one method to counter or overcome the weaknesses of another[98,143,144].

The benefits of the combination of quantitative and qualitative enquiry allow for distinct, specific questions or objectives to be investigated that ultimately contribute toward the same overall end aim or purpose. The defining hallmark of mixed methods research is therefore the integration of the different paradigms and types of evidence, and the central concepts of complementarity and meta-inference – the synthesis and interpretation of qualitative and quantitative data as a single body of evidence, as opposed to independent[98,143–145]. This notion of integration is what separates current views of mixed methods research from older perspectives in which investigators collected both forms of data but kept them separate or casually combined them rather than using systematic integrative procedures[98,143–145]. The end result is that any conclusions drawn from a mixed methods study are in a better position to provide stronger evidence in that conclusion.

Through the convergence and collaboration of findings, we allow for a more complete body of evidence to inform theory and practice.

These benefits were realised in this research project, particularly in Studies I, III and IV. Studies I and IV focused on understanding the role and potential influence of the practitioner and EMS system perspective on quality measurement in PEC. Given these general aims, it was important to gain as comprehensive an understanding as possible. In each study, the quantitative approach allowed for a baseline assessment, that could then be examined on a deeper level using qualitative enquiry. Including multiple data types allowed for every facet and viewpoint to be considered and scrutinised. Furthermore, in Study IV, the secondary data added important contextual understanding and corroboration to the outcomes of the primary data collection and analysis, further strengthening the overall conclusion of that study. In Study III, the benefits of mixed methods research were directly exploited in the development of the appraisal protocol, and serve to highlight the value of multiple data sources. In addition, adding the qualitative component proved to be particularly beneficial with the additional input that would not have otherwise been captured by the individual methods alone.

8.2 ACHIEVING VALIDITY

As with either individual paradigm, questions regarding validity are common with the utilisation of mixed methods research. Towards this, integration serves as not only a methodological process, but a key component of validity in mixed methods research. Integration is primarily achieved through one or a combination of four mechanisms that include[143,146,147]:

- *Connecting*: Occurs when one type of data links with the other through the initial sampling frame e.g.: in study with a survey and qualitative interviews, the interview participants are selected from the population of participants who responded to the survey.
- *Building*: An extension of connecting, integration through building occurs when results from one data collection procedure informs the data collection approach of the other procedure, the latter building on the former e.g.: items for inclusion in a survey are built upon previously collected qualitative data or vice versa
- *Merging*: Occurs typically after the statistical analysis of the numerical data and qualitative analysis of the textual data, when the two databases are brought together for analysis and for comparison
- *Embedding*: Occurs when quantitative and qualitative data collection and analysis are recurrently linked at multiple points

In achieving validity in mixed methods research, there is a level of subjectivity when applying the concepts of *Connecting, Building, Merging* and *Embedding*. Participant sampling strategy; the decision to emphasise either the quantitative vs qualitative component; the selection of where and/or how each component will be merged or

embedded are just a few examples of some of the questions that need to be answered before conducting a mixed methods study. While they are guided by the research aim and objectives, they are ultimately open to influence by the researcher. Consequently, there is the potential for inter-researcher variation in how these processes are applied and conducted, which therefore affects the overall validity of the research. To safeguard against this, where applicable in this research project, these process were discussed with my supervisors, so as to come to a consensus on the most appropriate manner they should be conducted towards achieving the study aim.

8.3 THE PROCESS OF TRUSTWORTHINESS

Trustworthiness in mixed methods research is a concept borrowed and expanded upon from qualitative research as a further expansion of the means and mechanisms of achieving validity[143,146–148]. As with integration, it utilises the combination of data collection and evidence types to answer a common question or achieve a common aim, and is primarily accomplished through:

- *Triangulation*: The comparison and corroboration of different methodologies towards a common amalgamated aim
- *Complementarity*: Expansion and elaboration on the results acquired from one method with the results of another method
- *Development*: Similar to the concept of *Building*, it highlights the outcomes acquired from one method to inform or further develop the other
- *Initiation*: Attempts to repeat questions and outcomes from method with the equivalent in another
- *Expansion*: Increasing the span and variety of enquiry by adopting different methods for different inquiry components

Studies I and IV relied heavily on the concepts of *Connecting*, *Building* and *Merging* towards achieving their aims and objectives. Similarly, Study III, incorporated elements of *Building* and *Merging* albeit as a part of the methodology that was developed as the outcome to the study. In terms of trustworthiness, Studies I and IV again utilised *Triangulation*, *Complementarity* and *Development* of the various data sources and types to add legitimacy to the outcomes and conclusions. Study III utilised the benefits of the concept of *Triangulation* in particular in the development of the appraisal protocol.

9 GENERAL CONCLUSION

9.1 CLINICAL IMPLICATIONS

This body of research represents amongst the first to comprehensively explore EMS quality and performance assessment not just in the SA context, but the broader LMICs as well. There are a multitude of implications of all aspects of the outcomes of this research, including:

- Increased awareness and understanding of quality systems, quality and performance measurement and the role of quality measurement towards improving the quality of patient care and safety, amongst EMS staff
- Identification of areas for improvement within the systems that implement and measure and monitor quality and performance within EMS i.e.: the quality systems
- The actual measurement and assessment of clinical care and operational performance of EMS for multiple patient types and presentations
- Benchmarking the measured quality and performance of EMS across multiple service types and locations
- Identification of areas for improvement in service delivery amongst EMS
- Allowance for greater transparency and therefore accountability of EMS delivery to both the public and EMS staff

Ultimately, the measurement of clinical quality and operational performance is the first step towards facilitating and ensuring that the patients we treat, and transport get the best care that is of the highest standard, consistently.

9.2 FUTURE RESEARCH

Measuring quality and performance of EMS delivering PEC in both SA and the LMICs is in its infancy. Consequently, the scope of potential future research is extensive. This research project focused primarily on the development of a framework of technical measures of quality and performance. However, there is a multitude of factors that affect the implementation and utilization of such a system that warrant further exploration. These vary from practitioner-associated factors that influence individual uptake and support of quality assessment, to the broad strategic system factors that affect the success and ongoing utilization of the system as a whole. In terms of the individual QIs themselves, healthcare is a dynamic field that is constantly evolving and adapting to improvements in clinical care and changes in evidence informing clinical care. As a result, there will always be equal scope for quality indicators to evolve and update as changes to clinical care itself improves and evolves.

