Emergency Care Assessment Tool for Health Facilities

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DECLARATION:

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

Signature: Date: 11 February 2016

Signed by candidate

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ABSTRACT

Background

To date, health facilities in Africa have not had an objective measurement tool for evaluating essential emergency service provision. One major obstacle is the lack of consensus on a standardized evaluation framework, applicable across a variety of resource settings. The African Federation for Emergency Medicine has developed an assessment tool, specifically for low- and middle- income countries, via consensus process that assesses provision of key medical interventions. These interventions are referred to as essential emergency signal functions. A signal function represents the culmination of knowledge of interventions, supplies, and infrastructure capable for the management of an emergent condition. These are evaluated for the six specific clinical syndromes, regardless of aetiology, that occur prior to death: respiratory failure, shock, altered mental status, severe pain, trauma, and maternal health. These clinical syndromes are referred to as sentinel conditions.

This study used the items deemed “essential”, developed by consensus of 130 experts at the African Federation for Emergency Medicine Consensus Conference 2013, to develop a tool, the Emergency Care Assessment Tool (ECAT), incorporating these using signal functions for the specific emergency sentinel conditions. The tool was administered in a variety of settings to allow for the necessary refinement and context modifications before and after administering in each country. Four countries were chosen: Cameroon, Uganda, Egypt, and Botswana, to represent West/Central, East, North, and Southern Africa respectively. To enhance effectiveness, ECAT was used in varying facility levels with different health care providers in each country. This pilot precedes validation studies and future expansive roll out throughout the region.

Aims and Objectives

This study aimed to administer the original ECAT tool to develop a refined, standardized, and reliable version of the tool with the potential to accurately and efficiently assess emergency care services in varying facilities across the African continent. To achieve this aim, the study had the following objectives:

- Administer ECAT in different facility levels (basic, district, tertiary/referral centre) in different African regions
- Collect feedback from participants and incorporate into changes of ECAT with the research team after each country
- Determine inter-rater and intra-rater reliability through different staffing perspectives

Methods

This study was a prospective administration of the tool at a convenient sample of health facilities at different levels of care in four different countries representing the four major regions of Africa. The countries participating in this study included Egypt, Uganda, Botswana, and Cameroon to represent North, East, Southern, and Central/West Africa, respectively. The tool was administered at three health facilities (one entry-level, one mid-level, and one referral-level) per country for inter-rater reliability. The tool was repeated for one participant per country to assess for intra-rater reliability of the participants. This study made refinements on the tool before administration to participants and after the administration in each country.

Results

The study resulted in the creation of a refined tool using signal functions, categorized by major sentinel conditions, evaluated against discrete barriers to delivery. This study also refined the methodology of completion of the tool, including the process of administering the tool. Determining intra- and inter-rater reliability was not possible due to small sample sizes. Preliminary data collected using the tool revealed the type of useful information that can be extracted from this tool in subsequent larger iterations.

Conclusions

ECAT is a tool that focuses on service provision at the individual facility level via the use of signal functions; it provides a standardized way to assess the capabilities of the health facility in handling critical emergency conditions. ECAT has the potential to collect meaningful information that can guide effective improvements in the delivery of emergency care. Finalizing ECAT would require further studies with

formal, qualitative interviews, robust reliability and validity studies, and the development of a scoring system for assigning meaningful facility designations.

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ACROYNYMS AND ABBREVIATIONS

AFEM:	The African Federation for Emergency Medicine
ECAT:	Emergency Care Assessment Tool
IFEM:	The International Federation for Emergency Medicine
LMIC:	Low- or Middle-Income Country
MoH:	Ministry of Health
WHA:	World Health Assembly
WHO:	World Health Organization

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CHAPTER 1

Introduction

1.1 Background

Emergencies happen everywhere; "*all healthcare facilities will be faced with acutely ill patients, whether they are prepared or not*" (1). Any person at any time is susceptible to needing access to quality emergent health care. These people, whether acutely sick or injured, will often access local health facilities for unplanned, undifferentiated care. Ideally, at these facilities, the emergency condition is recognised and interventions are made to prioritise, stabilise and properly manage patients, including further definitive care if indicated (1). High-income countries recognise this important role and intentionally organize and equip health systems and facilities with the proper resources and trained professionals to accomplish this. However, in low-income countries, multiple barriers exist, blocking access to those needing emergent care (2–5).

A properly functioning emergency care system significantly improves morbidity and mortality on a country-wide and regional scale (6–8). Delay in or provision of inappropriate emergency care lead to deaths (7). In countries without proper emergency care services incorporated into their health systems, demand for these services has already risen because of its proven benefits for providing life-saving interventions (6). Conversely, prompt treatment can potentially ease burden of disease of many conditions afflicting low resource settings (9). The Disease Control Priorities in Developing Countries project calculated that 45% of deaths and 36% of disability in low-and middle-income countries could be affected by emergency care system development (10).

Governments increasingly recognise the essential role of a developed emergency care system in improving public health initiatives and morbidity and mortality and so, support its development; this may be in the form of emergency care training in medical school curricula and nurse training, development of a national ambulance service, or the establishment of emergency medicine specialist training programmes (11–14). However, a formal structure for emergency care in many low resource settings, such as in Africa, is only in the beginning stages. In recognition of this, the sixtieth World Health Assembly (WHA) in 2007 culminated in the development of *WHA Resolution 60.22* which recognised the need for a country to have a "formal, emergency medical-care system" (5,15). It urged its member states

to “assess comprehensively the prehospital and emergency-care context.” Even with the recommendations for the evaluation and development of emergency care, there is a lack of formal methods in evaluating and developing such services.

This studies aims to address this gap in the development of an evaluation toolkit on delivery of emergency care at the facility level.

1.2 Emergency care

1.2.1 What is emergency care?

The terms ‘acute care’, ‘emergency care’, ‘emergency medicine,’ and ‘emergency services’ are widely used but loosely understood; many times these terms are improperly considered synonyms. Without clear definitions, discussion about, advocacy for, and advancement of such services are near impossible: only recently were precise definitions proposed (4,8).

‘Acute care’ is a broad term that encompasses multiple domains including emergency care, urgent care, short term stabilization, prehospital care, critical care, and trauma care and acute care surgery (8) (Figure 1). Specifically, this entails “the provision of initial resuscitation, stabilization, and treatment to acutely ill and injured patients, and delivery of those patients to the best available definitive care, regardless of their ability to pay,” as defined by the African Federation for Emergency Medicine (AFEM) (4). This definition emphasizes access to and quality of services in its definition. ‘Acute care’ refers more to a broader, systems level service, requiring a functioning health system with proper infrastructure (4).

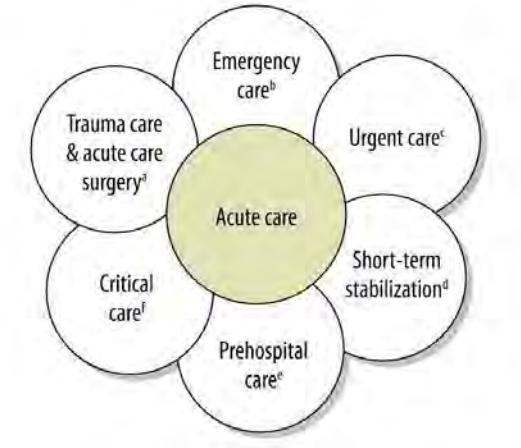

Figure 1 Domains in acute care (8)

The term ‘emergency care’ is one aspect of acute care that specifically refers to the “treatment of acute life- or limb-threatening medical and potentially surgical needs, such as acute myocardial infarctions or acute cerebrovascular accidents, or evaluation of patients with abdominal pain” (8). The concepts of urgency and risk are the two key facets in emergency care; intervening in a timely fashion for patients with conditions of high morbidity and mortality are the services emergency care must provide (1). This includes first recognizing life-threatening and time-sensitive syndromes, and then taking the steps to stabilise and manage these patients (1). This is mostly in-hopsital care, in contrast to “acute care” which includes pre-hospital care (4). The provision of emergency care can determine outcome and mortality and therefore can influence a person’s health (7).

‘Emergency medicine’ is a concept that is related to, but not equivalent to ‘emergency care’ or acute care’. It is defined by the International Federation for Emergency Medicine (IFEM) as a “*field of practice based on the knowledge and skills required for prevention, diagnosis and management of acute and urgent aspects of illness and injury affecting patients of all age groups with a full spectrum of episodic undifferentiated physical and behavioural disorders; it further encompasses an understanding of the development of prehospital and in-hospital emergency medical systems and the skills necessary for this development*” (16). Emergency medicine is a specific training programme with standardized and regulated curricula and examination (17). The focus of emergency medicine is providing emergency care (17). Emergency medicine is a specialist-based service that should not be confused with ‘emergency care’ or ‘acute care’.

Health care workers providing emergency care are often a patient’s first point of contact to definitive care, beginning with the first steps of recognition, prioritisation and stabilisation (1). Ideally, these health care workers must then be able to triage (prioritise) higher risk patients, and then appropriately intervene a patient’s time-sensitive illness (6).

In this dissertation, ‘emergency care’ and ‘emergency services’ will be used when evaluating the services provided to a patient presenting with an acute injury or illness at the facility-level. ‘Acute care’, referring to a wider system-based concept, was not evaluated in this dissertation.

1.2.2 Horizontal integration

The role of health systems is to improve the overall health of members of the community (17). As discussed above, this can be achieved in part through timely access to life-saving interventions via the development of acute and emergency care services. By incorporating these services, overall health systems can be strengthened, improving morbidity and mortality. The development of acute and emergency care services and its incorporation to a country's health system is a type of horizontal integration of services. Horizontal integration of emergency care services into the health system could ensure that patients receive life-saving care in a timely fashion.

Horizontal integration refers to providing services at the population level, such as a system for primary health care (5,18). In contrast, vertical integration focuses on intervening for specific health issues with a specific intervention, such as an independent HIV programme that is self-sustaining, functionally and financially (17,18). The advantages to a vertical integration strategy are more precise goals, less ambiguous results, and more straightforward management (17).

The development of a horizontal integration programme, however, has the potential to prepare and strengthen an entire health system for a multitude of health conditions, and will not prioritize limited resources to the management of only one condition or one specific intervention (9,17,19). With horizontal integration programmes, multiple points of intervention throughout the health system are developed or improved; this means that care can be extended beyond the management of one disease or one population group, or a single intervention like screening. As a result, the entire system, if equipped to handle a broader population, health condition, and interventions, can be better prepared for a variety of epidemics and disaster situations. In reality, the global agenda has focused on addressing specific disease states or at-risk populations in programmes specifically centred on decreasing mortality from Ebola and HIV/AIDs, or focused on pregnant women and children (1,9,17). This excludes a major portion of the population from benefitting from these programmes and only specific diseases that are addressed and fully managed. In recognition of this, more health initiatives are including aspects to strengthen health systems (20).

The development and strengthening of a health system that includes emergency care could improve outcomes for a wider range of populations and disease states (1). This is especially important in places where patients are seeking urgent, symptomatic care more than preventative or primary care, such as in Africa (1). Timely intervention through effective acute and emergency care decrease morbidity

and mortality (10). Conversely, effective acute and emergency care relies on the coordination of other resources and services, making it essential that acute and emergency systems are integrated into broader health systems (17). By horizontal integration of emergency care services into the health system, more of the population can receive life-saving interventions with fewer delays, resulting in better outcomes.

1.2.3 Historical beginnings of emergency care in Africa

Emergency care is not a new concept in Africa. In 1979, the government of Mozambique included and recognised emergency care services as a priority of health (6). However, only in recent years have an increasing number of countries in sub-Saharan Africa acted on the need for improved emergency care systems. As a part of this, several countries have developed emergency medicine (EM) specialist training programmes as a strategy to improve health care services countrywide (12,13,21–23).

Egypt was one of the first African countries to establish Emergency Medicine, with specific training programmes starting in 2001 (24). The Egyptian universities in Alexandria, Tanta, and Suez Canal offer master's degrees in emergency medicine with over 200 graduates as of 2013 (24). The first EM specialist training programme in Sub-Saharan Africa was established jointly at the University of Cape Town (UCT) and Stellenbosch University (SU) in 2004; the first specialists graduated in late 2007 (21,22). In common with other South African programmes, it consists of a four-year Master in Medicine degree, a dissertation and two sets of examinations (21). Tanzania and Ethiopia have since introduced 3-year Masters of Medicine programmes in Emergency Medicine at Muhimbili University of Health and Allied Sciences (MUHAS) and Addis Ababa University (AAU), respectively, and produced their first specialists in 2013 (12,23). Ghana established a formal specialist training programme in 2015, but has had an advanced training programme in emergency care since 2009 at the Komfo Anokye Teaching Hospital (KATH) in Kumasi (13).

In addition to formal residency programmes, professional emergency medicine societies in Africa have begun to emerge, including in countries without formal training programmes. These include the African Federation for Emergency Medicine, the Emergency Medicine Society of South Africa, the Emergency Medicine Association of Tanzania, the Egyptian Society of Emergency Medicine, the Libyan Emergency Medicine Association, the Ethiopian Society of Emergency

Medicine Professionals, the Sudanese Emergency Medicine Society, and the Society of Emergency Medicine Practitioners of Nigeria (25).

1.2.4 Emergency care in Africa

In 2007 at the sixtieth WHA, emergency care was determined as an essential component of a country's health system (15). Even with this mandate, development of a formalised structure for emergency care in Africa is only in the beginning stages. Emergency care provision varies throughout the region, but is mostly underdeveloped (17). Many facilities do not have a discrete area for emergency care, some may only have an area within a facility that provide emergency services, and in others, there may be a separate emergency department or casualty ward (26). In addition, those hospitals with dedicated emergency or casualty departments are many times in practice, only an arrival area for patients, rather than an area functioning to providing acute care services and interventions (6).

The types of resources dedicated to these distinct areas for acute care also differ based on facility levels. In basic level facilities, emergency care typically entails a one-room facility with a single health care practitioner (2,3). A facility considered district level may or may not have a designated area for emergencies; referral facilities also differ greatly in capabilities in managing acute conditions, including differences in equipment, infrastructure, and services provided (2,3). There is no standardized or agreed upon definition of these designations in providing care to a patient or quality improvement measures (2,3).

In addition, access to these areas is also limited and varied (17,27). Most countries in Africa have no formal transportation system for emergencies and the patient and the family are forced to find their way to the most convenient local health facility that may or may not be equipped to handle acute conditions (27). As a result, acutely ill patients improperly use primary care centres and their resources and staff, who are not equipped or trained in emergency care services (6,27,28). In practice, most patients do not seek or utilize primary care services as a preventative service, rather, opt to find care based on symptomatic presentation (29).

Once the patient does arrive to a health facility, in most hospitals in Africa, triage is not a recognised practice, rather, a *first come, first served* model predominates over severity of presentation (3). Acutely ill patients may have to wait since there is no triage system or training in triage to recognise those that require time sensitive interventions (30). This lack of triage can lead to increased mortality and morbidity

from delays in providing key early interventions (30). In addition, treatment protocols that have been shown to decrease mortality rates are largely lacking in facilities and training programmes (31).

Another major barrier to the development of emergency care in Africa is the lack of data available in documenting the burden of disease (26). There is little data on actual presentations to facilities, interventions attempted, and outcomes (6,17,32). The Disease Control Priorities project recognises that research on current epidemiology of critical conditions and interventions is essential to establishing emergency services that is specifically tailored to local needs (10). However, there is little information on what conditions facilities in low-income countries are facing and how they are managing these conditions (10,32). As a result, quality measures, regulation of quality, and improvement strategies are majorly lacking (26). First documenting the current state of emergency care in Africa is necessary before improving efficiency, outcomes, and cost-effective strategies to supplement those resources and services (10).

1.2.5 Barriers to developing emergency and acute care services

The development and improvement of acute and emergency care systems in low and middle income countries would greatly strengthen overall health systems and have proven to improve morbidity and mortality, and relieve burden of disease (7). Even with evidence showing the benefits of these services and mandates for its development, such as from the WHA, barriers prevent the improvement of emergency and acute care services and its incorporation into health systems (5,15).

As outlined by AFEM, barriers include (4):

- *Lack of data on burden of acute disease*
- *Lack of an integrated approach to triage, resuscitation, and stabilization of acutely ill patients*
- *Limited resources for health care in Africa, including a critical shortage of trained health care personnel in all cadres*
- *Lack of standardized regionally-appropriate clinical guidelines for acute care at the sub-district and community level*
- *Essential components of acute and emergency care have not been established, and there is no consensus on how to define the success of initiatives*
- *No current advocacy plan for placing acute care on the global health agenda*

To some extent, the lack of information can be remedied through the use of an assessment tool which looks at capacity for emergency care services in facilities; this could serve a secondary function and provide targeted recommendations for improvement. The development of such an assessment tool could be used to quantify lack of resources and training, to specify problem areas, to improve on guidelines at local levels, and to advocate for acute care; multiple barriers could be addressed with such tool.

1.3 Evaluation of facilities

1.3.1 Need for measuring capacity

The World Health Organization (WHO) defines health systems as "*(i) all the activities whose primary purpose is to promote, restore and/or maintain health; (ii) the people, institutions and resources, arranged together in accordance with established policies, to improve the health of the population they serve, while responding to people's legitimate expectations and protecting them against the cost of ill-health through a variety of activities whose primary intent is to improve health*" (33). To strengthen health systems, there must first be a way to recognise and measure those problems, and then implement changes that will improve health through adequate access, financial coverage, improved quality, or increased efficiency (33). Strengthening emergency care systems will enhance all of these functions of the health system because it is based on the principles of efficiency, life-saving interventions, and horizontal coverage for all population groups.

To strengthen health systems, countries can develop and improve emergency care and acute care services, but governments need to first determine the current state of these services, knowing how their facilities are functioning and at what availability (10). There is currently limited information on what facilities have or are lacking; most data are limited to only one part of emergency care services (34). For example, a 2011 study at hospitals in Ghana, Kenya, Rwanda, Tanzania, and Uganda evaluated the barriers to providing adequate emergency surgical care, not the full breadth of emergency services (28). This study found that none of the hospitals surveyed met the essential minimum standards set by the WHO in basic infrastructure, equipment, medicine storage, infection control, education, and quality control (28). In addition, less than half of surveyed facilities were capable of 24-hour services (28). A standardized, context-specific tool that captures a facility's ability to

provide all emergency services is necessary to recognizing deficits and making appropriate changes to strengthen a facility's delivery of care.

1.3.2 Current tools

There have already been attempts to develop tools to evaluate a facility's capacity to provide emergency services, however, none capture the full breadth of all possible emergency conditions or focus on service provision. There is no appropriate, standardized, and accurate assessment tool to guide health care facilities in the implementation of effective emergency care. The available tools are helpful in assessing capacity, but do not provide an in-depth assessment of emergency service provision (and indeed were not intended to fulfil that function). In order to assist in regional development of emergency care systems at a facility level, a standardised tool for facility evaluation is required.