Lastly, as alluded to, the outcomes of this research are viewed primarily from the perspective of the provider/clinician. Of equal importance, and out of the scope of this

research project, is the role of PEC specific patient reported outcomes, their development and testing; and inclusion in a system of quality and performance.

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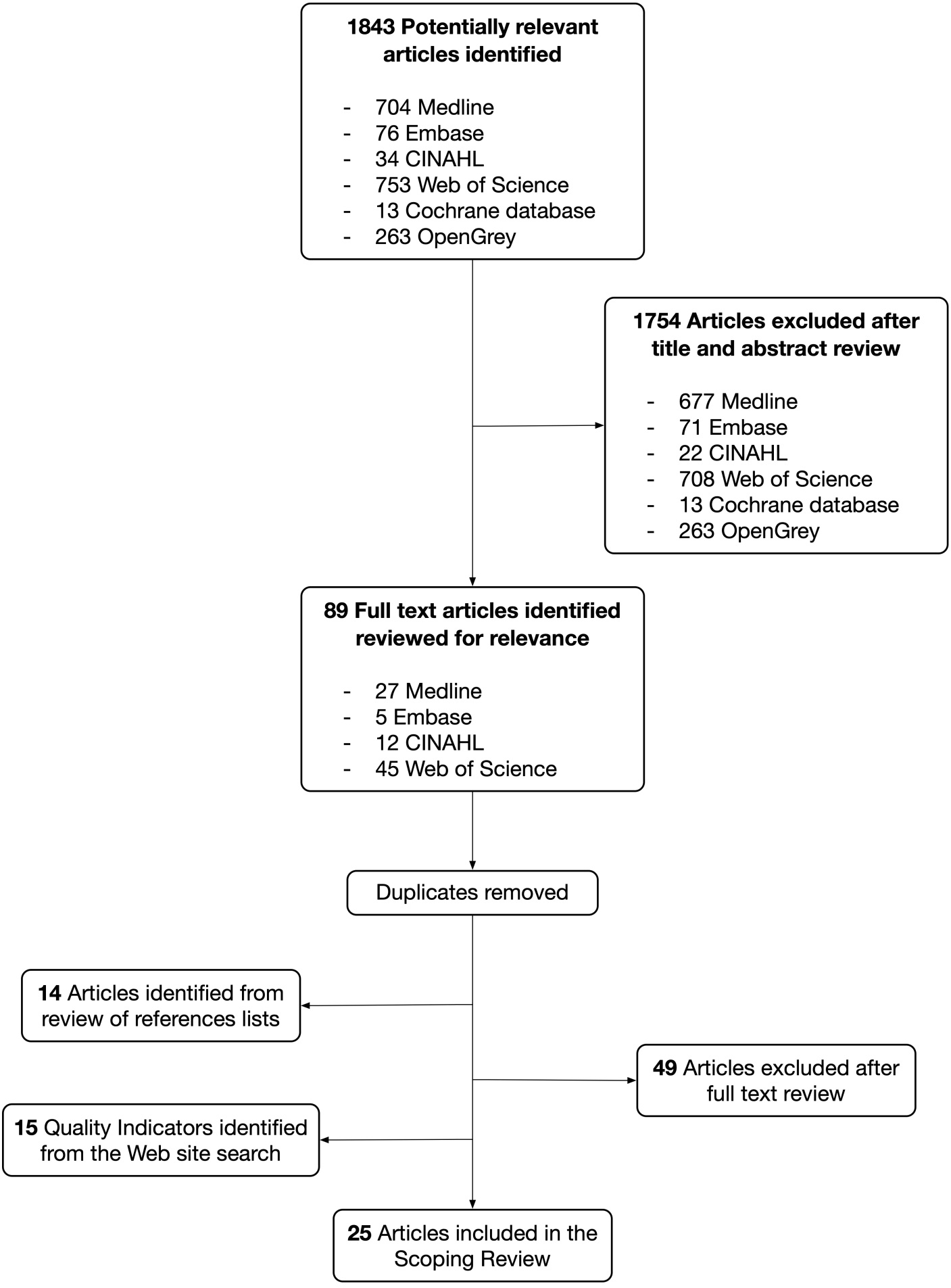
Appendix 1: Scoping Review process



Appendix 2: Quality Management Program Assessment Tool

A. **Quality Structure**
B. **Quality Planning**
C. **Quality Measurement**
D. **Quality Improvement Activities**
E. **Staff Involvement**
F. **Evaluation of Quality Program**

A) Quality Structure

A.1. Does the organization have an organizational structure in place to plan, assess and improve the quality of care?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No structure in place				
Score 1	Quality structure is only loosely in place; a few quality meetings of some staff; knowledge of quality structure is limited to only a few people in program; meetings are only used to discuss individual cases or problems.				
Score 2					
Score 3	Senior clinician/manager leads the quality committee; at least 4 quality meetings a year are held; multidisciplinary team members are represented in quality structure; routine reporting to external governing body; staff knows about quality committee meetings; minutes are kept; some links to external stakeholders.				
Score 4					
Score 5	Senior medical clinician/senior management is actively involved in quality committees; quality meetings include written minutes and written follow-up; understanding of entire staff about quality structure and reporting mechanism; active support by overall agency; strong links to external stakeholders; structured input from consumers or consumer advisory board.				

A.2. Have adequate resources been committed to fully support the quality program?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No resources are committed.				
Score 1	Only senior clinician or designated quality coordinator is responsible to coordinate quality efforts; quality is not part of staff's job expectations; quality work is done in addition to daily work loads; little resources have been made available for information systems.				
Score 2					
Score 3	Key staff members have time allotted for quality activities; half-time position is available for quality manager; moderate resources for information systems.				
Score 4					
Score 5	Most staff members have quality in their job descriptions and expectations; Full-time position of quality manager is available; resources are committed for information systems				

A.3. Do the leadership support the quality program?						
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**	
Score 0	No leadership support.					
Score 1	Program leadership reviews quality data; support for QI is not consistent and regularized; involvement is only active if needed; leadership has limited experience in QI activities; link to institution's overall quality program is only by reporting data.					
Score 2						
Score 3	Program leadership supports QI and sees quality improvement as a priority; leadership has established program commitment to quality; leadership supports staff and quality activities if needed; leadership involved in setting quality priorities; institution's overall quality program encourages interdepartmental cooperation.					
Score 4						
Score 5	Program leadership stresses being proactive; quality and patient focus are build into new programs and initiatives; program leadership advocates for QI with the rest of the organization; leadership is actively involved in ongoing education about quality; leadership uses every opportunity to promote quality improvement; quality and improvement issues are discussed at top staff meetings at overall organization.					

B) Quality Planning

B.1. Does the organization have a comprehensive quality improvement/management plan?						
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**	
Score 0	No QI/QM plan in place.					
Score 1	Quality program has only a loosely outline of a structured quality plan; a written plan does not reflect current day-to-day operations; goals for the quality program are not established.					
Score 2						
Score 3	The quality plan is reviewed and updated annually; the quality plan describes the quality committee structure and its frequency of meetings; key quality principles and objectives are outlined; annual goals have been discussed and agreed on by quality committee; the quality plan is shared with staff.					
Score 4						
Score 5	The written quality infrastructure includes a multidisciplinary membership and its reporting mechanism; the link to the organization's overall quality program is described; the quality committee oversees and provides feedback to quality improvement projects; staff is aware of the plan; staff is actively involved in review and update of the quality plan; annual goals are actively communicated and understood by staff; selection and prioritization process is clearly defined; staff is actively involved in selection process.					

B.2. Does the organization have clearly described roles and responsibilities for the quality program?						
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**	
Score 0	No roles are described.					
Score 1	Roles and responsibilities are not described for quality structure; staff has vague idea about involvement in quality program; no written documentation.					
Score 2						
Score 3	Key roles for quality program are clearly described; leadership and governance are					

	established; staff is informed about different roles; QI team roles are described; follow-up for quality activities are unclear.
Score 4	
Score 5	The staffs' roles and responsibilities are clearly described regarding involvement in committee structure, performance measurements, and quality activities; description of accountability is routinely reviewed and updated at least annually; staff is involved in design of roles and responsibilities; structure in place to monitor progress of quality activities.

B.3. Does the work plan specify timelines and accountabilities for the implementation of the quality program?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No work plan exists.				
Score 1	No specific timelines and accountabilities have been established; no formal process to assign timelines for quality projects; follow-up of quality findings only as needed.				
Score 2					
Score 3	Quality activities are somewhat planned for the near future; workplan specified annual cycle of review for goal statements; quality committee is aware of timetable; findings of quality activities are routinely discussed in quality committee; staff is not assigned to be accountable for the implementation of certain quality activities.				
Score 4					
Score 5	Process to assign timelines for all quality reviews and improvement projects is clearly described; annual plan for resources is established; most of staff are aware of timelines; structure to discuss update of all quality activities at each quality committee meeting; staff members have clearly assigned roles and expectations for projects; staff are held accountable.				

C) Quality Measurement

C.1. Are appropriate outcome and process quality indicators selected in the quality program?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No indicators are selected.				
Score 1	Only those indicators have been selected that were required; no process takes place to annually review and update indicators; selection of indicators was done by senior clinician or by quality coordinator.				
Score 2					
Score 3	Selection of indicators was based on results of internal quality initiatives and external audits; indicators have written definitions and frequencies of review; staff is aware of indicators; indicators reflect standards of care.				
Score 4					
Score 5	Annual process to update indicators; required and non-required outcome and process indicators have been selected; all indicators definitions include outcome and steps for follow-up; staff is involved in development of indicators; most staff knows indicators and their definitions.				

C.2. Does the organization regularly measure the quality of care?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**

Score 0	Quality of care is not measured.
Score 1	Program measures only what is required; only few staff members are involved in measurement process; no description of review process.
Score 2	
Score 3	Process in place to measure performance; performance reviews and implementation steps have defined timetables; most staff are involved in measurement process; results are reviewed in quality committee.
Score 4	
Score 5	Process to evaluate and measure performance clearly described; monthly performance reviews; quality results are regularly reviewed by the organization's leadership and action is taken on the results; staff are actively involved in measurement process; staff are trained in review process.

C.3. Are processes established to evaluate, assess and follow up on quality data?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No process in place to follow-up on quality data.				
Score 1	Only senior leadership receives quality reports. Results are not shared with other staff routinely, unless there is a problem. Reporting of quality outcomes and results often feels punitive. Sporadic reporting of results and no process in place to respond to results.				
Score 2					
Score 3	Quality reports are shared with senior leadership team and quality committee. Periodic quality changes and interventions attempted. No consistent process to act on results; no routine follow-up on all quality data reports; some staff receive the information.				
Score 4					
Score 5	All staff receive appropriate quality reports and results. Quality results are regularly reviewed by staff and action is taken on the results; staff is actively involved in staff meetings in discussing results and proposing improvement activities; staff is trained on how to use results to initiate improvement activities and how to communicate with quality committee. Innovation, within a clearly defined quality planning process, is encouraged and rewarded.				

D) Quality Improvement Activities

D.1. Does the organization conduct specific quality activities and projects to improve the quality of care?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No quality activities are taking place.				
Score 1	Quality improvement activities focused on individual cases without any analysis of underlying cause; reviews are primarily used for inspection/compliance; selection of project is done by single person.				
Score 2					
Score 3	A few staff members have input in selection of quality initiatives; quality improvement activities focused on processes; projects are conducted based on performance data results; findings are presented to quality committee; QI principles (consumer focus, staff involvement, teams) were applied.				
Score 4					
Score 5	Structured process of selection and prioritization; routine identification of customer needs				

	and input in quality improvements; majority of staff involved in quality improvement projects; findings are shared with entire staff.

D.2. Are quality improvement teams formed for specific projects?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No teams are formed.				
Score 1	A group of staff meets to discuss improvements; mostly the same staff members are involved; methodologies for quality improvement teams are not used.				
Score 2					
Score 3	One or two QI teams had been introduced; basic staff knowledge about QI team; multidisciplinary team approach; QI approach is used to address quality projects; results are presented at quality committee; QI teams use established methodologies.				
Score 4					
Score 5	QI teams are used routinely to address complex quality issues; participation of most staff in QI teams; staff is trained in their team roles; team continues to monitor changes; ongoing assistance is provided by leadership; results are shared with all staff.				