The WHO tools and non-WHO tools that are currently available focus on specific emergency conditions and do not comprehensively evaluate multiple conditions. For example, the WHO tools, *Guidelines for Essential Trauma Care* (35) (36), *Pre-hospital Trauma Care Systems* checklist (37), and *Monitoring emergency obstetric care* (38), assess only trauma, pre-hospital trauma care, and obstetrical emergencies, respectively. There are also non-WHO tools, however, they also focus only on one aspect: the *Harvard Humanitarian Initiative* tool (39), *PIPES: Personnel, Infrastructure, Procedures, Equipment, Supplies* (40), *G-TSET: Global Trauma System Evaluation Tool* (41), and *INTACT: International Assessment of Capacity for Trauma* (42), focus specifically on only surgical and anaesthetic or trauma care.

The tools that exist are mostly facility checklists, determining whether a certain item is present, and generally do not specifically focus on comprehensive service provision or capacity. The WHO *Guidelines for Essential Trauma Care* is a checklist of determining the presence of over 200 items for management of trauma in a facility, but does not ask about sufficient number of providers, skill level of providers, or policy barriers (35, 36). Other existing tools are similarly designed as facility checklists, including the *Integrated Management for Emergency and Essential Surgical Care- Tool for Situational Analysis to Assess Emergency and Essential Surgical Care* (43), *Prehospital Trauma Care Systems* (37), and *Essential resources for the delivery of emergency care in hospitals* (7). Although these tools capture important information, only one aspect is assessed: resource availability.

Existing tools do not cover all emergency conditions or do not specifically evaluate capacity of providing a service. Instead, most focus only one part of service delivery, such as the availability of a supply item or infrastructure. To better capture emergency care capacity, a tool must be developed that attempts to comprehensively include the majority of emergency conditions by delivery of service; this includes more aspects than can be captured in a facility checklist. This study strives to meet to develop a tool that can meet these goals.

1.3.3 Signal functions and sentinel conditions

In 2009, the WHO developed a tool targeting the specific clinical syndromes for obstetrical emergencies in *Monitoring emergency obstetric care* (EmOC) (38). These obstetric and newborn emergencies include haemorrhage, sepsis, unsafe abortion, pre-eclampsia, eclampsia, and prolonged obstructed labour (38). The WHO EmOC tool specifically uses "signal functions" to assess a facility's ability to deliver specific life-saving interventions to manage these emergencies (38).

Signal functions are life-saving services that are based on function, not individual components (38). An example of a signal function is the ability to administer antibiotics intravenously, which assesses knowledge, intervention, and supplies (1). The use of a signal function allows the evaluation to focus on the practical capacity and delivery of a service, rather than cumbersome checklists about specific supplies and equipment; however its sensitivity still allows for the detection of serious flaws at a facility level (38).

Using such functions, a health facility that provides obstetrical care can be considered "Basic" or "Comprehensive" based upon compliance of EmOC parameters (38). Such outcome indicators are better at reflecting the actual state of the health facility for management of obstetrical emergencies, than the conventional approach of mortality ratios (38). These indicators are superior to impact indicators because they provide more meaningful and useful information, and are directly translatable to informing and modifying health policies and programmes (38).

EmOC's signal functions were based on specific clinical syndromes that occur for obstetrical emergencies. Similarly, emergency conditions also have specific clinical syndromes, regardless of aetiology, that occur before death, called "sentinel conditions". Informed partly by the WHO *Integrated Management of Adult and Adolescent Illness,* the sentinel conditions for emergencies include:

- Respiratory failure
- Shock states
- Altered mental status
- Dangerous fever
- Severe pain, and
- Trauma (44).

Signal functions were developed for each of the sentinel conditions using the following organisation:

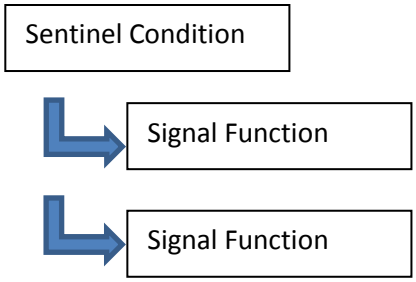

Figure 2 Sentinel conditions and signal functions

1.4 African Federation for Emergency Medicine and the development of the Emergency Care Assessment Tool

1.4.1 African Federation for Emergency Medicine

The African Federation for Emergency Medicine (AFEM), formed in 2009, is an international association aimed at networking and supporting national societies, organisations, and individuals dedicated to the development of emergency care across Africa. In 2011, AFEM hosted its first consensus conference where over 100 leaders in emergency and acute care in Africa acknowledged the gap in standardized ways to assess the impact of emergency care interventions (26). At this meeting, participants agreed on the need to develop an outcome metrics at the facility level for acute care interventions as a way to also collect data on burden of disease.

The second AFEM consensus conference – held in 2013 and attended by 130 experts from over 30 countries – continued on this mandate and recognised the need to define and agree on the necessary components of emergency care in order

to efficiently integrate it into health systems (26). The workgroup used the core sentinel conditions, partially informed by the WHO Integrated Management of Adolescent and Adult Illness (IMAI), to guide in the development of the necessary features, in the format of signal functions, of a facility providing emergency care (1,44). The signal functions were developed around each sentinel condition. Each signal function was carefully discussed and agreed upon as the minimum, essential service needed to recognise and stabilise patients.

In addition, the workgroups also developed standardized requirements of basic, intermediate, and advanced level facilities on areas such as facility infrastructure, technology, and supplies and equipment (26). The terms, “basic”, “intermediate”, and “advanced”, were chosen instead of ambiguous terms, such as “district” or “regional”, more commonly used by ministries of health (1). This standardization is important for ease of comparison and meaningful designations for each level of facility and to reflect how a facility labelled at a high level may only have a basic level of emergency care services.

The 2013 AFEM consensus conference resulted in a product with the basic framework of the essential components of delivering emergency care, based on sentinel conditions, using signal functions, and stratified by facility level by consensus of the leaders of emergency care in Africa.

1.4.2 Development of the Emergency Care Assessment Tool

Using the framework developed at the consensus conference, a preliminary tool, called the Emergency Care Assessment Tool (ECAT), was created (Appendix 1). The original ECAT tool included a total of 280 items, directly from the discussions at the consensus conference, and was categorized in three main sections. The first section was organized by the sentinel conditions informed by the IMAI (44).

The second section included items regarding facility infrastructure, and the third section was a list of specific materials which evaluated for physical availability and functionality.

1.5 Problem statement

There is a need to develop emergency care systems and to integrate them into health systems in Africa, and recently the desire to do so has been more evident. There is evidence that such developments can impact morbidity and mortality.

However, there is still no objective measurement tool that attempts to evaluate comprehensive essential emergency service provision by a healthcare facility. A tool which can assess a facility's current capacity and deficiencies, in an efficient way, through a focus on clinical service delivery, would be a useful addition to existing assessment tools. The results of such an assessment could then inform policy makers, hospital managers, curriculum directors, and other stakeholders to develop an action plan for emergency care delivery improvement. AFEM has developed such a tool, based on sentinel conditions and signal functions, but it has not yet been field tested in African health facilities.

1.6 Aim and objectives of study

1.6.1 Aim and objectives

This study aimed to refine the AFEM Emergency Care Assessment Tool. To achieve this aim, the study had the following objectives:

- Use ECAT in different facility levels (basic, district, tertiary/referral centre) in different African regions
- Take feedback from participants and incorporate into changes of ECAT after each country
- Determine inter-rater and intra-rater reliability through different staffing perspectives

1.6.2 Purpose of the study

The purpose of this study was to refine the ECAT; this was achieved by utilising it at three different level facilities in four African regions, surveying different provider cadres, and amending the tool based on user feedback.

CHAPTER 2

Literature review

Health systems can be improved through the development of emergency care systems (1). With functioning emergency care systems, patients with acute injury or illness can be recognised and managed in a timely manner (7). This leads to improved morbidity and mortality and a decreased burden of disease (7). There have been attempts at evaluating parts of emergency care service delivery, in the form of facility checklists or focusing on specific areas such as trauma, but there is no tool that covers the breadth and scope of all emergency services of a health facility (35,37).

High-income countries, such as the United Kingdom and Australia, have assessment tools such as the Quality Outcomes Framework and the Australasian Clinical Indicator Report, but these are not context appropriate for sub-Saharan Africa, which include mostly resource-limited settings (45,46). There are marked differences in burden of disease, established research, and public and facility infrastructure, making these tools unsuitable to most of Africa, where there are fewer uses of emergency services, resources, and capabilities (1,47).

In the low-resource setting, there is no standard framework for assessing a facility's capability in treating patients needing emergency care; as a result, it is impossible to assess effectiveness at a facility level (1). The only available tools assessing facilities are specific to certain specialities or conditions, such as obstetrics and gynaecology, surgery, or trauma (1).

The WHO has released *Guidelines for Essential Trauma Care* (35,36), *Integrated Management for Emergency and Essential Surgical Care* tool (43,48), *Prehospital Trauma Care Systems* (37), and *Monitoring emergency obstetric care* handbook (38); while helpful in assessing capacity, they do not provide an in-depth assessment of emergency service provision and were not intended to fulfil that function. There have been other tools to supplement the ones developed by the WHO (discussed below). However, there is still a lack of tools assessing emergency care provision at the facility level. This is not to suggest that any tools need to be replaced, rather that there is a lack of a tool that broadly assesses emergency conditions in general, using service indicators.

These checklists are created so that countries are able to strive to provide better quality care (35–38,43,48). If governments base policy and infrastructure off the results of these facility-based health checklists, patients could have a better chance of accessing health facilities, as well as ensure that they receive the appropriate care, such as surgery, hospitalization, and post-hospital care, when indicated (35).

2.1 Existing assessment tools

There is no appropriate, standardized, and accurate assessment tool to guide health care facilities in the implementation of effective emergency care. Rather, there are multiple checklists that are focused to only certain clinical conditions or speciality areas. Tables 1 and 2 summarise the most common assessment tools in use. Each tool serves a specific purpose and reveals meaningful data, however none use service indicators to evaluate emergency care, specifically or comprehensively, and few have been validated.

2.1.1 WHO tools

There are multiple tools developed by the WHO that are currently used to reach specific goals (Table 1). None of these adequately addresses emergency care specifically or comprehensively.

Table 1 Existing WHO assessment tools

WHO Tool	About	Advantages	Disadvantages
Guidelines for Essential Trauma Care (35,36)	• Human & physical resources • Based on 11 essential trauma services • Full Essential Trauma care Checklist • Brief Essential Trauma Care Checklist	• Three specialized checklists (basic, district, tertiary levels) • Stratification: essential, desirable, possibly required, irrelevant • Standardized designation	• Only trauma, no other emergencies • 260 items
Integrated Management for Emergency and Essential Surgical Care (IMEESC)- Tool for Situational Analysis to Assess Emergency and Essential Surgical Care (TSAAEESC) (43)	• Equipment and needs assessment • Measure surgical capacity	• Asks about interventions, not only surgical outcomes	• Referral level facilities only • Surgical services only
Prehospital Trauma Care Systems (37)	• Skills, supplies, equipment in prehospital phase	• Focus on assessing, stabilizing, transporting • Stratifies essential & desired	• Only prehospital trauma care • Not assess treatment of medical or obstetrical emergencies
Monitoring emergency obstetric care (38)	• Nine questions with categories of failures • Signal functions, not a list of individual components	• Fast (nine questions), based on service delivery (signal functions) • Designations: basic or comprehensive • Use outcome indicators: directly useful in policy decisions and programme changes	• Obstetrical emergencies • Missing component of time- assumes 24 hr/day service • Does not capture function or supplies

The *Guidelines for Essential Trauma Care,* by the WHO, comprises a list of 260 items of all the human and physical resources that a health care facility should have to provide appropriate care to an injured person, based on 11 essential trauma

services (35). There are three different checklists: one for a basic facility, one for a GP-staffed (district level) hospital, and one for both a specialist-staffed hospital and tertiary care facility (35). The 260 items are rated as “essential”, “desirable”, “possibly required”, or “irrelevant” depending on the level of the health facility (35). This guideline was developed to provide a comprehensive checklist for what the health facility should have; but it does not develop a standardized way to designate the health facility based on the results of the checklist (35,36). While a large fraction of the global burden of disease occurs from injury, this checklist does not account for other emergency conditions that contribute to morbidity and mortality. To simplify the process, the *Full Essential Trauma Care Checklist* was condensed to a one hour *Brief Essential Trauma Care Checklist* of only the most essential knowledge, skills, equipment, and supplies (36). These checklists include the WHO’s minimum recommendations to countries in providing adequate trauma care service, in regards to “human and physical resources” (1).

The *Integrated Management for Emergency and Essential Surgical Care* (IMEESC) tool provides an equipment list and needs assessment called the *WHO Tool for Situational Analysis to Assess Emergency and Essential Surgical Care* (TSAAEESC) that refer to only surgical capacity. However, this is a checklist for essential equipment for resuscitation and a needs assessment at a first-referral health facility with surgical capabilities (43,48). Surgical services are mostly only available at referral level facilities and so, this checklist is not applicable to facilities without surgical capacity or with fewer resources and providers with less training. The TSAAEESC tool focuses on the treatment of surgically-managed disease such as obstetrics and gynaecology, and acute surgical and trauma care (43). The checklist includes a list of essential items and asks about specific interventions, equipment, infrastructure, and human resources, rather than surgical outcomes(49,50). The IMEESC was designed to discover inadequacies in these areas regarding surgical services only, not for any emergency condition (51). As of 2012, the TSAAEESC tool was the most used in low resource settings to measure surgical capacity (52).

The *Prehospital trauma care systems* document was developed in order to identify the necessities to “enable lay people and health-care providers to assess, stabilise and transport injured victims” to appropriate facilities (37). It was designed based on the principle that there are two elements needed when assessing trauma care: knowledge and skills, and equipment and supplies (37). Each service and equipment is marked as “Essential,” “Desired,” “Physically Remote,” or “Irrelevant”

depending on the importance and cost effectiveness of that item in achieving a positive outcome (37). The goal is to describe efficient prehospital trauma care to ultimately guide governments in providing systems of care to an injured patient in the prehospital phase (37). This document also uses the designation “essential” and “desired” based on the type of provider in the prehospital setting: basic first aid, advanced first aid, basic prehospital trauma care, and advanced prehospital trauma care (37). This checklist is administered at a trauma facility to determine areas needing improvement including training, quality assurance, and hospital inspection (37). This checklist, however, is only for trauma and injury care; it does not include the clinical skills, equipment, supplies, or medicines for treating common medical or obstetrical problems (37).

The *Monitoring emergency obstetric care* handbook, EmOC, was designed specifically for obstetrically emergencies. Moreover, EmOC created a standardized way to translate information gathered from a simple survey into a meaningful designation (38). This handbook was created specifically to “define a health facility with regard to its capacity to treat obstetric and newborn emergencies” (38). Facilities are asked a series of nine questions based on treating these emergencies and are then categorized as either “basic” or “comprehensive,” subsequently (38). Patients who then use these facilities would know what services are available to them and hospital administrators would know which areas needed improvement.

This facility assessment was based completely around signal functions, not a long, burdensome checklist of equipment and provisions as typically done; in this way, it emphasized the importance of service delivery (1,38). However, EmOC advises that including a more detailed list of functions and supplies would be more helpful in advising areas of improvement (38). This assessment also assumes that each of the signal functions of an EmOC facility is available every hour, every day of the week but does not specifically address this aspect (38). Time availability is lacking in the EmOC Handbook and could be very useful information to collect. Upon the development of EmOC, there was also a desire to assess signal functions for other conditions besides just obstetrical emergencies (38).

It is important to note that these facility checklists do capture valuable information and that there is no need to replace these existing tools; there is, however, a gap in assessing facility functionality.

2.1.2 Non-WHO tools

There have also been a number of non-WHO tools that have been developed, each designed to collect different information (Table 2).

Table 2 Existing non-WHO assessment tools

Other tools	About	Advantages	Disadvantages
Harvard Humanitarian Initiative (39)	• Surgical capacity in Africa • Eight areas of surgical and anaesthesia care • Yes/no questions or quantifying amounts/frequencies	• Targets areas of need: resources, education, development	• Only surgical & anaesthesia care
PIPES (Personnel, Infrastructure, Procedures, Equipment, Supplies)	• Data collection and analysis of surgical care capacity • Based on personnel, infrastructure, procedures, equipment, supplies	• Designed for low- and middle-resource setting • Calculate index to follow up over time (easier data analysis)	• Only surgical care • No outcome measures • Assesses quantity, not quality of each category • Skewed statistical weight of certain items over other
G-TSET (Global Trauma System Evaluation Tool)	• Assess trauma system on national level • Given score based on no or full capability, benchmark score & component score	• Designed for low- and middle-resource setting • Top down perspective of system development (establish system framework)	• Only trauma care • Not facility based
INTACT (International Assessment of Capacity for Trauma)	• Based on PIPES and TSAAEESC for trauma care • 40 key elements of resuscitation, laparotomy, chest tube insertion, fracture repair, burn	• Elements of PIPES (infrastructure/ supplies, procedures, equipment/ personnel) • Scale of 0-10 from binary scoring system	• Only trauma care • Consensus of 3 authors
Essential resources for the delivery of emergency care in hospitals	• Quality improvement measures, personnel, organization and administrative capacities, lab services	• Stratifies resources across facility levels	• Mostly specific equipment and medications

The *Harvard Humanitarian Initiative* also developed a survey to assess surgical and anaesthesia capacity, specifically for sub-Saharan Africa (39). This yes/no survey, with some quantifying questions regarding amount and frequencies, is based on eight main components: access and availability, access to human resources, infrastructure, operating room information and procedures, outcomes, equipment, non-governmental organization delivery of surgical services, and pharmaceuticals (39). The goal was to evaluate infrastructure, training programmes and the system's ability to obtain data on surgical outcomes (39). A major limitation to the yes/no model is the lack of ability to note "creativity": for example, although hospitals may keep their medications cold by placing them under an air conditioner, a simple question asking if there is a refrigerator would not reflect a facility's true capabilities (39). This survey was able to collect targeted information regarding resource, education, and development inadequacies (39).