D.3. Are systems in place to sustain quality improvements?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No systems to sustain QI in place.				
Score 1	Quality improvement activities result in minimal change in delivery system; no training for staff is required; only some providers are impacted; efforts to improve the health of patients has only minimal impact; improvements are only short-term; minimal involvement by staff.				
Score 2					
Score 3	Some short and long-term benefits for some clients; process in place to continue to monitor change; some staff educated about changes; some job descriptions are altered.				
Score 4					
Score 5	Quality improvement activities result in a fundamental change of delivery system; improvements require staff to be trained; impact is measured and related to improved outcome; sustainable success for all intended clients; program demonstrated culture of support of learning and improvement; staff is actively involved in process.				

E) Staff Involvement

E.1. Is the staff routinely educated about the program's quality program?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No staff training in place.				
Score 1	Only a few people have access to training opportunities; one or two journals or books are available about quality; no additional resources for quality training are available.				
Score 2					
Score 3	No formal process in place to train all staff routinely about quality principles; some staff members can attend external quality training; some staff can order books and journals about quality.				
Score 4					
Score 5	Almost all staff members attend an annual quality training; staff knows about QI				

	principles; quality articles are routinely shared and forwarded among staff; many journals and books are available for staff; content of quality conferences and recent developments are routinely communicated among staff.

E.2. Does the organization routinely engage all levels of staff in quality program activities?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No involvement of different staff levels.				
Score 1	Results of quality activities are not routinely shared with staff; feedback is limited; staff can list only one quality indicators of program; no formal process in place.				
Score 2					
Score 3	Findings of quality activities are routinely shared with staff; staff can list some quality indicators of program; staff knows some findings of quality reviews; updates about quality initiatives are given to committee members and key staff.				
Score 4					
Score 5	Process in place to update staff about results of quality activities; staff is well aware of quality program goals; entire staff meets to discuss updates about quality improvement activities; staff is actively involved; results of quality activities are communicated with patients and key stake holders.				

E.3. Are patients involved in quality-related activities?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No patients are involved in quality-related activities.				
Score 1	Patient concerns are only discussed as they arise; patient satisfaction is not measured routinely; no structure in place to gather patients' feedback.				
Score 2					
Score 3	Patient needs and/or satisfaction are assessed; feedback of patients is discussed in quality committees; a patient-centered quality activity is launched.				
Score 4					
Score 5	Findings of patient satisfaction assessments are routinely integrated into the quality program; patient-centered advisory board in place; patient-centered feedback is incorporated in setting quality goals; results of quality activities are routinely communicated with patients.				

F) Evaluation of Quality Program

F.1. Is a process in place to evaluate the quality program?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No process in place.				
Score 1	No formal process is established to evaluate the quality program; quality activities are only reviewed if necessary; no review of quality workplan; no annual review of quality goals and infrastructure.				
Score 2					
Score 3	Review of ongoing quality activities by quality committee; quality committee routinely evaluates improvements achieved by quality improvement team(s); some evaluations are used to internally and externally (success stories, etc.) promote the quality program.				
Score 4					
Score 5	Process to assess effectiveness of quality program including workplan, goals, and				

	infrastructure; staff is actively involved; assessments are documented; leadership is well aware and involved in evaluation of quality program; quality awards for staff are given based on evaluations.

F.2. Does the quality program integrate findings into future planning?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No integration of findings into future planning.				
Score 1	Program does not learn from past successes and failures; when annual work plan is established, past performance is not really considered.				
Score 2					
Score 3	Results from evaluations are somewhat used to plan ahead; summary of findings are documented.				
Score 4					
Score 5	Structure in place to use evaluations to facilitate future planning for quality, including identification of improvement opportunities; past performance of performance measurements is used to update work plan, annual goals, and timelines; staff is involved in process; evaluations are used to annually review the quality infrastructure; improvements are spread into wider system, if indicated.				

F.3. Does the program have an information/data system in place to track patient care and measure quality indicators?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No information system in place.				
Score 1	Has no information system to track patient care; no or very basic medical/patient record system.				
Score 2	Has basic information system to track client care but no specific program information; limited capacity to expand to meet program needs.				
Score 3	Has functional information system to track client care, and some (not all) minimal components of program information system, but no specific quality information.				
Score 4	Has fully functional information system to track client care as well as track all minimal components of program information; limited capacity to easily manage quality with system.				
Score 5	Has fully functional information system to track client care, track core components of program, and produce useful quality of care information.				

Appendix 3: Qualitative exploration of the knowledge, attitude and practices (KAP) of clinical quality and performance assessment amongst South African trained ALS EMS personnel	
Category	**Supporting Quote**
General understanding of quality assessment	*"I think it's very important, and I will give you a little example of why I think it's important. So, when you think of somebody who is rich and somebody who is poor, if you go to somebody's house and the house is dirty, and let's say they're sort of lower income, keeping a house clean does not take a lot of money, or minimal. It's about a level of quality of cleanliness, if you understand what I'm saying? So just because somebody's poor, doesn't mean they shouldn't be clean. So, it's the same sort of thinking," … organisations that are resource limited can still achieve a reasonable sense of quality without all the fancy resources and fancy equipment. It comes down to basic needs of the patient. Yes, I think quality can be maintained, no matter how resource poor any institution or organisation is."* *"So basically, I feel, even in a resource limited setting, I do see the need and requirement for an audit tool of some form, because then we can further see what we are doing, is it right, wrong, or are we incurring harm or are we worsening cases?"*
The role of context in quality assessment	*"I would say that to improve uptake and acceptance, one would need to make it contextually appropriate and relevant and almost be localised adaption at provincial level or lower, but it still aligns itself to a greater set of criteria that is whatever methodology behind it or robustness behind it."* *"No, because if you're going to say that the Western Cape is resource limited, Cape Town central is not the same resource limited that is out in Northern Cape, in Kathu. So out in Kathu they've got one ambulance, so firstly from a human resource point of view they are resource limited. In Cape Town central, in my division, so in one division in Cape Town central, which is the western division, they have got four ALS on every shift."* *""There is financial motivation. If they don't make sure that their quality is up to standard, then they lose the contracts that they have with medical aids, and then their finances get affected."* *"From discussions I've had with private sector paramedics, they are more stringent in private sector, because private sector is, my view is that they are finance driven and if they do not put in information or they don't treat a patient in a certain way, they get penalised. So, the private sector, I think are more tight, in my opinion, on quality processes."*
Factors affecting implementation of quality assessment systems	*"if you get everyone to understand what benefit is there to their patients and what benefit is there to them for doing it, then it can be successful… it doesn't need to be a financial benefit. If I knew as a practitioner that if I took part in a clinical governance process, then I would confidently know that I'm giving the best possible care to my patients, you'd have my buy-in straight away."* *"There definitely needs to be an interactive system, a one sided 'review cases and then slap him down when there a poor interaction' is not particularly valuable. We've always focused on the disciplinary use of it and the corrective portion rather than the encouraging the good."*

	"Perhaps because of the way that it's been managed in the past, where people have had negative experiences, when it becomes a case of let's just tell you no, no, no, this is not how you do it."
Factors affecting on-going utilization of quality assessment systems	*"So, we do have bad apples, but as a whole, if you ask one of the top managers, what is your culture around dealing with mistake/medical error as such, they should be telling you that it is just culture. Now, if someone says that already, then at least you are somewhere. And I like the saying, culture trumps policy every time. We can have whatever policy we have."* *"… to properly implement it, you're going to need appropriate management, and you're going to need management that actually wants to. And in my opinion, I think we have a lot of management that is there simply because they can be there, and not because they take it at heart."*
Quality assessment system reliability and validity	*"…because the staff on the ground are intimately part of improvements. In fact, they are the key role players, so they should know exactly what the targets are, they should know exactly how it's being measured, so they are clear on what the expectations are."* *"If people can understand what you're doing and why you're doing it, you are going to have their buy-in a lot more than just by saying this is what we're doing and you're going to have to accept it. I think they would want to know, and also if you know why it's being done, you probably wouldn't be so sceptical about it or so nervous about it. You would probably embrace it a lot more and understand it."*
Advantages of an effective, efficient quality assessment system	*"So, I think if there was a standard thing implemented it would be huge for patient care, because I think they would pick up problems that they could actually fix for sure, and then I think it would help the staff to just stay more on top of things as a whole as well. I think, also knowing that their care is being watched closer would also prompt people to stay more current and attend more training, do you know what I mean? Like stay on top of things themselves also, because I think that people do get quite complacent there because they are kind of just left to just do what they like."* *"You know, we've only now recently started moving over to looking at quality indicators of positive things, things that we are doing well, instead of only looking at adverse events as quality - or saying we now only have - we've done 100 cases and we only had two reported adverse events. Where now, we are starting to look it actually good things as well."*
Disadvantages of an inappropriate, ineffective quality assessment system	*"And then I think of course that many people in our organisation fear the governance, because they are scared that someone is going to shout at them, they are going to look like an idiot in front of their peer, and I think in that way they probably don't understand what we are trying to achieve and what we're doing. And then some people are also actively against clinical governance, because I am an independent practitioner, so why are you governing me? I got my degree, or I have my diploma or my certificate, you should not govern me, there's no reason for that."* *"…that's where I think it can be a dangerous thing, because you might get people who come and just do what they have to do, just because they want the points, instead of doing it for the best interest in your service and your patients. I think because you don't want people to do something because they are going to get something out it."*

Appendix 4: Quality Indicators reaching consensus agreement - Clinical Category				
Subcategory type	**Applicable Scope of Practice**			**QI Classification**
	Basic Life Support	**Intermediate Life Support**	**Advanced Life Support**	
Acute Coronary Syndromes /ST Elevation Myocardial Infarctions subcategory				
Patients with a provisional diagnosis of ACS/STEMI who had an ALS practitioner in attendance			X	Process
Patients with a provisional diagnosis of ACS/STEMI who had a set of defined cardiac risk factors assessed and recorded		X	X	Process
Patients with a provisional diagnosis of ACS/STEMI who had a 12 lead ECG obtained		X	X	Process
Patients with a provisional diagnosis of ACS/STEMI who were administered Aspirin	X	X	X	Process
Patients with a provisional diagnosis of ACS/STEMI who were administered GTN		X	X	Process
Patients with a provisional diagnosis of ACS/STEMI who were assessed for suitability for thrombolysis by defined checklist		X	X	Process
Patients with a provisional diagnosis of ACS/STEMI who were administered prehospital thrombolysis			X	Process
Patients with a provisional diagnosis of ACS/STEMI who were transported directly to a Facility with PCI capabilities	X	X	X	Process
Patients with a provisional diagnosis of ACS/STEMI who had EMS activation of the receiving Cath Lab	X	X	X	Process
Patients who received/met all components of a defined ACS/STEMI composite bundle score			X	Process
Acute Pulmonary Oedema subcategory				
Patients with a provisional diagnosis of APO who were administered GTN		X	X	Process
Patients with a provisional diagnosis of APO who received CPAP			X	Process
Patients with a provisional diagnosis of APO who had a 12 lead ECG obtained		X	X	Process
Airway Management subcategory				
Patients who received a pre-ETI paralytic, following which there was a decrease in SpO_2 > 10% from baseline/or decrease below 70% overall			X	Process
Patients successfully intubated by EMS personnel where $EtCO_2$ monitoring was used post ETI			X	Process
Patients successfully intubated via RSI by EMS personnel where a paralytic agent was administered post-ETI			X	Process
Patients successfully intubated by EMS personnel where a sedative agent was administered post-ETI			X	Process
Patients successfully intubated by EMS personnel where a mechanical ventilator was used post-ETI for ventilation			X	Process
Patients in whom ETI was attempted by EMS personnel who had an alternative airway inserted as a final airway			X	Process
Patients in whom ETI was attempted by EMS personnel who had a surgical airway inserted			X	Process
Patients successfully intubated by EMS personnel with an $EtCO_2$ < 30 mmHg or > 50 mmHg post-ETI > 10 mins during EMS care			X	Process
Patients in whom RSI with ETI was unsuccessful when attempted by EMS personnel			X	Process