The *PIPES (Personnel, Infrastructure, Procedures, Equipment, and Supplies)* tool was developed by Surgeons OverSeas, based off of the WHO's TSAAEESC, to simplify data analysis of facility capacity assessments, specifically for low and middle income countries (40). The PIPES tool calculates an index score based from105 items regarding availability and the number of operating rooms, personnel, infrastructure, procedures, equipment and supplies; this score is based on the principle that higher index scores correlate to better conditions (40). The data is recorded into a binary score of "always available" or "not always available" and a weighted index score is calculated (40). This simple tool can be easily administered over time to reflect improvements or changes and allows easy comparison to other facilities (40). By quantifying capacity, it also removes ambiguous, subjective and, at times, unreliable answers to questions about areas such as skill (40). However, it does not directly assess skill or service delivery, and focuses more on quantification (40).

The *Global Trauma System Evaluation Tool* (G-TSET) was developed to assess trauma systems, rather than individual facilities, to provide recommendations for "nation-centred development" (41). G-TSET, which only assesses trauma, evaluates the necessary elements in a trauma system: system leadership, access to care, initial resuscitative care, acute injury care, rehabilitation, prevention, and education/research/quality improvement, each with recommended "benchmarks" and indicators (41). Each component is given a score, with details on areas for improvement and areas that are up to standard; these scores are then used to develop a composite score (41). This systems-level approach allows assessment of

prehospital care and care as well as at the facilities, rather than at a facility-level (41).

The *International Assessment of Capacity for Trauma* (INTACT) index is another facility-based assessment on the provision for trauma care, based on components of PIPES and the TSAAEESC, by consensus of three authors (42). INTACT includes 40 criteria regarding resuscitation, laparotomy, chest tube insertion, fracture repair, and burn management, assessing infrastructure/supplies, procedures, and equipment/personnel (42). INTACT only assesses trauma, and no other area. Similarly to PIPES, INTACT uses a binary scoring system for items necessary at all times for trauma care, with a maximum possible score of 10 (42). INTACT removed items from PIPES such as medical records, adjunct medical professionals and obstetrical procedures (42).

The Disease Control Priorities Project also provided an *Essential Resources for the Delivery of Emergency Care in Hospitals*, stratifying resources across various levels: major emergency care centre, regional emergency care centre, district emergency care centre, and primary care centre (7). Although it includes quality improvement measures, personnel, organization and administrative capacities, and laboratory services, most of the recommendations are of specific equipment and medications (7).

2.2 Contextualizing tools

These tools collect a range of information, prioritizing certain aspects more than others. The tools can be contextualized by the type of data each collect and the main focus of each tool (Table 3).

Table 3 Tools in context by function

Perspective	Purpose	Example	Outputs of Tool
Health System Governance Finances Info & Research Service delivery Med Prod/ Tech Health workforce	- Gives a unified picture of the health system readiness/capacity to implement emergency care	- WHO *Emergency Care System Assessment Tool* (*under development)* - WHO *Tool for Assessing health system capacity for disaster management* (53)	- Roadmap for health system change – recommended large scale modifications to change a population's outcomes
Service Delivery All health facilities	- Aggregate indicator ("quick check") of the most essential components of an emergency and then receiving appropriate care - Provides a regional overview of the emergency service delivery capacity at a variety of different facilities - Identifies general barriers to provision of critical life-saving interventions	**Emergency Care Assessment Tool**	- Recommendations for regional health planning (maps where essential services are delivered/not) and necessary inputs to remedy barriers to care delivery identified - With defined facility capacity and recognised barriers, provides usable data for disaster planning
Supplies and Delivery Single health facility	- Provides detailed knowledge about whether the necessary supplies (med prod/ tech), infrastructure and health workforce are present to provide services - often implies what services should be provide but doesn't necessarily evaluate in any detail	- *Personnel, Infrastructure, Procedures, Equipment, and Supplies* (PIPES) (40) - *The International Assessment of Capacity for Trauma* (INTACT) (42) - *Global Trauma System Evaluation Tool* (G-TSET) (41)	- Recommendations for what infrastructure and supply gaps there are that if present, may augment service delivery
Mixed Tools	- Provides more detailed information about actual service provision and the detailed analysis of the facility to make that service provision happen	- *Essential Trauma Care Project* (36)	- Recommendations for gaps in service delivery and the supply/infrastructure required to provide those clinical services

2.3 Previous studies using existing tools

There have been multiple studies using existing tools, but very few that test their reliability or validity. There have been no studies measuring the effectiveness of these tools. In addition, the conclusions made from these studies are specific evaluations of one component of emergency care; no existing tool assesses a facility's capacity of managing all possible emergency presentations.

2.3.1 WHO *Tool for Situational Analysis to Assess Emergency and Essential Surgical Care* (TSAAEESC)

The most commonly used tool in the literature is the WHO TSAAEESC tool. There have been numerous studies, including in Rwanda, Liberia, Sierra Leone, Uganda, Ghana, and the Gambia, that use TSAAEESC to evaluate surgical care capacity; in these countries, a country-wide assessment has never been done previously (52,54–58). These studies showed that the implementing TSAAEESC provided comprehensive, qualitative and quantitative data, showing baseline conditions of services, training, infrastructure, equipment and supplies, interventions, and human resources, important for future planning (52,54).. It provided a rudimentary "snapshot" of the country's capacity for surgical intervention, and major weaknesses; for example, every element of adequate surgical care in Sierra Leone was rated "severely limited" with absent running water and broken oxygen concentrators (54,55). In Uganda, where no hospital surveyed had a continuous supply of essential blood, oxygen source, medications, or pulse oximeter, the data showed that the need outweighs the resources with one of the highest rates of cases per operating theatre: 1,877 procedures per operating theatre (56).

Although not its primary function, the TSAAEESC tool also revealed patterns; for example, caesarean section is the most common surgical procedure performed in Rwanda (52). It also showed disparities of services geographically: in Rwanda, 80% of operating theatres exist in district level facilities but 80% of trained surgeons reside in Kigali, and in Uganda, 90% of physicians reside in Kampala but most hospitals are 30 to 500km away from Kampala (52,56).

This data allows for consulting with local authorities, especially ministries of health, to advise on most effective solutions (52). In Rwanda, most hospitals have the infrastructure to handle surgeries, but access and materials, specifically for emergency airway supplies, are limited (52). In Uganda, Sierra Leone, and Liberia, infrastructure is one of the main barriers to providing surgical care (54–56). In

contrast, Ghana has relatively well equipped facilities for surgical care, but has few properly trained personnel (57). The main focus on capacity, not outcomes, is a major advantage of the TSAAEESC over only mortality and morbidity rates, especially for consulting on future developments (52). It allows for appropriate priority setting, programmatic changes, policy and infrastructure development, budget re-appropriation, and deficits in supplies (54,55).

The use of this tool make comparisons possible among the international surgical standards, in addition to other resource-limited settings (52,54). With this tool, it was made clear that Uganda has one of the highest burden worldwide of surgically treatable diseases (56).

For most of these studies, the TSAAEESC had to be locally adapted (52,56). In addition, there were inconsistencies and wide interpretations using this survey, even as on-site interviews, because it primarily collected qualitative data and assessed a constantly-changing pool of personnel (52,55,56). In addition, only surgical data were collected, excluding emergency capacity of the facilities.

Moreover, there have been few reliability and validation studies of the TSAAEESC tool. In most instances, there were attempts to verify data informally from direct interviews, such as with physical inspection or with referencing log books and reports, however, these studies noted inconsistencies (55,56). In a formal validation study of the TSAAEESC tool, the kappa for the whole survey was 0.43, with a kappa of 0 for the surgical procedures section and higher kappas for infrastructure, 0.81, human resources 0.77, and emergency surgical equipment, 0.81 (59). This tool was still found to be reliable for “structure and setting” but recommended revision for “process of care” (59).

2.3.2 WHO *Guideline for Essential Trauma Care*

Similarly, the WHO’s *Guideline for Essential Trauma Care* successfully identified barriers to adequate care in trauma in India, Mexico, Vietnam, and Ghana, allowing for recommendations for improvements (60)(61). In India, there was a significant deficiency of essential, low cost materials such as chest tubes, and a “mismatch of resources,” such as a functional X-ray machine and trained technician but a lack of X-ray film, or a CT machine but few trained CT technicians (60). This survey allowed for an appropriate, targeted recommendation for low-cost, life-saving equipment and for specific training courses (60).

In other studies using the *Guideline for Essential Trauma Care* tool, recommendations were made based on the results of the survey (61). Personnel shortages in Ghana, revealed through administration of this tool, were found to be due to migration to urban settings or to foreign countries; focused remedies could include stronger local incentives and regulation of foreign recruitment (61). This study also showed delays in access to equipment were not always due to shortages, but from poor organization and planning of the facility (61). In addition, there were deficits in essential low-cost items, supporting the need for equipment monitoring and registries (61). This tool has been described as the most realistic tool to assess for the minimum and essential trauma care standards worldwide (61). However, there have been no validation studies using this tool.

2.3.3 Surgical capacity assessments

In a literature review of surgical capacity assessments, most barriers in low income settings were due to infrastructure and resource deficits (62). With such data on determining deficiencies, next steps can include specific strategies for improved inputs and outputs, and monitoring and evaluating with appropriate benchmarks (62).

For example, after administration of the Harvard Humanitarian Tool in Ethiopia, the government was able to address the lack of trained physicians in surgery with increasing numbers of training initiatives (39). The tool also revealed a “bottleneck of resources” because only one medical supplier existed for the entire country (39). This tool, though not tested for reliability or validity, was found usable and meaningful for future directions.

2.3.4 Overall trends

There were few studies done using non-WHO tools, none of which assessed emergency care, but universally, the studies showed the benefits to collecting baseline data, especially for targeting areas for improvement. These studies showed the importance and impactful data that a simple survey could capture. Although there are already a wide variety of surveys, there is still a need for a standardized survey for emergency care that is comprehensive but also usable and easy to administer, that provides accurate and meaningful information along consensual criteria with translatable data analysis. Each survey had marked

advantages and disadvantages, but there is still none that addresses all emergency conditions and capacity in service provision. In addition, most of the tools have not been tested for reliability or validity.

2.4 Development of the Emergency Care Assessment Tool

At the 2013 AFEM Consensus Conference, a group assigned signal functions needed to successfully care for pre-identified sentinel conditions. The guiding framework for discussion was organized around the six sentinel emergency conditions, informed by the WHO IMAI:

- Respiratory failure
- Shock states
- Altered mental status
- Dangerous fever
- Severe pain, and
- Trauma

The working group agreed that all levels of health care facilities, regardless of the resource level, should be equipped to recognise and manage these six conditions with graded levels of intervention. (1)

The ECAT tool was subsequently developed based on the agreed upon signal functions from the Consensus Conference. ECAT is intended to capture a facility's strengths and weaknesses in delivering emergency health services for the six sentinel conditions in a timely fashion using the appropriate resources. ECAT answers the crucial question: are life-saving services being delivered at the facility level?

Several existing tools, such as EmOC, categorize facilities as "Basic", "Intermediate", or "Advanced" (or similar language); ECAT is not intended to perform such categorization or undertake an equipment or resource audit (35,38,61). It will only assess a facility's ability to perform signal functions. In line with what EmOC does to monitor and evaluate a facility's ability to provide emergency obstetrical care, ECAT aims to present a way to capture a facility's ability to care for basic emergencies (38).

Similarly to EmOC, ECAT will be used to determine if there are functioning facilities that can manage basic emergencies and if quality care is provided (38). The main indicator for ECAT is the provision of essential emergency services.

In addition, as with obstetrical emergencies, there needs to be an assessment of how often and which barriers to delivery occur most in a given facility in caring for basic emergencies. This would allow for even more targeted and effective interventions to improve service provision. For example, if a service is not provided due to lack of training, then this barrier could be remedied with introduction of more training programmes or extra courses targeted for specific skills. However, if a service is not provided due to a lack of supplies or equipment, this must be remedied differently with potential budget changes, equipment and supply ordering, hiring of an equipment specialist for repairs, etc. Determining barriers to the delivery of care provide additional information to allow for targeted, specific improvements.

EmOC surveys why a signal function cannot be performed including “training issues”, “supplies, equipment, and drugs issue”, “management issue”, “policy issues”, and “no indication” as possible reasons (38). ECAT also includes similar categories. These were originally called “categories of failures” and then renamed to “barriers to delivery”. This study also determined if these barriers also apply to emergencies and if there are other barriers to delivery that need to be included.

CHAPTER 3

Methodology

This was a tool refinement study using prospective, on-site administration of the ECAT tool at health facilities. This study made improvements to the original tool developed at the AFEM consensus conference.

3.1 ECAT refinement process

3.1.1 The original ECAT tool (version 1)

The original ECAT tool, derived directly from the AFEM Consensus Conference, had a total of 280 items: 185 stratified by specific sentinel conditions, 28 regarding facility infrastructure, and 67 regarding specific materials (Appendix 1). The sentinel conditions were evaluated against availability; these categories were “available 24/7”, “usually available”, “occasionally available”, “never available”, and “unknown”. The facility infrastructure and specific materials were evaluated under the categories of “present”, “not present”, or “unknown”.

3.1.2 Stages of revisions

The ECAT tool was revised before conducting the initial survey and after administration in each country, using feedback from participants and consultation with the ECAT research team. Further details regarding this process can be found in later sections.

The original ECAT was a list of signal function items agreed at the consensus conference. It needed revisions regarding organization, specific inclusion and exclusion of certain items, removal of redundant items, layout, and formatting. From the conference, there was consensus on the signal function items, but there was no agreement on what these items would be evaluated against: availability, time, barriers to delivery. With discussion of the ECAT research team, multiple revisions were made prior to conduction of the survey.

A preliminary toolkit was pilot tested at referral level facility in South Africa. Using participant feedback, the ECAT research team made further revisions – primarily to the language used – for improved usability, feasibility, and clarity. The research

coordinator/author (CB) collected and examined each survey for comments which was relayed to the research team.

The survey was then refined after administration in each country (three facilities per country). The research coordinator (CB), again, collected all comments written on the designated 'comments' section on the surveys and relayed to the research team. After a discussion weighing all of the comments to make changes or not, the ECAT was revised for piloting in the subsequent country. These changes included clarifications on wording, changes in methodology, and formatting. Although surveys from each facility were carefully reviewed, the same survey was used in each country and changes were only made after completion of the survey in all three facilities in a country. This revised version was then used in the next country's facilities.

3.1.3 Research team

The research team included:

- Professor Lee Wallis, MBChB, MD
- Assistant Professor Emilie Calvello, MD, MPH
- Associate Professor Teri Reynolds, PhD, MD
- Assistant Professor Andrea Tenner, MD, MPH
- Morgan Broccoli, MSc, MD candidate
- Crystal Bae, MD candidate (ECAT research coordinator and author)

3.2 Administration of ECAT

3.2.1 Survey procedures

First, participants read information about the study and the administrator gave them the opportunity to ask questions; after clarification, the participants signed the consent form (Appendix 2). Next, they completed a form regarding background questions on their facility to determine the participant's position and skill level at the facility, and about the health care facility itself, and confirming the facility level itself (Appendix 3). They were then explicitly told that questions and comments during the survey were encouraged. Next, the administrator explained and provided examples for each barrier to delivery and allowed time for questions. They were also given a standardized reference sheet with these definitions and examples to use throughout the administration of the survey (Appendix 4).

The tool administration included a series of yes/no questions with possible follow up questions based on the response. The administrator explained that answering "yes" to a question was under the assumption that the signal function was available all the time, 24 hours a day, and 7 days a week. As a prospective survey, ECAT was administered using appropriate language. For example, the administrator would ask "If a patient with *(sentinel condition)* entered your health facility right now, would you be able to *(signal function*)." If an item was marked "Yes," then the administrator moved to the next question. If an item was marked "No," then the administrator followed up and asked why, in the framework of the "barriers to delivery" that were explained prior to the start of tool. The administrator marked the appropriate box for "barriers to delivery" and documented any further details under the "comments" section. It was important that the administrator stress that ECAT is assessing the capability of the health facility and not the knowledge base of the participants.

The administors asked participants for clarification after each sub section of the survey. In Cameroon, the tool was administered in English; however Dr. Hollong did make clarifications and explanations in French when requested. At the end of the entire tool, the administrators asked each participant for informal feedback which was recorded in the "comments" section of the tool. The interviews were not recorded. Tool administrators did not check for the validity of the responses of the participants, which was beyond the scope for this study.

3.2.2 Training to administer ECAT

Each administrator was trained on administering the ECAT survey with a one-on-one training session either in-person or via video call using copies of the documents to be used during the survey by the research coordinator. The session entailed a review of the details of the survey including each question and barriers to delivery, anticipated goals and outcomes of the administration, aspects to emphasize, and practicing administering part of the survey. Once trained, each ECAT-trained researcher was given a document summarizing important points for referencing (Appendix 5).

3.2.3 Administrators of ECAT

The following administrated the ECAT tool at the pilot sites:

- Egypt: Dr. Gamal Khalifa

- Uganda: Crystal Bae (author/research coordinator)
- Botswana: Bridget Griffith
- Cameroon: Dr. Bonaventure Hollong

3.3 Design

3.3.1 Study sites

This study sampled the major geographic African regions. We chose four countries to represent the regions: facilities were in Egypt, Uganda, Botswana, and Cameroon to represent North, East, Southern, and Central/West Africa, respectively. South Africa was specifically not chosen to represent Southern Africa in this study, to allow for a more accurate representation of the southern region; South Africa has relatively more resources than other southern African countries (63).

AFEM has local representatives in each of the chosen countries who facilitated in selecting appropriate health facilities representing different levels of the health system, using convenience sampling A total of three health facilities (one district, one regional, and one referral/university centre) were surveyed per country; 12 unique facilities were studied overall.

3.3.2 Participants

After obtaining local ethics approval, AFEM's local representative identified appropriate health facilities to survey based on convenience sampling. Random sampling was not used since this was not an analysis of health facility capacity, but rather a survey development study. The hospital manager at each facility helped to identify three personnel in the designated emergency area in each of the facilities: one senior physician, one senior nurse, and one other clinical provider to participate at each site. An ECAT researcher, trained in the protocol, conducted the tool administration for each personnel.

3.3.3 Protocol

Surveys were conducted in four different African countries, at three different facility levels per country. In order to help refine the tool, completed surveys at each health facility were collected and reviewed before administering at the next health facility.

The exact same tool was used in the three sites for the same country. ECAT was refined with agreed-upon changes after consultation with research team, based on the results and feedback of the administration of the survey; this was done before the next country was surveyed.

At each facility, three different providers participated; this was in an attempt to evaluate inter-rater reliability among the three providers.

At one randomly selected site per country, a repeat assessment was done of the same tool after one week. This assessment was done with one of the three clinicians who had previously participated in an attempt to assess intra-rater reliability of the assessment tool of the participant.

After the visit, the health facilities was offered a copy of the survey for their review; however, it was made clear from the outset that this was a tool development activity and not an assessment of the health facility itself or capabilities of the region.

3.4 Country-specific background

Table 4 Country-specific data

Botswana (South)	**Uganda (East)**	**Egypt (North)**	**Cameroon (West/Central)**
Upper middle income (64)	Low income (65)	Lower middle income (66)	Lower middle income (67)
High burden of disease: trauma (68)	High burden of disease: road traffic accident (69)	High burden of disease: heart disease (70)	High burden of disease: infectious diseases (71)
• 3 public referral hospitals (11) • 1 facility using triage scale (72,73) • Ambulances for transfers between facilities (11) • 2011: establishment of EM specialist programme (11)	• EM not recognised by the Ministry of Health • No specialist EM programme established • Emergency Care Practitioners (mid-level providers) (74)	• 2001: establishment of EM programmes (24) • Many Egyptian EM physicians leave Egypt (24) • Many local positions filled by generalists (75)	• EM not recognised by the Ministry of Health • No specialist EM programme established • Few facilities provide after-hours care (76)

3.4.1 Botswana

Botswana is in Southern Africa and is, according to the World Bank, considered upper middle income, with steady economic growth, increasing enrolment in school, and a national health system (64). With a population just over 2 million and an average life expectancy to age 47 in 2014, Botswana has few emergency care provisions (11). Pre-hospital care in Botswana consists of a fee-for-service model, which only those that can afford high costs can utilize, ambulances with only drivers and no trained professionals, and a lack of a national dispatch system and emergency call centre (11). As a result, most patients arrive to the designated emergency area on their own or by transfers from other facilities (68).

The three public referral hospitals in the country are Princess Marina Hospital (PMH) in Gaborone, Nyangabwe Hospital in Francistown, and Sbrana Psychiatric Hospital in Lobatse; most of the emergency care services available at these hospitals are provided by medical officers and nurses with little training in emergency care (11). In a one-year review of patient presentations to the emergency centre in PMH from May 2010 to April 2011, 20% of presentations were from trauma (68). Such high burden of disease reflects the need for training in acute management of trauma, especially from motor vehicle accidents (68). The next most common diagnoses were also conditions that require urgent recognition and skill; these were pregnancy complications, gastrointestinal disorders, and pneumonia (68). This reflects on the need for adequate emergency care services.

Emergency care is still an emerging specialty in Botswana. Emergency Medicine was only recently recognised as a specialty in 2009 by the Botswana Health Professions Council, and in 2011, Emergency Medicine was established as a postgraduate programme through the University of Botswana School of Medicine (11). This programme accepted four Emergency Medicine residents into a four-year Master of Medicine programme, modelled after the South African residency curriculum (11). Currently, the few residents in this new programme and the foreign emergency medicine physicians that train these residents are the only physicians with specialized training in the entirety of the country (11). There are very few formally trained physicians in emergency medicine in Botswana.

In addition, at PMH, the Princess Marina Hospital Accident & Emergency Triage Scale (PATS), found that proper triaging, individualized to the local context and modified from the South African Triage Scale (SATS), prevented “under-triage” and “over-triage” (72,73). Avoiding undertriage allowed severely ill patients to receive timely and appropriate care and avoiding overtriage prevented wasting time and resources (72,73).

3.4.2 Uganda

Uganda is in East Africa and, according to the World Bank, is considered a low income country with a population of almost 39 million people, a life expectancy to age 59 years in 2014, a fertility rate of 6 births per woman, and mortality under age 5 years of 66% in 2013 (65). Emergency Medicine is not currently recognised as a specialty by the Ugandan Ministry of Health and there is currently no specialty training programme for emergency medicine physicians through any university in Uganda. Most of the major referral health centres in Uganda have an outpatient area for emergencies during the day, but at night, patients are directly admitted to the hospital (69). There is no pre-hospital system in place and patients are mostly brought by self-referral, family or police (69).

A study done in Kampala, the capital of Uganda, in 1998, found that 50% of injuries were caused by road traffic injuries and that 73% of injury patients were male, most of whom were young students (69). With delays in accessing care, those with severe injuries have poor outcomes; those that died arrived an average of 45 minutes after injury (69). This study importantly noted that many die before reaching the hospital and many with severe injuries do not even seek formal care at a facility (69).

There is minimal development of emergency care services in Uganda, with no formally trained, local EM physicians in the country. There has been the development of midlevel health providers, Emergency Care Practitioners (ECPs), in an attempt to fill part of this need (74). ECPs are midlevel health providers, nurses with at least 2 years training in acute care, that further specialize in providing acute care (74). These are the highest trained providers in emergency care in Uganda (74).

3.4.3 Egypt

Egypt, according to the World Bank, is a lower middle income country with a population of over 83 million people, a life expectancy of 71 years in 2013, and a mortality rate of 22% in those under 5 years (66). In 2013, a major burden of disease was heart disease, according to the Institute for Health Metrics and Evaluation (70). Egypt was one of the first African countries to establish Emergency Medicine, with specific training programmes starting in 2001 (24). As of 2013, there

were over 200 graduates and three universities in Egypt, Alexandria, Tanta, and Suez Canal, offering master's degrees in emergency medicine with approved curriculum (24).

Although established over 14 years ago, emergency medicine training programmes in Egypt are not monitored for quality, resources are limited in many facilities, and many of these trained emergency medicine graduates are leaving the country (24). In a 2013 survey on current emergency medicine residents in Egypt, 100% surveyed were unhappy with their training due to a lack of prioritization of emergency medicine by policy makers, little value towards education and evaluation, and no mentoring (75). As a result, local positions at emergency care facilities are being filled by general physicians, or those trained in other specialties (24). Although Egypt has established programmes, the maintenance of the quality of programmes and satisfaction of its trainees are important to its future successes and ultimately, improved patient care.

3.4.4 Cameroon

Cameroon is a lower middle income country, according to the World Bank, with a population of almost 23 million, a life-expectancy of 55 years in 2013, and a 95% mortality rate for those under age 5 (67). According to the Institute for Health Metrics and Evaluation, infectious diseases posed as one of the highest burdens of disease in Cameroon in 2013 (71).

In addition, emergency medicine is not a recognised field by the Ministry of Health and there are no current specialist emergency medicine training programmes in place. According to an estimate in 2002, there is approximately one emergency ward for every 1.25 million people, with most of the resources and skilled providers at the major referral centres (76). Of the 12 referral hospitals surveyed, only one hospital was able to provide emergency services at night; the others did not have adequately trained health care workers or resources for services after hours (76).

3.5 Data collection and management

Surveys were collected from 12 different facilities across four countries, with a total of 36 different participants. There were a total of 40 surveys, including the repeat assessments administered in each country. The earlier versions took approximately one hour to complete, but later versions took up to 30 minutes. The surveys were

collected and kept by the ECAT researcher and sent to the research coordinator (CB) for analysis. Specific health facility results were made known to the health facility administrator and the regional authorities upon request.

Collected data were compiled and handled by ECAT researchers only. Only study investigators had access to the completed toolkits and results. All data were stored on a password protected work computer.

The results did not contain any identifying information of the participant or the administrator. The information will not be sold or used for any commercial purpose.

3.6 Data analysis

Microsoft Excel was used for recording answers to the survey by the research coordinator (CB). Each item was keyed as 'yes' or 'no', for each survey. All data points from each survey were then checked by two others on the research team for accuracy. To assess for reliability, the yes/no responses to the surveys were used. First, Kappa analysis was used to determine inter-rater reliability for the three health care providers who participated at each facility. Then, Kappa analysis was used to determine intra-rater reliability for the surveys that were repeated with the same participant; this was done only once per country.

Responses from "barriers to delivery" were not analysed using quantitative statistics due to the qualitative nature of these answers. Frequencies were determined for each marked barrier to delivery.

3.7 Ethical considerations

Ethical approval was obtained from the University of Cape Town's Human Research Ethics Committee (HREC/REF number 858/2014) (Appendix 6). Local ethics approval was obtained for each country, the process unique to each setting; either via individual facilities, through specific scientific committees, or through the country's ministry of health (Appendix 7).

- Ethics approval in Botswana was obtained from the Botswana Health Research and Development Division of the Ministry of Health (Reference number: HPDME 13/18/1 1X (407)
- Ethics approval in Uganda was obtained from the Mulago Hospital Research and Ethics Committee and from local hospital managers

- Ethics approval in Egypt was obtained at each facility by each hospital manager
- Ethics approval in Cameroon was obtained by Le Comite National d'Ethique de la Recherché pour la Santé Humaine from the Ministry of Health

Participation in the study was voluntary, and participants were given the option to decline at any point of the survey. All participants signed a formal consent form which also guaranteed anonymity. In addition, the first page of the tool provided information about the study. At that time, participants were given the opportunity to ask questions pertaining to the survey. The subsequent page included questions regarding background information of the health facility and of the participant, including his or her signature. There was no reimbursement for participation in this health facility survey.

ECAT is intended for any facility, however, in this study, only public hospitals were assessed since the majority of the population in each country seeks care in public hospitals.

3.7.1 Risk to participants

This study did not anticipate any risk to participants by taking part in this survey. It is possible that participants experienced discomfort, however using non-judgemental and standardised language (as outlined during ECAT administration training), this could be avoided. In addition, there was clear communication that the survey was not an assessment of the participant's knowledge base or a comprehensive regional analysis of health facilities.

3.7.2 Benefit to participants

Benefits after the finalisation of the tool will lead to a standardised way to assess the capabilities of the health facility in handling critical emergency conditions. This will lead to a clearer way of finding areas of improvement for a given health facility, allowing for a more targeted approach in improving better patient care and handling the majority of life-threatening conditions most amenable to timely intervention.

CHAPTER 4

Results

The aim of this study was to use the original ECAT tool in three different facility levels (basic, district, and referral levels) in each of the four regions of Africa (North, East, Southern, West/Central) to create a refined and standardized tool with the potential to accurately and efficiently assess emergency care services in varying facilities across the African continent.

To do this, this study:

- Used administrator feedback and incorporated responses into changes of ECAT with the rest of the research team after each country
- Attempted to determine inter-rater and intra-rater reliability through different staffing perspectives

This chapter is organised as:

- Tool development phase
    - Overview of tool development
    - Original ECAT
- Changes prior to administration
- Administered ECAT versions (by country)
- Preliminary reliability studies
- Preliminary facility-level data

4.1 Tool development phase

4.1.1 Overview of tool development

There were several changes made during the tool development phase. Table 5 gives an overview of the main changes.

Table 5 Overview of changes during tool development

ECAT versions	Descriptions	Problems
Original versions of ECAT: • Version 1- from consensus conference (Appendix 1) • Version 2- subheadings • Version 3- Designations • Version 4- Partial scoring parameters (Appendix 8)	• Section 1-3 (sentinel conditions, facility infrastructure, materials) • Availability parameters (section 1) • Time allowance (sections 2 & 3) • Basic, Intermediate, Advanced designations • Subheadings	Facility Checklist • Not consistent use of signal function • Too long • Repetition in items points (condition & material)
Simplification of ECAT: • Version 5- modelled from EmOC • Version 6- secondary questions (Appendix 9)	• Signal functions only • Removed sections 2 & 3 • Sentinel conditions: add “maternal health”, removed “dangerous fever” • Scoring • Binary yes/no question for availability (24hrs/day) • Two-tiered questioning • Categories of failures	• Too simplified and general • Preliminary categories of failures (later changed to “barriers to delivery”
Final versions of ECAT: • Version 7- signal functions • Version 8- • administered in Cameroon (Appendix 10) • Version 9- administered in Uganda and Egypt • Version 10- administered in Botswana/ Resultant ECAT (Appendix 11)	• Signal functions only • Sentinel conditions only • Barriers to delivery • Not a 2-tiered format • Failed use of subheading questions	• Compromise of comprehensive but simplified

- Original ECAT: 280 items, 17 pages, 3 sections with 5 sentinel conditions, availability parameter
- Resultant ECAT: 73 items, 8 pages, 6 sentinel conditions, 6 barriers to delivery

4.1.2 Original version of ECAT (version 1)

The original ECAT tool was developed directly from discussions during the 2013 AFEM Consensus Conference; each item was reviewed and agreed upon at the conference as an essential component of emergency care delivery at level of health facility (Appendix 12). The original ECAT had three main sections: capabilities of the management of sentinel conditions, facility infrastructure checklist, and a materials checklist.

- Section 1: Sentinel Conditions
    - General capabilities- 13 items
    - Management of respiratory failure- 50 items
    - Management of shock- 47 items
    - Management of altered mental status- 28 items
    - Management of dangerous fever- 11 items
    - Management of severe pain- 36 items
- Section 2: Facility Infrastructure- 28 items
- Section 3: Materials
    - General materials- 16 items
    - Materials to treat respiratory failure- 26 items
    - Materials to treat shock- 16 items
    - Materials to treat altered mental status- 2 items
    - Materials to treat dangerous fever- 1 item
    - Materials to treat severe pain- 6 items
- (Total items = 280 items)

For section 1, items were evaluated against availability; these categories were “available 24/7”, “usually available”, “occasionally available”, “never available”, and “unknown”. “Available 24/7” meant that the facility could successfully complete the signal function every day of the year and every hour of the day. “Usually available” meant that it could be completed more than 50% of the hours every week of the year. “Occasionally available” meant that it could be completed any percentage of time less than 50% and greater than 0% any given week. “Never available” meant that it could not be completed.

For section 2 and 3, facility infrastructure items and materials were also evaluated against availability but in categories of “present”, “not present”, or “unknown”. “Present” meant that the attribute of the facility or materials was available at the

facility at the time of administering the survey. “Not present” meant that the attribute or material was not available at the time of the survey.

This original tool had a total of 280 items, with a number of repetitive items, specifically with the items in the “general capabilities” categories, most of which were covered throughout the rest of the sections. For example, “glucometer” was under both “general capabilities” as a skill in using the glucometer as well as “general materials” for presence of the item. This occurred for a number of items such as “gloves”, repeated in general materials and general capabilities, “ultrasound”, repeated in the management of severe pain, facility infrastructure, and materials to treat severe pain, and “supraglottic device” under respiratory failure and “supraglottic airway” under materials to treat respiratory failure.

4.2 Early ECAT (Changes prior to administration)

The major changes made to ECAT were based on discussion of the following:

- Use of signal functions
- Scoring and designations
- Availability and time element
- Question format
- Updated sentinel condition categories
- “Categories of failure” and “Barriers to delivery”
- Administration of ECAT

This section reviews the changes made thematically. Further details of these changes are discussed in chapter 5.

4.2.1 Facility checklist format vs. Signal functions

A major issue with the original versions of the ECAT (versions 1-4) was its format. The tool was intended to be a concise and efficient way to determine if a facility could provide adequate, essential emergency care services, however a 10-page survey with 179 item points was not reflective of this. It took more than an hour to fully complete in this form, with three separate sections of: sentinel conditions, facility infrastructure, and materials, making the ECAT tool too lengthy and unwieldy.

ECAT was subsequently changed in versions 5 and 6 to reflect facilities' willingness and ability to be flexible to provide services. As a result, section 2 (facility infrastructure) and 3 (materials) were deemed extraneous once the items in section 1 (sentinel conditions) were transformed to true signal functions. ECAT was revised to focus on assessing skills, which encompassed the need for materials, but did not exclusively assess availability of materials.

In contrast, versions 5 and 6 were too vague and general, allowing too much to interpretation. "Can your facility manage an obstructed airway?" was improved as an inquiry of capacity and not a checklist; however, it was not as informative. Although simpler, this format was too reductionist. Participants were left to interpret this question on their own, which allowed inconsistency and non-standardized responses. The management of an obstructed airway was inclusive of multiple levels of skills and the addition of the secondary questions was necessary to capture what was meant by "managing an obstructed airway".

The final versions of the tool (versions 7-10) were transformed to accomplish both simplicity and completeness by using only signal functions that were edited to assess function but still be informative.

4.2.2 Designations and scoring

At the 2013 consensus conference, each signal function that was discussed was marked as either "essential" or "desired" for a "basic", "intermediate", or "advanced" facility. The first decision made was to only include the signal functions that were considered "essential" at the consensus conference, not "desirable". This meant that items that were considered "desired" in an advanced facility, such as "dental area/cart", "ENT area/cart", and "ophthalmologic area/cart" were eliminated from the tool.

In addition, after further testing, the facility infrastructure and materials checklist were removed due to issues with designations and scoring.

Another problem with earlier ECAT versions with designations was the assessment of the signal function against time and availability. In earlier versions, the parameters of "available 24/7", "usually available", "occasionally available", "never available", and "unknown" were used. A numerical scoring system was attempted in version 4 (0 = absent but should be present, 1= inadequate, 2= partially adequate,

3= present and functional). This was changed to the use of binary yes/no questions in later versions to imply “always available” for a signal function

A scoring sheet was developed but testing and finalisation of this scoring sheet was beyond the scope of this tool refinement study (Appendix 13).

4.2.3 Availability and timing

The original versions of ECAT evaluated signal functions against availability parameters; these were ultimately removed in the later versions.

The original versions of ECAT used the parameters for time:

- “available 24/7”- facility can successfully complete the signal function every day of the year and every hour of the day
- “usually available”- can be completed more than 50% of the hours every week of the year
- “occasionally available”- can be completed any percentage of time less than 50% and greater than 0% any given week
- “never available”- cannot be completed
- “unknown”

In an attempt to assign scores and designations to facilities using the results, a numerical scoring system was developed in version 4 to attempt to evaluate availability:

- N/A= not applicable at that level
- 0 = absent (and should be present)
- 1= inadequate
- 2= partially adequate (present, but use not assured; present, but not all the time; present, but not readily available)
- 3= adequate (present and used appropriately)

In line with using the strict definition of “essential” to mean “always” available, the availability parameter was removed. If a facility could not perform an essential signal function at all times, then it was indicated as not a fulfilled signal function.

The team also attempted to provide discrete parameters for “in a timely manner” for delivering a signal function. However, it was ultimately defined that this should be left ambiguous, as it depends on the service provision and the scenario.

4.2.4 Question formatting

ECAT was meant to determine current capacity of a facility and so, it was decided from the start to ask questions prospectively. The format of asking the signal function items was specified to the time frame of “today”.

In addition, the ECAT questioning was changed from open-ended answers to close-ended. In the first version, the intended way to administer the tool was to first ask a general question such as “Ask how the provider would address a patient who is not breathing”. If not specifically mentioned, the administrator was to specifically ask about the items that were in that category.

After multiple discussions and using participant feedback, the ECAT research team standardized the administration of ECAT. For following surveys, the questions would be asked in the format: “You have a patient coming in with [sentinel condition], can you perform [signal function]…” with a section for comments and clarification at the end of each sentinel condition section.