Patients in whom Non-RSI ETI was unsuccessful when attempted by EMS personnel			X	Process
Patients in whom RSI with ETI was successful when attempted by EMS personnel			X	Process
Total number of patients successfully intubated via RSI by EMS personnel			X	Process
Patients who received/met all components of the defined Airway management composite Bundle score			X	Process
Anaphylaxis subcategory				
Patients with a provisional diagnosis of Anaphylaxis and evidence of bronchoconstriction documented who were administered a B2 agonist		X	X	Process
Patients with a provisional diagnosis of Anaphylaxis and evidence of bronchoconstriction documented who were administered an Anti-cholinergic bronchodilator		X	X	Process
Patients with a provisional diagnosis of Anaphylaxis who were administered an antihistamine			X	Process
Patients with a provisional diagnosis of Anaphylaxis who were administered a corticosteroid			X	Process
Patients with a provisional diagnosis of Anaphylaxis and signs of a severe systemic response recorded who were administered IM Adrenaline			X	Process
Asthma/Bronchoconstriction				
Patients with a provisional diagnosis of Asthma/Bronchoconstriction with lung sounds assessed and documented (pre and post treatment)	X	X	X	Process
Patients with a provisional diagnosis of Asthma/Bronchoconstriction with a SpO2 documented (pre and post treatment)	X	X	X	Process
Patients with a provisional diagnosis of Asthma/Bronchoconstriction who were administered a B2 agonist bronchodilator		X	X	Process
Patients with a provisional diagnosis of Asthma/Bronchoconstriction who were administered an anticholinergic bronchodilator		X	X	Process
Patients with a provisional diagnosis of Asthma/Bronchoconstriction who were administered a corticosteroid			X	Process
Patients with a provisional diagnosis of Asthma/Bronchoconstriction recorded with documented severe wheezes/silent chest/BP < 90 mmHg systolic BP who were administered IM Adrenalin			X	Process
Patients who received/met all components of the defined Asthma/Bronchoconstriction composite bundle score			X	Process
Burns subcategory				
Patients with a provisional diagnosis of Burns with burns dressings applied	X	X	X	Process
Patients with a provisional diagnosis of Burns with body surface area and burns type assessed and recorded	X	X	X	Process
General subcategory				
Serviceable suction unit devices available per defined area and/or time period		N/A		Structure
Serviceable 3 lead ECG monitoring devices available per defined area and/or time period		N/A		Structure
Serviceable 12 lead ECG monitoring devices available per defined area and/or time period		N/A		Structure
Serviceable portable oxygen cylinders available per defined area and/or time period		N/A		Structure
Serviceable Defibrillator/AED devices available per defined area and/or time period		N/A		Structure

Serviceable mechanical ventilators available per defined area and/or time period	N/A			Structure
Patients with reduced level of consciousness with a blood glucose measured	X	X	X	Process
Patients with a recorded SpO2 < 95% who were administered supplemental Oxygen	X	X	X	Process
Patients with a provisional diagnosis recorded	X	X	X	Process
Hypoglycaemia subcategory				
Patients with a blood glucose level < 5 mmol who were administered Glucose	X	X	X	Process
Patients with a blood glucose level measured and recorded following Glucose administration	X	X	X	Process
Neonate/Paediatric subcategory				
One min APGAR score assessed and recorded for newborn patients	X	X	X	Process
Five min APGAR score assessed and recorded for newborn patients	X	X	X	Process
Paediatric patients with a provisional diagnosis of Croup who were administered oral/inhaled steroids			X	Process
Paediatric patients with a provisional diagnosis of Croup who were administered nebulized Adrenalin			X	Process
Patient transportation to a facility with specialist Paediatric capabilities/resources	X	X	X	Process
Obstetrics subcategory				
Obstetric patients who deliver prior to EMS arrival	X	X	X	Process
Obstetric patients with postpartum haemorrhage who were administered TXA			X	Process
Obstetric patients with a provisional diagnosis of Eclampsia or Pre-eclampsia who were administered Magnesium sulphate			X	Process
Obstetric patients who deliver during EMS care	X	X	X	Outcome
OHCA subcategory				
Patients with a provisional diagnosis of OHCA with a witnessed collapse documented	X	X	X	Process
Patients with a provisional diagnosis of OHCA who received documented bystander CPR	N/A			Process
Patients with a provisional diagnosis of OHCA who received documented telephonic CPR advice	N/A			Process
Patients with a provisional diagnosis of OHCA with VF/VT as first presenting rhythm on arrival of EMS	X	X	X	Process
Patients with a provisional diagnosis of OHCA with Asystole/PEA as first presenting rhythm on arrival of EMS	X	X	X	Process
Patients with a provisional diagnosis of OHCA intubated with alternative airway device			X	Process
Patients with a provisional diagnosis of OHCA for whom resuscitation was cancelled prior to arrival at hospital			X	Process
Patients with a provisional diagnosis of OHCA who were transported to hospital (incl. ROSC and Non-ROSC patients)	X	X	X	Process
Patients with a provisional diagnosis of OHCA with ROSC at hospital handover	X	X	X	Process
Patients with a provisional diagnosis of OHCA with VF/VT at hospital handover	X	X	X	Process
Patients with a provisional diagnosis of OHCA with Asystole/PEA at hospital handover	X	X	X	Process