4.2.5 Updated sentinel condition categories

Throughout ECAT tool development, sentinel condition categories were also changed. In version 1, the categories were:

- Management of respiratory failure
- Management of shock
- Management of altered mental status
- Management of dangerous fever
- Management of severe pain/ trauma

In the early versions, efforts were made to keep these original six sentinel conditions (however, pain and trauma were grouped together in version 1). However, to be more comprehensive and clear, specific changes were made: trauma was considered its own discrete category, separated from pain, dangerous fever was removed, and maternal health was added.

The resultant ECAT had the following categories:

- Respiratory failure
- Shock
- Altered mental status
- Severe pain

- Trauma
- Maternal health

4.2.6 “Categories of failure” and “Barriers to delivery”

Barriers to delivery, originally termed “categories of failure”, were used in lieu of the availability parameter, which were discontinued based on reasons in chapter 5.

Categories of failure were introduced in version 5 and were based on those in EmOC (38). They included:

- Capacity building and education issues:
    - Lack of educational resources
    - Lack of training programmes
    - Lack of human resources
- Supply gap
    - Equipment is not available or functional
    - Medication is not available
- Lack of process protocol
    - Lack of process protocol to triage
    - Policy issue (governmental bodies do not allow this function to be performed)
- System architecture issue
- Management issue: providers are uncomfortable or unwilling to perform this function for reasons other than training (i.e.: alternative procedures are encouraged)
- No indication: no patients have needed this procedure
- Other: please put in comment section

In order to better define the categories, training and human resources were separated into discrete categories and “system architecture” was separated into facility infrastructure and system management. The categories of failure in version 6 of ECAT were edited to:

- System management (triage system, processes for patient flow, financial provision for emergent patient)
- Human resources
- Health care worker training
- Supplies, equipment, medications

- Local policies mandating care
- Facility infrastructure (water, power, blood bank, CT, X-ray)
- No indication
- Other

The category, “system management” was eliminated. For version 7, distinct definitions and examples were developed for clarity:

- Policies: lack of policies and process that facilitate optimal patient care (e.g. triage system, timely patient movement to definitive care, automatic financial provision for emergent patient
- Human resources: insufficient number of authorized cadre of health care workers to perform the desired function
- Health care worker training: authorized cadre is available but not trained, or there is a lack of confidence in providers’ skills
- Supplies, equipment, medication: supplies and equipment are not available, not functional or broken, or needed drugs are unavailable
- Infrastructure: critical facility based infrastructure, such as electricity, lab, blood bank, X-ray, CT scan, intensive care unit, are not available or not functional
- No indication: no client needing this procedure comes to this facility
- Other/Comments

No additional categories were suggested by the participants to add as another possible option while ECAT was administered in the countries. It was also decided to rename the categories to “barriers to delivery”.

4.2.7 Administration

The early versions of ECAT took over an hour to complete and resulted in the collection of redundant information. The later versions took a maximum of half an hour to complete, depending on the knowledge of the participant. In general, those in lower level facilities, where more participants required detailed explanations of signal functions, participants required more time to complete the survey.

Over time, the research team developed a formal protocol to administer the ECAT survey. To standardize administration of the tool, a 20-minute training session accompanied by a detailed document entitled “instructions to administer ECAT” was required for each ECAT researcher to complete (Appendix 5). This document

provided specific instructions for before, during, and after the administration of the tool, addressing commonly asked questions. Next, participants completed a simple form regarding background information about the person undertaking the assessment, to clarify the participant's position and skill level at the facility, and about the health care facility itself, confirming the facility level (Appendix 3). After receiving consent and addressing additional questions, the ECAT researcher explained the barriers to delivery and encouraged use of the document throughout the survey (Appendix 4). Investing time to carefully explain each the barrier to delivery led to faster completion of the survey and, arguably, more accurate results.

Most of the changes to ECAT were done prior to administration in each of the countries. At this point, the ECAT was an 11-page toolkit with 73 items.

4.3 Administered ECAT versions (by country)

These versions of ECAT were revised after administration in each country, using feedback from participants and consultation with the ECAT research team.

4.3.1 Cameroon

ECAT version 8 was the tool administered in Cameroon. However, a scoring sheet was also developed corresponding to the basic, intermediate, and advanced signal functions.

Changes made to the tool after Cameroon included:

- Under abdominal pain, the signal function of performing a urine dipstick/HCG test was found confusing as some facilities were able to do one but not the other. As a consequence, this item was separated into two discrete signal functions to reflect how these are different tests.
- For items regarding administration of medications, participants found it confusing when asked "if yes" to the ability of administering a medication to only "circle one" from the options of the route of administration: "PO", "IM", or "IV". These items were changed to "If yes, circle: PO, IM, IV" of the routes capable at the facility, instead of instructing to only circle one item.
- Development of a "Barriers to delivery" documents with definitions and examples for referencing.
- The development of "Instructions to administer ECAT" document with specific instructions for the administrator to refer to at any time.

- Changing terminology from “primary”, “district”, and “referral” to describe facility levels to:
    - “entry-level” facility to include clinics or basic level facility
    - “mid-level” facility to include regional and district level facilities
    - “referral-level” facility to include academic and university level facilities

4.3.2 Uganda and Egypt

ECAT researchers used the same survey in Uganda and Egypt because the project received local approval at similar times.

The changes made after administration in Uganda and Egypt:

- Instructions when administer: Clarity that the availability of a signal function is in the emergency care area of the facility, not at another site in the facility
- Multiple barriers to delivery could be indicated as problematic to delivery of a function
- Removal of subheading questions
- For administration of medication, “rectal” was added as another possible route in addition to “PO”, “IM”, and “IV”.

Specifically in Egypt, there many instances where barriers to delivery were not chosen when it was indicated. This was due to poor training of the ECAT administrator, who did not have a clear understanding that this was the necessary step to successfully completing the toolkit. This was remedied in the training for the ECAT administrator for the next country.

4.3.3 Botswana

No changes, other than formatting, were made to the survey after administration in Botswana.

After administration of the pilot in four African countries, the resultant ECAT was 8 pages with a total of 73 items, instead of the original 280 items. These items were stratified based on sentinel conditions: 15 items regarding respiratory failure, 18 regarding shock, 10 regarding altered mental status, 9 regarding severe pain, 17 regarding trauma, and 4 regarding maternal health. Each signal function was evaluated against six possible barriers to delivery. Barriers to delivery included

problems with policies, human resources, health care worker training, supplies/ equipment/ medication, infrastructure, and no indication.

By the end, training of the administrators was standardised and clarified, and the research team refined the ECAT toolkit. With smoother administration of the toolkit, completion of ECAT was faster and more streamlined. The resultant toolkit took 20-45 minutes, depending on the knowledge base of the participant; those with more advanced medical background asked for fewer explanations and a faster completion of the tool.

4.4 Preliminary reliability studies

The ECAT protocol attempted to assess for inter- and intra-rater reliability. To assess for inter-rater reliability, three different personnel providing emergency care participated for each facility. To assess for intra-rater reliability, one of those who participated repeated the survey one week later. The conformance reflected by the kappa values and confidence intervals, however, were poor; this was unsurprising and indicative of the small sample size. The reliability was not appropriately assessed in this pilot because the sample sizes to determine each kappa value were either two or three.

4.4.1 Inter-rater reliability

The sample size to assess inter-rater reliability was three personnel: one nurse, one doctor, and one other provider. Fleish kappa was used to compare the results of the three respondents. The kappa values ranged from -0.35 in the Egyptian referral-level facility to 0.00 in the Ugandan referral-level facility to 0.96 in the Egyptian entry-level facility. Even if the low boundary value of 0.60 for the Kappa score was used, not all of the facilities surveyed showed inter-rater reliability. Four out of the twelve facilities surveyed (the entry-level and referral-level facilities in Cameroon, none in Uganda, the entry-level facility in Egypt, and the mid-level facility in Botswana) did reach a kappa value above 0.60.

The confidence intervals also had wide ranges, with the inclusion of the value of zero in two of the twelve surveyed facilities (the Ugandan referral-level facility and the Egyptian mid- and referral- level facilities).

Table 6 Cameroon Inter-rater reliability measures

	Kappa	Confidence interval (lower 95% to upper 95%)
Entry-level	0.67	0.52 to 0.80
Mid-level	0.56	0.38 to 0.70
Referral-level	0.79	0.65 to 0.91

Table 7 Uganda Inter-rater reliability measures

	Kappa	Confidence interval (lower 95% to upper 95%)
Entry-level	0.52	0.36 to 0.67
Mid-level	0.54	0.38 to 0.68
Referral-level	0.00	-0.10 to 0.11

Table 8 Egypt Inter-rater reliability measures

	Kappa	Confidence interval (lower 95% to upper 95%)
Entry-level	0.96	0.91 to 1.00
Mid-level	0.24	-0.01 to 0.49
Referral-level	-0.35	-0.44 to -0.26

Table 9 Botswana Inter-rater reliability measures

	Kappa	Confidence interval (lower 95% to upper 95%)
Entry-level	0.58	0.43 to 0.72
Mid-level	0.67	0.53 to 0.80
Referral-level	0.27	0.05 to 0.46

4.4.2 Intra-rater reliability

Intra-rater reliability was also difficult to analyse because only one randomly chosen person repeated the assessment one week later. This meant that the kappa values and confidence intervals were determined from two values.

The kappa values were higher than 0.60 for the respondents in two of the four facilities: Cameroon and Botswana. The confidence intervals were within acceptable limits and a relatively smaller ranger for the facilities in Cameroon and Botswana. But there was high spread and the inclusion of zero for the confidence interval of the Ugandan facility. Similarly for inter-rater reliability, to appropriately evaluate intra-rater reliability of ECAT, a significant number of participants at each facility would need to be surveyed.

Table 10 Intra-rater reliability measures

	Kappa	Confidence interval (lower 95% to upper 95%)
Cameroon (repeated by doctor)	0.78	0.64 to 0.92
Uganda: referral-level (repeated by medical officer)	0.46	-0.03 to 0.80
Egypt: entry-level (repeated by doctor)	0.50	0.16 to 0.77
Botswana: entry-level (repeated by doctor)	0.81	0.67 to 0.94

4.5 Preliminary facility-level data

The focus of this study was the development of a tool that could accurately assess a facility's management of emergency conditions. Part of the development of the tool was ensuring that the information collected at each facility was informative, useful, and applicable to make improvements. Although informally done, since this study was not intended to actually assess facility performance, data collected from each facility were collected using the ECAT tool. It is important to note, that like the values reflecting reliability, the information collected on the facilities were based off only 3 participants per facility. However, this data shows the potential power of ECAT and the types of conclusions that can be drawn for use in the future.

The organization of the tool was designed with signal functions assigned to particular sentinel conditions; this allowed for ease of translation to other specialties. The signal functions were evaluated against specific barriers to delivery which were particularly useful in terms of intervention. The following reports on preliminary data for each country that reflect the potential of ECAT. The "barriers to delivery" and signal functions by sentinel conditions were analysed using simple descriptive statistics to determine how frequently a given barrier occurred for a signal function and how often signal functions were not considered achievable. In general, referral-level facilities were capable of performing more signal functions than mid-level facilities were and mid-level facilities were capable of performing more than entry-level facilities. However, this is only considered preliminary since the actual focus of this study was the development of the tool itself.

4.5.1 Cameroon

In Cameroon, the most indicated “barrier” to care delivery were the two categories: “health care worker training” and “supplies, equipment, and medication” across the three facility levels assessed. The least indicated barrier was “human resources” and then “policies”.

At entry-, mid-, and referral-level facilities in Cameroon, respiratory failure was the sentinel condition with the most marked signal functions that were not considered attainable. Maternal health, for all three facility levels, had the most signal functions that could be provided.

4.5.2 Uganda

In Uganda, there was more variation based on facility level than there was in Cameroon. For the entry- and mid-level facilities surveyed, the categories “supplies, equipment and materials” and “health care worker training” were the most indicated barrier to delivery of care. In referral facilities, the same two barriers plus “policies” were indicated as the biggest barriers to delivery.

There was also variation, by facility level, on management of sentinel conditions in Uganda. Signal functions for the management of respiratory failure were indicated most unachievable at the entry-level facility, trauma at the mid-level facility, and maternal health in the referral-level facility. In contrast, the signal functions for maternal health at the entry- and mid-level facilities were most indicated as accomplishable.

4.5.3 Egypt

In Egypt, there were many instances where barriers to delivery were not chosen when they should have been marked or the questions themselves were not answered. This was mostly due to poor training of the ECAT administrator, as discussed above. But of those that responded, “Policies” was the most indicated barrier to delivery overall.

Regarding sentinel condition management: the entry-level facility had most difficulty with achieving the signal functions for altered mental status and maternal health, and both mid- and referral-level facilities had the most difficulty with trauma signal functions.

4.5.4 Botswana

Botswana facilities had trends applying to all three facility levels. “Health care worker training” and “supplies, equipment and medication” were the most specified barriers to delivery of care. “No indications” was marked least frequently as a barrier to care.

In Botswana, trauma had the most signal functions that were marked as not achievable by providers of all three levels surveyed.

CHAPTER 5

Discussion

5.1 Tool development

The result of this study was the development of a refined tool that can comprehensively capture the provision of essential emergency care services at the facility level. The resulting tool was well-received in four countries at a variety of facility levels, among multiple health providers. ECAT was refined into an eight-page tool with 73 items that takes only around 30 minutes to complete. It assesses life-saving interventions using signal functions for sentinel conditions and evaluated against specific barriers to delivery of care.

5.1.1 Signal functions

Early ECAT versions made attempts to function in two very different capacities. In its original form, it functioned as both a detailed facility assessment list and as a signal function tool, leading to inefficiencies and poor utility as a user-friendly and simple and quick assessment tool. In actual use, these capacities must be separated. Sections 2 (facility infrastructure) and 3 (materials) of the original ECAT consisted of only checklist items, reflecting the facility assessment capacity of the original ECAT, with questions about availability only. Section 1 (sentinel conditions) reflected the second capacity present in the original ECAT, which assessed service provision with signal functions.

Many of the checklist items overlapped with the signal function questions. For example, the original ECAT included both “supraglottic device” in the materials section, as well as, “supraglottic airway” under management of respiratory failure in the sentinel conditions section; this collected redundant information. The materials section assessed for availability only, whereas the sentinel condition section assessed for availability plus a skilled provider with knowledge of use of the material, and the infrastructure to do so. This was because the sentinel condition section was made of signal functions, designed to capture more than just the presence of an item. Another example was for “glucometer”. Use of the glucometer as a signal function implied that the item was present and available, in addition to proper usage and reading of the glucometer. This meant that the presence of a glucometer did not need to be asked again in the materials section of the original

ECAT. The converse, however, was not true: even if a glucometer was present in a facility (assessed in the materials checklist section), this did not necessarily mean that the glucometer was used properly since material checklists do not account for skill and knowledge of a provider.

This redundancy continued with other equipment in the survey. For example, a facility's "ultrasound" was technically useless, even if the machine itself was present and available, if there was no skilled provider who could properly use or interpret the information. In contrast, inquiry of an ultrasound's use via a signal function already implied that it was present; the tool did not need to ask this again in the materials checklist section. In actuality, the more meaningful information was in the sentinel conditions section with signal functions. It was more important to know if a service could be provided, and if not, what reason or reasons caused this function not to be performed. This could include a lack of certain items, but it was also important to assess more than just item availability.

In addition, checklists did not account for or acknowledge a facility's ability to improvise. For example, during the informal pilot using version 2, the facility noted that though it did not have actual umbilical vein catheters, its providers were able to improvise and use feeding tubes to accomplish the same endpoint. As a checklist, ECAT would not have reflected that the facility could still provide this service. Similar issues continually arose because it intended to assess for facility capabilities but actually collected information as a checklist, leading to misleading results. For example, items such as "xeroform" did not account for the availability of other equivalent dressing that could be used as an alternative. This occurred with most of the material items. The same issue also arose with facility infrastructure questions. Facilities that did not have a formal "obstetric area", but may have an informal area or mobile cart or equipment that could be brought to the patient were penalized in the early ECAT versions.

These issues aligned with the EmOC study which showed the utility of the signal function model, as opposed to checklists, as more useful to offering ways to improve facilities and provision of care (38). Signal functions rendered the material and infrastructure checklists redundant because they did reveal any more information. Signal functions focused on function and did not penalize improvisation of life-saving interventions. It also made the tool faster and easier to complete, since it covered multiple aspects in one item.

In addition, facility checklists are too specific to context, culture, and resource level, making it difficult to make ECAT, in its original form, a standardized assessment to allow for comparisons with and across the African continent (1). Ministries and governments are necessary for consultation when developing such facility checklists because of the context-specific nature of checklists (4). As exemplified in this project, each facility, region, and country, had varying policies and allocated resources for certain materials and equipment, staff, and infrastructure, making facility checklists unhelpful for comparisons across cultures and countries.

ECAT was intended not to function as a checklist; however, the original ECAT was partly formatted as one. This led to much inefficiency because the original ECAT functioned in two capacities that should be separated: it was a checklist and a functional assessment. This made the survey repetitive, long, and not user-friendly with uninformative sections; the ECAT was intended, however, to be a rapid assessment of strengths and weaknesses in a facility. In addition, checklists could not account for improvisation and were not suitable for comparisons across different contexts. However, by removing the facility checklist sections, ECAT could function solely as a signal function survey and still have the ability to capture availability information. As a result, the sections regarding facility infrastructure and the materials checklist (sections 2 and 3) were removed.

There were still issues with section 1 of the original ECAT, the sentinel condition section comprised of signal functions, mostly due to the design of the signal function items themselves. To the ECAT research team, section 1 was not clearly made of only signal function items, even though it was intended to be made of only signal function items. For example, in management of altered mental status in this section, one of the signal functions was “lumbar puncture”. The intention for “lumbar puncture” as a signal function here was not clearly represented. Participants could perceive this item to ask if a lumbar puncture kit was present. In actuality, this item was meant to capture if all components of performing a lumbar puncture was possible, and if not, what those reasons were, including if there was a lack of certain materials. The signal functions in the original ECAT had to be changed to clearly make signal function items an assessment of more than just item availability, such as skilled providers, infrastructure, and policy.

ECAT was subsequently changed in versions 5 and 6 to be made of only signal functions that clearly assessed for service provision. For example, the signal functions were modelled similarly to: “Can your facility manage a patient in acute shock?”. This led to an improved, simpler tool that assessed capacity, rather than

just a checklist; however, it was too general. The ECAT research team was believed that participants would be left to interpret this question too generally, leading to inconsistent and non-standardized responses. The research team developed version 6 in an attempt to remedy this, and included secondary follow up questions, to the primary broad questions. For example, the management of an obstructed airway was too broad and inclusive of multiple levels of skills, so secondary questions were added to capture what was meant by “managing an obstructed airway”.