Patients with a provisional diagnosis of OHCA with survival to Emergency Centre discharge	X	X	X	Process
Patients with a provisional diagnosis of OHCA with survival to hospital discharge	X	X	X	Outcome
Pain Management subcategory				
Patients with level of Pain measured via defined pain score	X	X	X	Process
Patients with a defined pain score threshold who were administered analgesia		X	X	Process
Patients with level of pain measured via defined pain score following analgesia administration	X	X	X	Process
Seizures subcategory				
Patients with a provisional diagnosis of Seizures with a blood glucose measured and recorded	X	X	X	Process
Patients with a provisional diagnosis of Seizures who were administered an antiepileptic for ongoing Seizures			X	Process
Stroke/TIA subcategory				
Patients with a provisional diagnosis of Stroke/CVA/TIA with a blood glucose measured and recorded	X	X	X	Process
Patients with a provisional diagnosis of Stroke/CVA/TIA with a Stroke screening assessment performed (e.g.: FAST)	X	X	X	Process
Patients with a provisional diagnosis of Stroke/CVA/TIA with serial blood pressure measurements recorded (X3)	X	X	X	Process
Patients with a provisional diagnosis of Stroke/CVA/TIA delivered to a specialist Stroke Centre	X	X	X	Process
Patients with a provisional diagnosis of Stroke/CVA/TIA with direct delivery to CT scan	X	X	X	Process
Patients who received/met all components of the defined Stroke/CVA/TIA composite bundle score	X	X	X	Process
Trauma subcategory				
Patients designated as a trauma case with entrapment on scene documented	X	X	X	Process
Patients designated as a trauma case with a BP < 90 mmHg		N/A		Process
Patients designated as a trauma case with partial/full amputation who had a tourniquet applied	X	X	X	Process
Patients designated as a trauma case with a femur fracture and traction splint use	X	X	X	Process
Patients designated as a trauma case with a BP < 90 mmHg who were administered TXA			X	Process
Patients designated as a trauma case with direct transportation to a specialist Trauma Centre	X	X	X	Process

Quality Indicators reaching consensus agreement – Non-clinical Category				
Subcategory type	**Applicable Scope of Practice**			**QI Classification**
	Basic Life Support	**Intermediate Life Support**	**Advanced Life Support**	
Adverse Events subcategory				
Number of patient deaths while in EMS care	X	X	X	Adverse Event
Number of defined Adverse Events reported during EMS care	X	X	X	Adverse Event
Number of defined equipment/technical failures reported during EMS care	N/A			Adverse Event
Number of accidental or unexpected extubations reported during EMS care			X	Adverse Event
Number of patients with a decrease in GCS of 3 or more points during EMS care	X	X	X	Adverse Event
Number of defined failed intubation attempts	X	X	X	Adverse Event
Total number of patient injury reports during EMS care	X	X	X	Adverse Event
Number of EMS staff on-duty injury reports	N/A			Adverse Event
Number of defined medication errors during EMS care	X	X	X	Adverse Event
Communications/Dispatch subcategory				
Number of cases compliant with defined ALS Dispatch criteria	N/A			Structure
Number of cases with call processing time within defined limits	N/A			Structure
Number of Service Call Centre calls received per 10000 population	N/A			Structure
Number of unanswered/missed calls to the Service Call Centre	N/A			Structure
Number of cases with a delay in dispatch and/or response time waiting for a police/security escort	N/A			Process

ACS – Acute Coronary Syndrome; **AED** – Automated External Defibrillator; **ALS** – Advanced Life Support; **APGAR** – Activity, Pulse, Grimace, Appearance, Respiration; **APO** – Acute Pulmonary Oedema; **BBA** – Born before arrival; **BP** – Blood pressure; **CPD** – Continued professional development; **CPR** – Cardiopulmonary resuscitation; **CT** – Computed tomography; **CVA** – Cerebrovascular accident; **ECG** – Electrocardiogram; **EMS** – Emergency Medical Service; **EtCO2** – End tidal carbon dioxide; **ETI** – Endotracheal intubation; **ETT**- Endotracheal tube; **FAST** – Face Arm Speech Time; **GCS** – Glasgow Coma Scale; **GTN** – Glyceryl trinitrate; **HEMS** – Helicopter Emergency Medical Service; **IO** – Intra-osseous; **IOD** – Injury on duty; **IV** – Intravenous; **MAP** – Mean arterial pressure; **mmHg** – Millimeters mercury; **ODD** – Oesophageal detection device; **OHCA** – Out of hospital cardiac arrest; **PCI** – Percutaneous coronary intervention; **PEA** – Pulseless electrical activity; **PEFR** – Peak expiratory flow rate; **POC** – Point of care; **ROSC** – Return of spontaneous circulation; **RSI** – Rapid sequence intubation; **SPC** – Statistical process control; **SpO2** – Capillary oxygen saturation; **STEMI** – ST elevation myocardial infarction; **TIA** – Transient Ischaemic attack; **TXA** – Tranexamic acid; **VF** -Ventricular fibrillation; **VT** – Ventricular tachycardia

Appendix 5: Literature review of evidence base																
Indicator Category	**Indicator subcategory**	**Total QIs**	**Indicator Type**				**Level of Evidence**									
			Structure	**Process**	**Outcome**	**Adverse Event**	**1a**	**1b**	**1c**	**2a**	**2b**	**2c**	**3a**	**3b**	**4**	**5**
Clinical	Acute Coronary Syndromes	25		23	2					4	5				2	14
	Airway management	8		8							2		1		1	2
	Acute Pulmonary Oedema	2		2						2						
	Asthma	10		10						1						9
	General	18		15	3					2					4	12
	Hypoglycaemia	3		3												3
	Out of hospital cardiac arrest	44	4	38	2					2					3	39
	Pain management	1		1												1
	Seizures	2		2						2						
	Stroke	11		11							3					8
	Trauma	16	3	11	2					4			5			6
Non-clinical	Adverse Event	25				25					9			11		5
	Deployable resources	15	13	2	2										5	13
	Dispatch/Call times	90	7	73	6					3	1		26	17	4	39
	Documentation	16	3	13								2		2	3	11
	Employee focused	16	16											2	2	12
	Service user rating/satisfaction	9		6	3										1	8
Total		311	46	218	20	25	0	0	0	20	20	2	32	32	25	182
%			15%	70%	6%	8%	0%	0%	0%	6%	6%	1%	10%	10%	8%	59%

QI – Quality indicator

Appendix 6: Qualitative exploration of the Quality Program Assessment		
Participating Service & Interviewee	**Sub-category**	**Supporting Quote**
1 Western Cape Director level participant	Leadership	"We're at the disadvantage where [the director] who normally drives this [quality] has been away for probably almost two years now and as a consequence, much of these questions where we had answered reasonably well before, realistically speaking we are nowhere near that because the person responsible for coordinating that has not been here"
	Mandate	"I'm of the view that in the South African context, we are a logistics company, we are not a medical company…we are a transport system"
	Historical factors	"Because of the nature of the South African services, because of the socio-political aspects of the way cities are structured in South Africa, particularly in Cape Town, response time performance had to be prioritised, due to spatial divide… our cities are racially designed which means in a post-democratic country, in a way to break that up, you have to put a transport system in place, so that the racial divide, the inequity isn't perpetuated, and where you don't have a public transport system, when it comes to healthcare, that's the primary purpose of ambulance service"
	Safety	"so, what has happened as a consequence of safety, as a consequence of all of these ambulance attacks, one of the things we've had to do, we've had to engage with the community more often, so what is happening relatively frequently, is we attend patient health forums. The district managers must attend or send a representative to every community health forum meeting or community safety forum meeting. So, at these sessions, a patient voice invariably comes through"
2 KwaZulu Natal Deputy Director level participant	Structure	"EMS in KwaZulu Natal has a provincial M&E (measurement and evaluation) manager and then one FIO (facility information officer) per district. We have eleven districts in total. Information and quality currently measured are focused on service delivery. The quality of medical care provided to patients is an area that is currently lacking. A set of indicators is reported on monthly by each district using an excel spreadsheet, this is a huge challenge as data is manually captured at each level from the source to final consolidation and reporting"
		"We do have a quality plan in place. This is reviewed annually. The plan takes into account available resources, available budget and timeframes. The plan contains mainly issues around service delivery and strategies to improve service delivery. The plan is reviewed by the EMS management team which includes the EMS provincial management team and EMS district managers."
	Mandate	"When we measure quality of services, we look at the national norms currently available together with the demand for services. Firstly, we look at available resources and how we compare to the 1 ambulance per 10 000 population national norm. Then we look at the demand for services - what the available resources had to attend to. And then we look at the percentage P1 cases responded to within the national norms. These are all viewed as a piece of the complete puzzle and should not be measured or reported on independently as the picture will be incomplete. The assumption is that, if you have 1 ambulance per 10 000 population then you should be able to achieve the response time norms to P1 cases taking into account your case load has not spiked due to any unforeseen circumstance"

		"This is the focus of our performance measured on a continuous basis where trends are monitored on a monthly, quarterly and annual basis. Other quality indicators are measured as and when required, particularly if we have a special project or intervention in place."
	Engagement	"performance results are presented at our EMS management team forum and distributed to districts by the provincial M&E manager. EMS district managers are encouraged to present their performance to staff at all levels within the districts, but this is not happening in all districts"
		"As EMS we do not have much public engagement regarding our performance however our performance reports are included in the departmental annual reports which are public documents. These are also discussed at public imbizo events where the public has an opportunity to pose questions, concerns, comments to the departments senior management where EMS is represented"
3 Limpopo Director level participant	Strategic planning	"The EMS plan fits into the broader department strategic plans, where we have a section that is focused on EMS… the strategic plans are updated and planned for over several years and then re-evaluated at the end of that period. Where we have failed to reach a target or goal, we re-incorporate those projects into future plans"
	Relationships	"We form part of the (health) departments system as a whole and filter into the departments committees… for me the most important thing is the relationship we have with them. I would rather we have someone with an understanding of quality and quality systems and improve their understanding of EMS, than have someone from EMS and need to bring their understanding up to understand quality. But either way, for me the most important thing is still about the relationship we have with them"
		"We measure quality through response times targets, through the number of complaints, and from feedback from the facilities we take patients to. Their feedback about the interaction with our staff is very important to me."
	Attitude	"The attitude of the staff is very important to me, and that's one of the biggest improvements we have planned for... It will be very difficult, but we want to involve organized labour, and invite them to be a part of the process… here they determine success or failure and that's why I want to make sure they have buy-in to the process and provide feedback"
	Technology	"Having systems in place such as CAD systems will allow us to monitor everything involving staff, vehicles, how they are used, all of which will allow us to monitor our performance more closely and to make the sure the staff are held responsible and accountable, because this will also allow us to provide extra information to the public as a measure of our performance as well"
4 North West Director level participant	Structure	"We're not a provincialized service, we're a totally decentralised service, each EMS station reports to the subdistrict they are in, so there's no provincial structure. Currently we are the only province that is like that… Basically we've got like 19 different EMS services in the North West."
	Staff capacity	"we lost a lot of them to OSD (occupational specific dispensation) …the OSD has shot us in the foot. We're losing a lot of staff because we can't retain them, so we're training, but we're actually training for [other services]"
	Non-personal resources	"I'm finding out from research that we don't need such a high amount of ambulances, we need to be focusing more on planned patient transport, because 65% of our calls are actually P3, so we're using a very expensive resource to transport something that we don't need to transport"
	Technology	"the unfortunate thing is all our stuff is paper-based, and we don't have a digital system. So, we are moving towards a digital communication system, but currently it's very easy to lie to your statistics, so I cannot trust the information given to me"

5 Private Service Senior manager level participant	Leadership	“We’re probably as good as a 5 as you can get, in my opinion. [Representatives] From the CEO, to the operational crews sit on a clinical committee, there’s a quality assurance manager that sits at an executive level, and all of this works through, it’s all auditable through minutes and committee meetings that report into the executive committee”
	Representation	“we’ve got representatives from cross the organisation sitting on the clinical panel to discuss what the consumer wants, what training needs to be provided, what operations is currently doing and where the operations within operations is needed”
	Improvement focus	“If we’re doing a quality improvement project, if it gets written down as a quality improvement project, and not just an intervention, then we do put the assurances in place, putting in the checks to monitor it over and time and then look at whether there’s a consistent change in behaviour or not”
	Fit for purpose	“our biggest problems in terms of this are systems. We often review stuff, and we often see, and we might know what quality indicators to use, but the problem comes in that the system we currently have is, manual, and very hard to change any kind of quality indicators, because it’s an accounting system that we’re using for quality indicators essentially, and it’s still paper-based, and manually captured”
	Patient/community engagement	“In terms of a structured patient satisfaction assessment, we do have that. In terms of having a point of entry into the business for patients concerns to be brought up, we do have that, that’s very well developed at [parent company]. I think the problem comes in when you start talking about patient or community engagement when it comes to patient centred events, and I don’t think we’re there yet.”