The major problem with this formatting was in its inefficiency in capturing as much data as possible. This led to the potential of missing valuable data. For example, if an participant answered “can you facility manage a patient with haemorrhagic shock” with a “yes”, the participant would skip the column of “categories of failure” (later called barriers to delivery) and be prompted to a series of more questions that would each be checked off or not:

- 1. Physical manoeuvers for control of haemorrhage
- 2: Arterial tourniquet
- 3: Pelvic wrapping
- 4: Packaging and suturing for control of haemorrhage

If any one of these questions was marked as not possible, in this format, the tool was not able to capture the reason why. This version was not efficient in collecting all of the appropriate and desired information; if a facility could only perform 2 out of the 4 functions under haemorrhagic shock, the most important information would be why it was not able to, but this version could only capture the binary, if the function was possible or not.

In version 8, the research team added the use of subheading questions in attempts to remedy previous problems. All of the signal functions were organized under the appropriate subheading. This was done to ensure that the tool was comprehensively capturing all possible emergency scenarios. They were also added, believing that this would facilitate in faster completion of the survey and easier administration during the tool administration. The instructions with the subheadings was to first ask the subheading question; if yes, then the participant skipped the signal function questions for that subheading and moved to the next subcategory. If the answer was “no” for that subheading question, then the participant was required to go through all of the signal function items for that subheading.

An example using the subheading question: first ask if the facility can manage general trauma. If yes, the next step would be to skip the 10 signal function items assigned to general trauma and move to the next subcategory with the question, can your facility manage head trauma. However, if the participant answered “no” to managing general trauma, the participant would be required to go through the 10 signal function items under general trauma and identify the appropriate barriers to delivery for each item. Then the participant would move onto the next subheading question. This was to make completion of the survey faster for higher functioning facilities with fewer barriers to delivery of care. These were not being used appropriately, if at all, during administration at facilities and participants found them confusing. As a result, the team removed subheading questions from the final version (version 10).

The final version of the tool designed so that there were no longer primary and secondary follow up questions and no longer subheading questions. This way, every signal function item could be evaluated against a barrier to delivery. The final version of ECAT was a combination of the detailed, informative items in the earliest versions and of the simple, reductionist items in versions 5 and 6. The resultant tool was a balance of simple but comprehensive, using only signal functions that were edited to assess function but still be informative.

5.1.2 Designations and scoring

The focus of ECAT was not to assess the ideal emergency capabilities of a facility, but rather, on the minimum basic provision of essential lifesaving functions, stratified by ECAT designations. The ECAT designations are instrumental in its utility for accurately assessing the level of an emergency care facility and using standardized and recognised definitions to label that facility by capacity. The agreed upon designations from the consensus conference were “basic”, “intermediate”, and “advanced”. These terms were considered superior to “primary”, “secondary” and “tertiary” since these already have connotations in certain settings and this type of numbering can vary by country and culture. Previous tools also have not made facility level distinctions clear. The WHO *Guidelines for Essential Trauma Care* stratified facility levels using the terms: “basic facility, general practitioner staffed hospital, specialist staffed hospital, and tertiary care facility” and acknowledged that these categories overlapped without clear distinctions (35). This confusion in facility designations continued in studies using the tools; in a study using the *Guidelines for*

Essential Trauma Care tool, facilities were referred to as “clinic”, “small hospital”, and “large hospital” with ambiguous definitions for each (61).

The agreed upon terms “basic”, “intermediate,” and “advanced” were descriptive for the capabilities of the facility, and not just a simple label for the facility itself. Those in attendance at the 2013 consensus conference found this to be a useful translation of the results of the ECAT into a meaningful concept of care. At the conference, each signal function that was discussed was marked as either “essential” or “desired” for a “basic”, “intermediate”, or “advanced” facility. For example, “lumbar puncture” was considered “desirable” at an intermediate facility and “essential” at an advanced facility and “intraosseous access” was considered “essential” for both intermediate and advanced facilities (1).

For the tool, only the “essential” designations were used for each facility level (basic, intermediate, and advanced) since the “desirable” designations were considered not essential. This meant removal of items such as “dental area/cart”, “ENT area/cart”, “ophthalmologic area/cart” because these were only indicated as “desired” in an “advanced” facility.

The ECAT designations were meant to be assigned differently than for previous checklists. For example, the *Guidelines for Essential Trauma Care* has separate checklists for the variety of levels; one for the basic level, the general practitioner hospitals level, and the specialist hospital and tertiary care levels (36). The *Guidelines for Essential Trauma Care* assessed accuracy of a facility’s designation, whether the health facility was actually functioning at whichever level they claimed to be functioning at. However, the role of the ECAT tool was meant to take a different approach. A facility was to first complete the ECAT tool and then based on the results, receive a standardized designation as a basic, intermediate, or advanced facility. Using a different approach, ECAT was more about the level of function, whereas the trauma checklist was more focused on material resource availability. In addition, the ECAT checklist was comprehensive to all emergencies, not only trauma. It looked more broadly at a facility’s ability to manage all acute care, including trauma, without having to do multiple checklists.

In theory, these designations were meant to serve another function in addition to carrying concrete meaning of capabilities. The tool could be used to accurately assess the level of an emergency care facility, but also be used prospectively as a guide to what areas to improve. If a facility was designated as basic level in a certain sentinel condition category, the facility also knew exactly what was

necessary to invest in to achieve a higher level of functionality based on the signal functions in the ECAT tool. ECAT categorized what actually was available and gave a specific road map for improvement.

Upon completion of the ECAT project, these designations were meant to serve multiple functions; however actually determining a method to assign these designations proved to be problematic. Designations per signal functions had already been assigned at the consensus conference, but translating those designations into a score was complex and continues to be a “work in progress”.

First, in the early ECAT versions, assigning designations were problematic when three sections were being surveyed, and when both a signal functions and a checklist model were used. For example, if a facility did not have an umbilical vein catheter but was still able to improvise with feeding tubes, it would inaccurately imply that a facility should be considered inadequate at that attributed level solely from lack of a specific material item. With a facility infrastructure and material list, ECAT had the potential to inaccurately underestimate the capacity of a facility. However, ECAT is an assessment of the bare minimum. It was ultimately decided that only the signal functions would determine the designation, not the facility infrastructure and material list. This decision was made easier when the research team decided to remove the facility infrastructure and separate materials checklists altogether.

The complexity of these designations was further recognised when trying to keep ECAT in line with the EmOC tool’s strict scoring for and definitions of “basic EmOC” and “comprehensive EmOC” (38). The EmOC tool was one study that did assign designations based off the results, like the ECAT tool, with the labels: basic comprehensive, or non-EmOC (38). To be a basic EmOC facility, seven out of the nine EmOC signal functions must be met; to be a comprehensive EmOC facility, nine out of the nine signal functions had to be met (38). At the consensus conference for ECAT, it was agreed that ECAT should be based on only essential capabilities like in EmOC: that a facility must achieve all of the functions attributed to that level. But during ECAT tool development, this direct translation of results into designations (like it was for EmOC) was found not to be directly applicable to ECAT, a tool with more than one sentinel condition (not just maternal health) and much more comprehensive than nine signal functions.

The ECAT tool is more horizontal (covering multiple sentinel conditions) than the EmOC tool, making it difficult to decide whether to give a facility only one general

overall designation or designations by sentinel condition. One general designation would be ideal, however, how would this be accomplished if a facility was functioning at different levels per sentinel condition? For example, if a facility could manage respiratory failure at an advanced level, shock at a basic level, and trauma at an intermediate level, it would be difficult to give one overall score to label the facility. The tool captured so much information that summarizing the results into a one-word label was challenging.

Moreover, redundant signal functions, applicable to more than one sentinel condition, were removed; this made assigning designations even more difficult. For example, “administration of parenteral magnesium sulphate for pregnant patient” was applicable for both sentinel conditions: “altered mental status” and “maternal health”. To avoid redundancy, it was only included one time in the tool under “altered mental status”. However, if this function was not possible, would it only be included in determining the score/designation for “altered mental status” or for both applicable sentinel conditions? Since no signal function was repeated to keep ECAT concise, the scoring for ECAT would be extremely complicated due to the applicable nature of so many of the signal functions to multiple sentinel conditions.

Furthermore, the ECAT research team discussed that the tool would be inappropriately calibrated if most of the emergency centres surveyed were not even able to achieve a basic level. The guidelines for a facility to achieve a specific designation were too stringent if 100% of the signal functions attributed to a level were necessary. However, the research team discussed new cut-off scores for “basic”, “intermediate”, or “advanced”, however these were arbitrary. The team discussed possible scores of 60% or 75% of attributed signal functions to a “basic”, “intermediate”, or “advanced” were necessary to be called that level. However, no previous study (other than EmOC) supported any cut off score; any percentage discussed was unsupportable by evidence and only by expert agreement at the consensus conference in 2013 for performance of the signal function to be 100% of the time.

A scoring sheet, separated by basic, intermediate, advanced abilities for each sentinel condition, was developed; however, further discussions are necessary to determine how to assign these designations. Instead, during tool development, ECAT’s creation was focused around capturing meaningful data for assessment and improvement, and less on a single score.

5.1.3 Availability and timing

The team discussed evaluating the availability of fulfilling a signal function, whether, always, usually, occasionally, or never, or by absent, inadequate, partially adequate or adequate. However, this was removed altogether due to some issues.

Firstly, the development of these definitions was arbitrary. For example, when asked about availability of an ultrasound or the expertise of a specialist, participants commonly responded “during the day hours”, and less often identified with using “50% of the time” as a parameter. The ECAT research team discussed using “during office hours (08h00 to 17h00)” instead of “usually available” in an effort to be more applicable to a clinical setting. The problem was that “office hours” were variable based on setting and defined differently based on context. It was difficult to agree on definitions of time parameters.

Next, by definition of “essential”, all of the signal function items should be present at all times. In reality, it was not very informative to know if a function was “available” vs. “occasionally available” or if an item was “inadequate” vs. “partially adequate”. If a facility could not always provide an essential service, then that facility could not be labelled as having the capacity to completely fulfilling that function. To align more appropriately to its role, ECAT was changed to reflect a binomial of only essential items that should always be available. The dedicated emergency care area should have the capability of providing essential life-saving interventions at all times.

There was also ambiguity within specific signal function items that involved time. It was impossible to give the terms “urgent” and “timely” specific, defined time parameters. For the signal function: “Are surgical services available within XX hours?”, determining the number of hours was near impossible. There was also debate on what was meant by the signal function “performing a fasciotomy or escharotomy”; did it assess if a provider could do one immediately, could call a consultant to come and perform it within a time limit, or was willing to do this function with instructions? The poorly-defined answer to clarifying “urgent”, “timely” and “access to any service” was technically that these services could be provided immediately and at all times.

The ECAT research team attempted to define a time frame and argued different parameters; however, it was not possible to give an actual number of hours because it was situational. Some on the ECAT research team thought it reasonable to consider “within 24 hours” as an emergent, life-saving intervention. However, this

time frame was arbitrary and not based on evidence. Previous studies, such as the WHO *Essential trauma care checklist*, avoided a time limit and defined its time parameter as 'timely, but not on a 24-hour basis" (36). In congruence with the WHO checklist, the team decided that the time frame in ECAT would also be left ambiguous to assess for access, not a particular time frame. For ECAT, "timely" was purposely left without a clear hour limit and to mean immediately and always available and accessible. For example, the signal function for "fasciotomy" was considered achievable if the facility had access within a timely fashion.

5.1.4 Question formatting

The ECAT team decided from the beginning to administer ECAT with prospective questioning. In contrast, the question format for EmOC was retrospective, asking facilities if they were successful in performing each signal function within the past 3 months (38). The advantage to this format was it avoided theoretical questioning and, therefore, theoretical answers (38). Facilities were asked about concrete times that a signal function was performed. For ECAT however, the research team decided that the 3 months that EmOC used was an uninformed time frame and misleading, and that current capacity was more important. If a function was not done frequently but was still a capable signal function, such as "venous cut down", asking about only the performance of that function in the past 3 months was misrepresentative about actual capacity.

So instead of "could you have done [signal function] in the past XX months?" like in EmOC, the ECAT format was "if indicated, could you do [signal function] today?" (38). This better assessed capacity, rather than frequency of a signal function. Although, this would lead to theoretical answering and signal functions that could not be validated by actual recent examples of performance, capturing current capacity was more important for ECAT.

This was done in an attempt to assess knowledge of how and when to use items for each sentinel condition. However, redundant signal functions that were applicable to multiple sentinel conditions were removed so that signal functions only appeared once. Because of this, each sentinel condition did not necessarily have all of the possible signal functions that would be necessary for that category. So assessing by sentinel condition as a discrete section by the tool was not always accurate; the repetitive signal functions only showed once. This meant that "administering parenteral antibiotics for those in septic shock" only occurred once in the "shock"

section, even though it could appear additionally in the “dangerous fever section”. This meant that evaluating the “dangerous fever” section could no longer be used as an independent, comprehensive section, with the removal of redundant signal functions.

In addition, early versions of ECAT used open, general questions, like “Ask how the provider would address a patient who is not breathing”. Open-ended questioning was also time-consuming because it required the participant to spontaneously reply with management of a sentinel condition; if the participant did not mention a specific item, the administrator was then required to ask them anyways. For example, the instruction was “ask how one would manage foreign body airway obstruction. If not specifically mentioned, ask about Magill’s forceps.” So, leaving the questioning open-ended to assess the participants knowledge of management did not align with making ECAT concise.

The open ended-questions in version 2 also made participants feel as though the administrator was judging their knowledge. This was especially the case for specific item names like “xeroform”. It was not important that the participant knew the name of specific equipment, rather if it could be used properly. It also did not allow for credit for improvisations if participants were unfamiliar with specific names of items and their functions. As a result, administrator s used the format: “You have a patient coming in with [sentinel condition], can you perform [signal function]…” As a compromise, the tool added an open-ended section for comments and clarification at the end of each sentinel condition section.

5.1.5 Sentinel condition categories

In the early versions, efforts were made to keep the original six sentinel conditions: respiratory failure, shock, altered mental status, dangerous fever, and severe pain/trauma (pain and trauma were originally categorised together). However, in function, these specific six were too rigid for actual survey of comprehensive emergency care capacity. It was discussed that these original six conditions were to serve only as guidelines to ensure that all signal functions were being asked, but that the sentinel conditions themselves could be modified to reflect a more practical application.

In the first version, severe pain was meant to also encompass “trauma” signal functions. However, over time, “trauma” was considered as its own discrete category with a significant number of signal functions applicable to it. As a result,

“trauma” and “severe pain” were separated into discrete sentinel conditions because they assessed different capacities. Severe pain was separated to account for functions regarding general severe pain, abdominal pain, and chest pain. Trauma included the subcategories of general trauma and burns.

The sentinel condition “dangerous fever” was completely removed as a category because the signal functions that applied to it overlapped to those in the “altered mental status” category. The signal functions under the “dangerous fever” condition included “rule out organic causes of altered mental status”, “sepsis protocol”, “administration of critical therapeutics”, and “temperature control”, all of which were already accounted for.

Lastly, “maternal health” was added as its own discrete category because of the importance to specifically assess capacity of the management of pregnant women. The intention of ECAT, via signal functions, was to serve as a sensitive predictor of the larger emergency system function in scenarios where intervention in the dedicated emergency area of a facility would affect morbidity and mortality. Maternal health qualified as a high source of morbidity and mortality in many low-resource settings with specific interventions that would be life-saving. The signal functions added to ECAT were based off of the EmOC signal functions and included functions that had not been asked in a previous section (38).

The resultant categories were respiratory failure, shock, altered mental status, severe pain, trauma, and maternal health.

5.1.6 Barriers to delivery

With the removal of the availability parameter, ECAT could assess for barriers to delivery of care, why a signal function was not possible. This information is important for determining patterns and trends and for advising facilities on ways to improve. This addition was particularly helpful when eliminating the sections regarding facility infrastructure and materials in the early versions. For example, instead of asking if a material was present or not, it was put into context with signal functions in later ECAT versions; materials and infrastructure were two of the possible reasons why care could not be provided.

Originally called “categories of failure”, these barriers to delivery were based on those in EmOC (38). However, to refine these categories and provide specific definitions, “training” and “human resources” were separated into discrete

categories and “system architecture” was separated into facility infrastructure and system management. The category, “system management” was considered redundant with the other categories including “policy”, and was therefore eliminated. It was also a category that was found confusing, difficult to define, and not applicable for each of the signal functions as a possible category of failure.

To remove the negative connotation of the word “failure”, the research team changed “categories of failure” to “barriers to delivery”. Furthermore, feedback from participants preferred this name because it implied less blame on the facilities and used a more optimistic name.

Some participants did confess confusion on the types of barriers to delivery, even with the reference document. Most questions were directed toward explaining the “policy” barrier. There was discussion on whether it may be more accurate for the administrator to mark the barriers to delivery based on the participant’s response, instead of the participant choosing the barrier. This way, the survey would collect qualitative data, and then the trained administrator could categorize responses in a standardized way. This would also avoid participants’ confusion regarding barriers to delivery as a potential cause of inaccurate results. Future studies need to address this issue and possible solutions.

Informal feedback from participants approved this final list and considered it to be comprehensive of all possible categories of failure. By the time countries were surveyed with the ECAT tool, there were no additional categories suggested by the participants to add as another possible option.

5.1.7 Administration of ECAT

The protocol for administering the ECAT tool included a training session, with an accompanying document, consent form and time for questions, completion of background information, review of the barriers to delivery, and the encouragement of comments and feedback. During administration of the survey, participants pick barriers to deliveries themselves. The research team indicated the need to administer the survey by an ECAT researcher to incorporate feedback into the development of the tool. However, once validated and refined as a high quality tool, it may function as a self-reporting survey.

5.1.8 Changes after administration in countries

The comments received and informal feedback after administration in Cameroon, Uganda, Egypt, and Botswana described ECAT as extremely detailed and inclusive of all possible emergency scenarios. However, there were some points of confusion. The issues after administering the survey in these countries included:

- Regarding the barriers to delivery categories, the team discussed that multiple barriers to delivery could be marked as reasons why a function could not be performed. Also, participants noted that “Policies” was the most confusing term and that it was perhaps not chosen as often because there was a lack of understanding of legislation, the lack of examples when explaining these terms, or other possible reasons. As a result, a standardized document, with definitions for each barrier to delivery and examples of each, was created and given to each subsequent participant to refer to during the tool administration.
- The administrator, during administration of the survey, forgot to use the subheading questions to streamline the process, mostly because it was not as apparent in the survey. As a result, a formal “Instructions to administer ECAT” document was created with specific instructions for the administrator to refer to at any time. This document was used for future training of ECAT administrator s and reiterated the use of the subheading questions and the “barriers to delivery” document for participants.
- Participants in Egypt and Uganda were confused by the subheading questions. In Uganda, participants asked for clarification on the subheading questions because they were so broad and could indicate multiple scenarios In Egypt, there were discrepancies between the answers to the subheading question and its assigned signal function items. The original intention with the subheading question was that if a subheading was marked as possible, the assigned signal functions for that subcategory would also be implied as possible, in an attempt for faster completion of the survey. However, in Egypt, this was not the case; for example, an participant would mark that the facility in question could manage general trauma, but then indicated that not all corresponding signal functions for general trauma could not be done.
- In addition, it became confusing for the signal function items that could be categorized under multiple headings such as “Administration of parenteral magnesium sulphate for pregnant patient” which could fall under “Maternal health” or for “Altered mental status: Seizure”. In the survey, to avoid

repetition, these signal functions appeared only once, but it also meant that all of the signal functions for each subheading was not necessarily complete. To avoid confusion and problems with the subheading questions, these were removed.

- There was confusion on whether the signal function capabilities were regarding the entire facility itself. For example, at the participating referral hospital in Uganda, administration of parenteral magnesium sulphate for pregnant patients was not indicated in the dedicated emergency area, but was possible once the patient was referred to the obstetrics/gynaecology part of the facility. To be clearer that the questions were regarding the area designated for emergency care only, this was specifically added to a discussion point that the administrator must make clear before the start of the tool.
- Another interesting point was that at the referral facility surveyed in Uganda, many of the signal function items were not possible due to policy issues. However further questioning pointed out that even if policy changes were made, the facility still would not have the capacity to perform that function. In terms of data collection, it was decided that in cases such as those, all barriers to delivery, and not only "policy", should be marked as a barrier to delivery.
- Lastly, when collecting background information on each of the facilities, it was noted that the terms "primary", "district", and "referral" level facilities were confusing and not straightforward terms to describe each of the facilities. This was not surprising since the ultimate goal of ECAT is to avoid these ambiguous terms and give meaningful designations to the facilities based on delivery of emergency care. However, since the ECAT protocol included surveying three different facility levels per country, the new terms used were:
    - "entry-level" facility to include clinics or basic level facility
    - "mid-level" facility to include regional and district level facilities
    - "referral-level" facility to include academic and university level facilities

5.2 Main results

5.2.1 Reliability studies

This ECAT project was not able to assess for inter- and intra-rater reliability due to the sample sizes of three participants to determine reliability measures. Unsurprisingly, such small sample sizes led to large variations of kappa scores and confidence intervals with areas of high and low conformance.

As a prospective self-reporting tool, one health care worker at the same facility could be more confident than another; with a sample size of three per facility, the data were skewed. Regardless of the calculated kappa values and confidence intervals, this must be repeated with the appropriate sample size to determine inter- and intra-rater reliability. With improved sample size, it would then be possible to identify specific areas where conformance was poor and possible reasons why.

In addition to the small sample size, the poor conformance values for intra-rater reliability also mirrored the inherent problem with self-reporting tools in general (77). It relied on the participant to take very good care with the survey and showed how not paying close attention could lead to unreliable and inaccurate answers. It was essential in this study to first determine the best methodology to avoid this potential flaw, before assessing reliability.

Proper reliability studies were also difficult because the surveys were slightly changed after administration in each country. As a tool development study, edits to the tool were expected but this made it challenging to compare results of slightly different tools by country.

Although there were flaws with determining reliability of ECAT, calculating preliminary values was important for future studies focused solely on determining the quality of ECAT. In addition, even with a sample size of two or three values for intra- and inter-rater reliability, there were still some confidence intervals that were appropriate at the 95% level and acceptable kappa values. This suggests that there can be a reasonable sample size to determine reliability and will be part of the next steps in the development of ECAT.

5.2.2 Initial data

The organization of the tool was designed with signal functions assigned to particular sentinel conditions; this allowed for ease of translation to other specialties. The signal functions were evaluated against specific barriers to delivery which were particularly useful in terms of intervention. The following reports on preliminary data for each country that reflect the potential of ECAT. The “barriers to

delivery" and signal functions by sentinel conditions were analysed using simple descriptive statistics to determine how frequently a given barrier occurred for a signal function and how often signal functions were not considered achievable. In general, referral-level facilities were capable of performing more signal functions than mid-level facilities were and mid-level facilities were capable of performing more than entry-level facilities. However, this is only considered preliminary since the actual focus of this study was the development of the tool itself.

The information collected during this administration of the survey was not meant to be an actual assessment of the facilities and only collected informally as a way to refine the tool. Like the values reflecting reliability, the information collected on the facilities was based off only 3 participants per facility. However, part of the tool development process was ensuring that the information collected at each facility was informative, useful, and applicable to make improvements. Eventually, the goal would be to accurately assess facilities and unveil trends; so the information collected during this tool-refining study was meant to mimic this future use and appropriately edited for this capacity. As a result of appropriate tool refinement, the preliminary data revealed initial trends and illustrated the potential power of ECAT and the possible next steps using that information to make the most effective advances. The collected data from the ECAT tool can give information regarding a patient's access to quality care: determine differences by facility levels, the major barriers to care, and the major services (i.e. sentinel conditions) that are missing and reasons why. The following section exemplifies this using the limited data collected during this pilot.

5.2.3 Initial trends- Barriers to delivery

In Cameroon, the most problematic obstacles to providing adequate emergency care were "health care worker training" and "supplies, equipment, and medication". This could reveal a systemic issue because this occurred regardless of facility level. This meant that the government in Cameroon would be recommended to prioritize country-wide interventions in improving these two aspects. It could intervene with increased development of and targeted assessments of current training programmes. Since "supplies, equipment, and medication" was highly marked as a barrier, the facility could then be directed to undertake a more detailed survey, such as the WHO essential medication list, to determine what exactly was lacking in their

facilities across the country. Botswana, with the same indicated barriers to delivery in this initial stage, could take similar steps.

In contrast to facilities in Botswana, Cameroon's facilities indicated "human resources" as the least frequent barrier to care. This further emphasized the need for targeted training of specific skills in Cameroon, since a lack of providers was not considered a major problem according to ECAT. Results from facilities in Botswana, however, showed that increasing the number of providers could aid emergency care management, but training was more of a priority.

Facilities in Uganda and Botswana marked "no indication" least frequently. This suggested that the signal functions on the tool were appropriate for the patient population that those facilities served and that the signal functions were "indicated" in their setting. This was found at all facility levels assessed, which may show that patients presented with a broad scope of needs in both countries, regardless of the facility. A wide range of emergencies presented to facilities in Uganda and Botswana and there was an indication for each of the signal functions that were asked.

Interesting trends were revealed with "Policies" as a barrier to delivery of care. Egyptian facilities indicated this to be the most encountered barrier to providing life-saving care, contrasting Cameroon facilities, where it was least considered problematic. This may lead to recommendations suggesting a revision in Egyptian policies to ensure that facilities could perform essential signal functions. In Uganda, this barrier was significant for only the referral-level facility, and not an issue at the entry- or mid-level facilities. For example, at a referral level facility in Uganda, providers explained that they were unable to administer parenteral magnesium sulphate for a seizing pregnant patient because of their facility's policy. Their policy was to transfer the patient needing this service to the obstetrics and gynaecology service; providers were specifically told not to perform this life-saving intervention, even if needed emergently. In fact, the policy at this facility for management of pregnant patients was not to intervene, only refer them to other providers. As a result, their dedicated emergency area was not properly equipped and its providers were uncomfortable with maternal health management. It was interesting to note that policy issues were the main barriers, but even if policies were changed, a lack of skills and equipment would continue to prevent proper management of maternal health care in this situation.

With this information, the results from ECAT administration can assist facilities in making the most effective changes to allow for proper management of emergency conditions. ECAT can provide well supported arguments for specific intervention priorities; it would allow those invested in emergency care to better advocate for improvements and inform administrators, who may not even be aware of easily remedied barriers. ECAT can provide evidence on how interventions should not only focus on education if lack of resources is the main barrier. It can advise that if a piece of equipment is lacking, training should not be focused on use of that specific equipment. It would enhance strategic planning for those devoted to improving the management of essential emergency care (1).

5.2.4 Initial trends- Sentinel conditions

ECAT was also able to discover patterns with sentinel conditions. In Cameroon, signal functions regarding maternal health were the most attainable, for all facility levels; this may be reflective of the Cameroon's campaign to prioritizing maternal health. This was also the case in Uganda, except in the referral level facility where maternal health was scored as the worst managed sentinel condition due to policy barriers.

The worst managed sentinel condition in Cameroon for all facility levels was respiratory failure. This may be an indication to focus training and resources to better manage this condition. This may also correlate with epidemiologic data and reflect burden of disease in the country, but this was beyond the scope of ECAT.

Trauma was the sentinel condition with poor management in facilities of multiple countries and levels: the mid-level facility in Uganda, the mid- and referral-level in Egypt, and all three levels assessed in Botswana. This correlated with the need for improved management of trauma.

Trends revealed by ECAT may also have the potential to reflect the organization of a country's government. For example, the governments of Cameroon, Botswana, and Uganda are more centralized than in Egypt (64–67,70,71). Perhaps this explained the facility-level dependent trends in Egypt versus more uniform country-wide trends in Cameroon, Botswana, and Uganda, regardless of facility level.

5.3 Scope of ECAT

Throughout the tool development process, there were multiple discussions regarding the scope of ECAT and its intended focus. The following signal functions were ultimately not included in the final ECAT but were discussed throughout the development process.

Signal functions regarding the referral process was considered for inclusion in the ECAT tool. The referral process is critical to providing emergency care and most facilities in a region are not tertiary centres. Some on the ECAT research team believed it to be important to understand the referral process, including how long it took, how patients would be transported, the skill level of those transporting the patients, etc. Recognizing that one's facility would not be able to manage an emergency situation, no matter what the barrier, and the ability to take the next steps to safely and successfully transferring a patient needing higher level care, may be considered a life-saving intervention. However, this was considered beyond the scope of ECAT and not directly indicative of the level of emergency care provided at that specific facility. As a result, this function was not included in the ECAT tool.

Another interesting aspect of emergency services was its function as a safety net for those who do not regularly access care. Examples of this function include a tetanus vaccine to a patient with a laceration, testing for HIV in a high risk patient, screening for diabetes in the appropriate patient, and providing hypertensive medication when indicated. Although emergency care has come to provide these roles in less functional health systems, it was decided that this does not fulfil the requirement of a true facility assessment for emergency capacity. These were considered extremely important skills that the health system should provide for and address, however, not necessarily in the setting of emergency services.

There was also discussion on whether it was important to add who was able to perform the signal function: the specialist on call, the nurse, trainee, etc. It was ultimately decided that, as long as the function was being performed properly and successfully, it would not provide useful or applicable information for improvements.

5.4 Value and utility of ECAT

As a tool development study, the research team continually revisited the utility of ECAT to re-focus the tool for its intended purpose. The intention of ECAT, via signal functions, was to serve as a sensitive predictor of the larger emergency system function in scenarios where proper management in the facilities would affect

morbidity and mortality (7). Most presentations of emergency scenarios do not require a specialty consultant for definitive care, but rather are syndromes or diagnoses where early intervention in the facilities would make large differences in outcome (30). ECAT was based specifically on those syndromes and diagnoses.

The ECAT tool was meant to serve as a balance of comprehensive and informative, yet simplistic. For example, “management of altered mental status” was too broad and non-specific to carry meaning but equipment but facility equipment lists were too detailed and specific and a poor reflection of capacity; signal functions were developed as a compromise of both. The value of ECAT’s signal functions was to function as a diagnostic tool to determine “flares” or flaws within the facility. They function as a low input way of receiving an indication when a part of the facility’s capacity to provide basic emergency needs is not met. Then a facility can prioritize areas for intervention based on this “flare”.

With ECAT, it would be possible to determine the areas needing improvement in different facilities in different levels, how many times certain failures occurred in certain countries, and other trends. For example, it would be extremely valuable to a ministry or government to know what percentage was related to a lack of training versus a lack of equipment. ECAT was intended to be an assessment tool that facilities and systems could aim toward via targeted improvements.

Although ECAT is currently an individual facility assessment, with expansive use and certain modifications, it can be used as a broader assessment of the entire community, similarly to EmOC. Signal functions were hypothesized to be a sensitive predictor of the larger emergency system function and perhaps epidemiologic data, especially via patterns revealed with using the tool evaluated against barriers to delivery (1,38). For example, EmOC used other indicators, in addition to signal functions, such as geography and appropriate ratio of number of facility to population size, to assess capacity at a regional scale (38). With use in a significant number of facilities in a region, ECAT could be used similarly, to determine the degree of dysfunction in a system and country. ECAT could serve as an objective measurement of capacity to meet the demand for emergency health systems development for population-level needs, not only in the field of obstetrics (7).

5.5 Public vs. private facilities

ECAT was intended for any facility, however, in this pilot, only public or government hospitals were assessed since the entire population does not have access to private facilities. Upon its completion, ECAT could be applied to any facility, however, to use facilities that serve the greatest and widest population, only public facilities were chosen for the pilot. In the future, ECAT could be used as an indirect way to incentivize facilities, private or public, to improve their facility's emergency care abilities; especially if a facility that is labelled as a higher capacity level is revealed not to actually provide higher comparing against facilities that have been designated as a lower- level facility. The ECAT tool can be used to look at marked differences between ministry hospitals and other private ones.

5.6 ECAT in context of existing tools

As previously discussed, there are many tools that already exist and are in use; however ECAT is intended to fill a much needed role that other tools have not been able to achieve. In addition, some tools could serve to supplement the missing details in ECAT.

ECAT was based constructed using the successes of EmOC's signal functions (38). Signal functions were particularly useful in determining capacity in the emergency care setting, not exclusively assessing management of maternal health. In addition, EmOC is unique because it is used to assess a very particular part of healthcare: maternal health (38). In theory, EmOC evaluated the management of a healthy person from the start of care and a healthy person at the end of care; maternal health involves a single acute event that is not actually a disease. In contrast to obstetrical emergencies, emergency care has other complexities in the recognition and intervention of syndromes and toxidromes of particular diseases or sentinel conditions (1). Although ECAT is based on the EmOC format, ECAT was tailored to reflect this key difference.

ECAT's future role is to assign designation to facilities as "basic", "intermediate", and "advanced" based on capacity and not an arbitrary measure. This differs from the WHO Trauma checklist which assesses facilities based on their arbitrary designations; it assesses if the claimed facility level is accurate (36). In contrast, ECAT aims to actually give appropriate and meaningful designations instead of critiquing facilities' current level. In addition, future studies include validation of the tool before expansive roll out. Previous studies, such as the PIPES survey, are not

well validated yet, using arbitrary scoring to rank facilities; before expansive roll out, ECAT will have undergone more rigorous evaluation and testing (39).

ECAT was developed to serve as a broad, general assessment, to quickly determine flaws in the emergency care system; it was not meant to or designed to collect nuanced details. However, it can be supplemented with existing, detailed equipment lists after this “first-pass” with the ECAT tool. For example, for a facility that does poorly on the “trauma” section of ECAT, could then be directed towards using the WHO Trauma checklist (36). For a facility that needs improvement with maternal health according to ECAT, could then complete the WHO EmOC tool (38).

In addition, specifics regarding medication were left out of the ECAT tool, but could easily be supplemented with existing WHO medication checklists (78). The ECAT tool left signal functions with medication requirements open-ended, for example: “administer locally appropriate antidote for toxic cause, e.g. anti-venom” and “administer critical therapeutics for reactive airway disease”. During the development of ECAT, these signal functions were purposely designed to be vague because medication stocks and its use are context-specific; different snakes are endemic to different areas, and so different anti-venoms are indicated by region. It was impossible to make these signal functions both context-appropriate and applicable continent-wide and were therefore left to a general assessment of managing toxidromes without specific medication availability. However, to capture the detail missing in ECAT with specific medications, medication checklists that have already been approved could be used. For facilities that indicated deficiencies in medication as a barrier to delivery of emergency care on ECAT could then complete the WHO essential medication lists to determine specific medications gaps (78).

5.7 Limitations of study

There were multiple limitations of this study that need to be acknowledged for improvement of the tool. The focus of this phase of the study was the development of a tool with specific functions, not yet collecting quantitative data.

As a foremost qualitative study, this project did not test the resultant ECAT for quality. Now that the tool has been developed, the next steps are reliability and validity studies. This study included only informal evaluations for quality, with insignificant sample sizes; this study’s preliminary data are not vigorous enough to draw conclusions from. The sample sizes were too small to provide evaluations of

the tool's reliability. This project was not able to assess for validity in the participants' responses. However, in its most current format as a prospective survey, ECAT must undergo validity studies; this will ensure that the responses collected through ECAT are an accurate representation of ability.

In addition, this study used only convenient samples of participants, not a random sample. It was more important to receive feedback from countries throughout the major regions of Africa, rather than develop a study with random sampling. Also, the tool was slightly altered after each country so comparing results by country may not be as accurate as if the tool had been the same. Future studies will remedy these limitations.

5.9 ECAT transformation

The ECAT toolkit underwent major revisions after piloting this study. From the consensus conference, the new ECAT has now been piloted in the four major regions of Africa and has the potential to collect key information about service provision at the facility level. The new ECAT has the capacity to assess a facility's ability to manage a patient with any of the major sentinel conditions that will ultimately lead to death in a patient. The resultant ECAT is now an easy, comprehensive, informative tool that is only an 8-page, 73-item toolkit that any emergency care provider can complete.

CHAPTER 6

Conclusions

In terms of a tool development study, the resultant ECAT tool underwent major revisions; it took into account usability, specific terminology, translation into other specialities, its use in context with existing tools, the ability for rapid administration while still capturing the type of service delivery accessible to patients. ECAT is a tool that focuses on service provision at the individual facility level via the use of signal functions; however it also allows implications to be made about the larger emergency care system.

There is a need for a tool that assesses the capacity of acute and emergency care services at the facility level as a way to provide information on current capacity, and concrete information to stakeholders, such as administrators and policy-makers, on how to improve provision of services at that facility(26). It should also be able to collect data on functional status of emergency care systems across Africa (26). Proven with the preliminary data gathered from this study, ECAT has the potential to serve these functions.

With the completion of the development of the tool and methodology, the future steps needed to finalize ECAT include:

- Formal, qualitative interviews after administration of the tool
- Proper intra- and inter-rater reliability studies with significant sample sizes and random selection
- Reliability studies with the categories of failures
- Validity studies to ensure that self-reported capabilities of participants are providing accurate self-assessments
- Determining a scoring system to assign facility designations
- Language testing and cultural refining

6.1 Recommendations

6.1.1 Qualitative interviews

After developing the tool and administering the survey for a handful of participants, future studies must include qualitative interviews in order to formally assess usability of the tool. The interviews must include specific questions that must ensure

that changes made during this tool development were appropriate. For example, interviews must confirm that changing the survey to include only signal functions using the updated sentinel condition categories are still comprehensive without the facility infrastructure and material questions, yet rapid and easy to complete. The interviews also need to ensure that assuming that signal functions are always available is a realistic way to view signal function ability or if adding a time component, such as available 24 hours vs. available during office hours, is a more genuine assessment. There needs to be confirmation that the “barriers to delivery” category is comprehensive and usable. Lastly, there needs to be feedback on how to complete this part: whether it would be better if administrator s categorize responses themselves to avoid confusion or if participants need to be better trained on the barriers to delivery categories.

6.1.2 Reliability and validity studies

Now that the tool has been developed and major changes have been completed, future studies can be designed to collect proper data. Next projects include formal inter- and intra-rater reliability studies to ensure the quality of the tool. This study was insufficient to provide dependable values to evaluate this, and so, next steps include conducting rigorous studies with random selection and larger sample sizes. This will determine if different people within the same facility can be surveyed to obtain the same information and if the tool is designed to provide reproducible results.

To further improve the quality of the tool, reliability studies on the signal function questions and the barriers to delivery could be performed. This will help determine if there are any particular questions or barriers that are not useful and ensure that the tool is collecting information in a meaningful way.

Although essential, this study could not evaluate tool validity to ensure that participants are actually doing what they claim to be able to do. In the future, there needs to be a study encompassing direct observations over time to confirm that participants can accomplish signal functions that they consider performed on the survey. This will require partnering with local providers and trained ECAT researchers with clinical experience. Validity studies could also confirm which group of providers, nurses versus doctors, are more accurate in reporting capabilities.

It is also important to note that these plans to ensure ECAT’s quality will be unprecedented by studies of other tools. Most existing tools have not undergone

rigorous studies assessing their quality. The study in Ghana included the re-administration of their tool one month later, but no other quality studies (57). The study in Liberia attempted to validate their study by confirming survey results by phone or on-site inspections (54).

Once confirming reliability and quality, ECAT could have the potential to become a self-administered survey that only physicians need to complete. In concordance with WHO tools, which only surveys the head physician of the dedicated emergency area, there may only be a need to survey only provider once inter-rater reliability has been confirmed. In addition, once validity studies have been done, ECAT could be used as a self-administered survey. These modifications could be helpful in terms of increasing usage of the ECAT tool in more facilities and help with future scoring and assignment of facility designations.

6.1.3 Designations

During this phase of the study, scoring systems were attempted but ultimately not fully created. The final goal is to use the ECAT tool to determine if a facility could be considered “basic”, “intermediate”, or “advanced” based on actual capacity, not on arbitrary labels. It is not yet possible to determine if the tool is calibrated too vigorously so that too many African facilities would not be able to even reach “basic” level. It also is unclear if it is most beneficial to give one designation per facility or if designations should be stratified by sentinel conditions to allow for more targeted improvements. After conducing qualitative interviews and studies ensuring tool reliability and validity, the ECAT team must make decisions regarding how to assign facility designations.

6.1.4 Cultural testing

In the future, language testing and cultural refinements need to be made to the ECAT survey. Even during this tool refinement study, specific cultural differences were noticed. For example, the term “paramedic” in Uganda is another name for “clinical officers”, in Botswana the same term refers to those who drive transport vehicles between hospitals but have no clinical skills, but in Egypt, it refers to trained first responders in the pre-hospital setting. The ECAT tool will eventually need to undergo rigorous cultural testing to ensure that terms with context-specific meanings are used appropriately.

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Appendix 1 Original ECAT (version 1)

Emergency Care Checklist

Instructions: Availability of each signal function implies availability of all materials, facility capabilities and trained personnel necessary to successfully complete the function. "Available 24/7 means that the facility can successfully complete the signal function every day of the year and every hour of the day. Usually available means that it can be completed more than 50% of the hours every week of the year. Occasionally available means that it can be completed any percentage of time less than 50% and greater than 0% any given week. Critical signal functions are listed by the sentinel condition they address. Signal functions may address multiple sentinel conditions; however, as their availability to address one sentinel condition implies that they would be available for other conditions as well, they are only listed once. Survey intended to be administered in its entirety--an incomplete survey is insufficient for assessment of a facility's emergency care.

Note: Several supplies are noted where there is a range of sizes. If, in general, the supplies are present but some sizes are missing, they may be marked as 24/7, usually available, etc., but please make a note in the margin about what sizes are missing.

General Capabilities

Signal Function	Available 24/7	Usually Available	Occasionally Available	Never Available	Unknown
Triage Capabilities					
Is there a triage system in place?					
Stethoscope					
Clock					
Pulse oximeter with adult & paediatric probes					
Non-invasive blood pressure monitoring device (incl paediatric and adult cuffs)					
Thermometer including					

low reading capability					
Glucometer					
Paediatric scale					
Gloves					
Personal protective equipment – surgical masks					
N95					
Sterile surgical protective equipment					
Documentation					

Management of Respiratory Failure

Signal Function	Available 24/7	Usually Available	Occasionally Available	Never Available	Unknown
Opening the airway					
Insertion of oral/nasal airway					
Oral airway sizes 000-5					
Nasal Airways size 3-7					
Manual manoeuvres such as head-tilt, jaw thrust					
Relief of foreign body airway obstruction					
Heimlich manoeuvre,					
Mechanical: i.e. Magill forceps					
Use of suction					

Suction device and					
Suction catheters (rigid & flexible)					
Suction tubing					
Sucking chest wound management: Three-way dressing					
Xeroform					
Management of asthma: Administration of bronchodilators, epinephrine and steroids					
Nebulizer					
Tension Pneumothorax management:					
Needle decompression					
14 gauge catheters (needle decompression)					
Chest tube insertion					
Scalpels					
Chest thoracostomy/ decompression sets					
Management of hypoxia: oxygen					
Air Concentrator					
Oxygen Bottle, Regulator, flowmeter					
Non-rebreather mask					

Simple face mask					
Venti-mask					
Nasal Prongs					
Management of Respiratory Failure					
Bag-valve mask					
Non-definitive advanced airway with supraglottic device					
Laryngeal Mask Airway					
Definitive advanced airway					
Laryngoscope set with adult and paediatric blades					
Spare bulb					
Spare battery					
Tracheal tubes, uncuffed (size 2.4-5.5mm), Cuffed (size 3.0-8.5mm)					
Water-soluble lubricant					
10ml Syringe					
Tape					
Meconium adaptor/aspirator					
Non-ascultatory					

intubation detector Device					
Stylets					
Gum elastic bougie adult and paediatric					
Cricothyroidotomy Set					
Tracheostomy Tube sizes 00-6					
Mechanical invasive Ventilation (i.e. presence of ventilator)					
Mechanical non-invasive Ventilation (i.e. presence of ventilator capable of connecting to Bi-pap/CPAP mask Bi-pap/CPAP mask					

Management of Shock

Signal Function	Available 24/7	Usually Available	Occasionally Available	Never Available	Unknown
Management of Haemorrhage					
Arterial tourniquet availability					
Pelvic wrapping					
Physical manoeuvres for control of haemorrhage (direct pressure etc.)					
Splinting of fracture					
Plaster of paris					
Crutches					
Packing and suturing for haemorrhage					
Management of arrhythmia/ACS					
Defibrillation/Cardioversion					
ECG monitor/defibrillator					
conductive paste or pads, paddles					
razors					
12 lead ECG Monitor					
Electrodes					
Paper					
Presence of personnel to interpret EKGS?					
Transcutaneous pacing ability					
Management of tamponade:					

Pericardiocentesis					
Spinal needle and syringe or Central line kit					
Management of hypovolemia/dehydration					
General					
Sharps Container					
Needles and syringes 1-50ml					
IV administration sets including blood administration sets					
Drip Stand or equivalent hanging device					
Fluid warmer					
Peripheral intravenous access					
IV cannula 14-24G and appropriate securing material					
IV tubing (giving sets)					
Venous cut down					
Intraosseous access					
Paediatric & Adult intraosseous access					
Central venous access					

Kits and lines for central venous access					
High flow infusion Catheters 8.5F					
Umbilical vein catheters					
Administration of Fluids via NGT					
Nasogastric tubes					
Administration of isotonic IV fluids (crystalloids)					
Availability of Pathogen-Screened Blood Transfusion					
Management of Cardiac Arrest after Penetrating trauma: Thoracotomy					
Administer Critical Therapeutics					
TXA					
Oxytocin					
Epinephrine					
Thrombolytic					
Parenteral antibiotics					
Parenteral antimalarial					
Vasopressors					

Management of Altered Mental Status

Signal Function	Available 24/7	Usually Available	Occasionally Available	Never Available	Unknown
Assessment of AMS					
Measure glucose and/or administer glucose					
Blood Glucose Monitor					
Close monitoring available to protect from secondary injury[1]					
Rule out organic causes of altered mental status[2]					
Blood Lab Collection tubes					
Measure electrolytes					
Measure BUN/Cr					
Measure LFTs					
Measure TSH					
Measure NH3					
Measure Urine Tox					
Measure EtOH					
Ability to perform Lumbar Puncture					
Lumbar puncture kit					
Ability to perform lab analysis on CSF					

[1] Specifically, is there adequate personnel/infrastructure to monitor the patient closely, including: head-tilt chin-lift, jaw thrust, recovery position, elevate head of the bed, protection from fall, monitoring blood pressure and avoiding hypotension, avoiding hyperthermia and cooling if necessary

[2] i.e. assessment for hypoglycemia, hyponatremia, uremia, thyroid abnormalities, hypertensive emergency, cerebral hypoperfusion, sepsis, meningitis/encephalitis, seizure, stroke, space occupying lesion.

CSF Collection tubes					
Perform Urinalysis					
Perform Head CT					
Perform Rapid Diagnostic Test for Malaria					
Check Salicylate levels					
Check Acetaminophen levels					
Administer Critical Therapeutics[3]					
Intravenous antihypertensive agents[4]					
Benzodiazepines (PO and IM)[5]					
Available antidote/ antivenom					
Magnesium[6]					
Insulin					
Antipsychotics					

Management of Dangerous Fever

Signal Function	Available 24/7	Usually Available	Occasionally Available	Never Available	Unknown
General management of dangerous fever					
Rapid cooling capability					
Measurement of serial lactate					

[3] Assessor: please indicate generic name of the therapeutics available in each category
[4] For treatment of hypertensive urgency/emergency
[5] For seizures, sedation, and alcohol withdrawal
[6] For eclampsia and torsades de pointes

Appropriate blood tubes					
Management of Infectious Source					
Bedside surgical ability to manage septic foci (e.g. abscess, empyema or perform D&C)					
Basic Surgical Kit					
Gauze					
Operating Theatre for surgical control of septic foci					
Critical treatment algorithms					
Adult sepsis protocol					
Paediatric sepsis protocol					

Management of Severe Pain

Signal Function	Available 24/7	Usually Available	Occasionally Available	Never Available	Unknown
How would you manage severe pain?					
Administer an analgesic agent					
Management of chest pain					
Administration of aspirin for concern for ACS					
Management of extremity pain					
Basic immobilization (sling, splint, inline immobilization for spinal fracture)					
Reduction of fracture/dislocation					
Limb Traction device					
Sling/swath material					
Fasciotomy for compartment syndrome					
Access to definitive surgical services					
Neurosurgical					
General					
Orthopaedic					
Thoracic					
How would you manage a wound: Initial appropriate wound care[7]					
Sutures					

[7] Cleaning, dressing and infection control

Therapeutic paracentesis					
Assessment of cervical spine pain					
Cervical spine immobilization					
C-spine immobilization, restraining devices (including blankets/towel rolls)					
Assessment of Head injury					
Are there sufficient personnel resources to reassess head trauma for secondary injury[8]					
General Assessment of abdominal pain					
Urine dipstick					
Placement of Foley catheter for urinary outlet obstruction[9]					
Urinary Catheters sizes 8-18					
Ultrasound					
Is there someone available to interpret Ultrasounds?					
Assessment of female with abdominal pain: complications of pregnancy					
Pregnancy testing Kits					
How would you manage a circumferential burn with evidence of compartment syndrome or respiratory compromise: Escharotomy					
Autotransfusion from chest tubes					
Are X-rays available and is there someone available to interpret X-rays?					

[8] e.g. assessment for raised intercranial pressure, cerebral hypoperfusion, or cerebral hypoxia

[9] Indicated by distended bladder on ultrasound and oliguria without signs of traumatic urethral injury

Critical treatment algorithms					
Adult trauma protocol					
Paediatric trauma protocol					
Burn victim hydration protocol					
Critical therapeutics					
Administer tetanus vaccination					
Administer antibiotic [10]					
Rabies IVIG/vaccination[11]					

[10] Empirically for open fracture

[11] Indication for IVIG is post exposure treatment of vaccine naïve patients. Indication for vaccine is treatment of post exposure patient regardless of previous rabies vaccination

Facility Infrastructure

Instructions: A facility attribute or material is deemed as “Present” if it is available at the facility in question at the time of the survey. If not available at the time of the survey, the attribute or material is deemed “Not Present”.

Facility Attribute	Present	Not Present	Unknown
Ambulance Accessible			
Vehicle Accessible			
Specialized Resuscitation Area			
Obstetric Area/Cart			
Ophthalmologic Area/Cart			
ENT Area/Cart			
Dental Area/Cart			
Paediatric Area/Cart			
Triage Area with multiple patient capability			
Isolation Room			
Procedure Room/Cart			
Waiting area for family			
Safe psychiatric room			
Quiet space for family discussions			
Decontamination area			
Management centre with communications			
Intimate partner violence patient area			
Dirty Utility			
Education Room			
24 hour Services			
Pharmaceutical Dispensing			
Pharmacist-staffed pharmacy near ED			

X-Ray in immediate proximity			
Ultrasound			
CT scan			
24 hour laboratory services			
Point of Care Laboratory Services			
Security Personnel Available			

Materials

General Materials	Present	Not Present	Unknown
Stethoscope			
Clock			
Pulse oximeter with adult & paediatric probes			
Non-invasive blood pressure monitoring devise including paediatric and adult cuffs			
Thermometer including low reading capability			
Glucometer			
Paediatric scale			
Gloves			
Personal protective equipment – surgical masks			
N95			
Scalpels			
Plaster of paris			
Crutches			
Xeroform			
Sterile surgical protective equipment			
Documentation			

Materials to Treat Respiratory Failure	Present	Not Present	Unknown
Oropharyngeal airway sizes 000-5			
Nasopharyngeal Airways size 3-7			
Laryngeal Mask Airway			
Laryngoscope set with adult and paediatric blades, spare bulb & spare			

battery			
BVM			
Tracheal tubes, uncuffed (size 2.4-5.5mm), Cuffed (size 3.0-8.5mm)			
Water-soluble lubricant			
10ml Syringe			
Tape			
Meconium adaptor/aspirator			
Non-ascultatory intubation detector Device			
Stylets			
Gum elastic bougie adult and paediatric			
Suction devise and suction catheters rigid & flexible Tips			
Oxygen Bottle, Regulator, flowmeter			
Supraglottic Airway			
Cricothyroidotomy Set			
Tracheostomy Tube sizes 00-6			
14 gauge catheters (needle decompression)			
Chest thoracostomy/decompression sets			
Non Auscultory ET tube Assessment Gauze			
Ventilator			
Nasogastric tube			
Nebulization			
Air Concentrator			

Oxygen Masks			

Materials to Treat Shock	Present	Not Present	Unknown
IV cannula 14-24G and appropriate strapping			
Packs and lines for central venous access			
Needles and syringes 1-50ml			
Sharps Container			
Paediatric & Adult intraosseous access			
High flow infusion catheters 8.5F			
IV administration sets including blood administration sets			
Crystalloids			
Fluid warmer			
Umbilical vein catheters			
Drip Stand or equivalent hanging device			
Sutures			
Basic Surgical Kit			
ECG monitor defibrillator with conductive paste or pads, paddles, electrodes & razors			
12 lead ECG Monitor			
Cardiac Arrest Board			
Transcutaneous pacing ability			

Materials to Treat Altered Mental Status	Present	Not Present	Unknown

Blood Glucose Monitor			
Collection tubes			

Materials to Treat Dangerous Fever	Present	Not Present	Unknown
Lumbar Puncture Kit			

Materials to Severe Pain	Present	Not Present	Unknown
Urinary Catheters sizes 8-18			
Pregnancy testing Kits			
C-spine immobilization, restraining devices			
Blankets & towel rolls			
Ultrasound			
Limb Traction device			

Appendix 2 ECAT consent form

ECAT Consent Form

You are being asked to take part in a research study that aims to refine the African Federation for Emergency Medicine (AFEM) Emergency Care Assessment Tool (ECAT). We hope to develop an objective measurement tool for evaluating comprehensive emergency service provision applicable to the African context.

If you agree, we will ask you to complete the following survey, based around a series of questions on the ability of the health care facility in managing specific emergency conditions. We do not anticipate any additional risks to you from participating in this study. Any report generated will NOT include information that will make it possible to identify you. The interview time will take no more than 45 minutes.

There are no direct benefits to you by taking this survey. We hope to use what we learn from this study and validate ECAT for future use, which will ultimately help health Ministries to improve their emergency care systems.

The results of this toolkit will be compiled and analysed as a group, and will be used by AFEM for a more expansive roll out throughout the region to aid in providing excellent emergency services. The study will conclude with the production of a paper.

Taking part in this study is completely voluntary. You may skip any questions that you do not want to answer. If you decide not to take part or to skip some of the questions, it will not affect your current or future relationship with AFEM. If you decide to take part, you are free to withdraw at any time.

If you have any questions about the survey or the study as a whole, please contact Crystal Bae at programs@afem.info.

Please contact the University of Cape Town, Faculty of Health Sciences, Human Research Ethics Committee at (021)-406-6338 or sumayah.ariefdien@uct.ac.za with any ethical concerns regarding study reference 858/2014.

Statement of Consent: I have read the above information, and have received answers to any questions I asked. I consent to take part in the study.

Your Signature _____ Date _____

Your Name (printed) _____

Appendix 3 Background information

Emergency Care Assessment Tool for Health Facilities

Thank you for your participation in the research study, "Emergency Care Assessment Tool (ECAT) for Health Facilities." The ECAT toolkit was designed in order to determine if health facilities in Sub-Saharan Africa have the capacity to provide critical emergency services. The aim of this study is to refine the ECAT for different levels of health facilities in low and middle income countries in sub-Saharan Africa.

This is NOT an assessment of your health facility, rather, a way to determine the applicability and feasibility of using this toolkit for future use.

You will be asked a series of questions based on:

- Background Questions
- The management of:
    - Respiratory failure
    - Shock
    - Altered mental status
    - Severe pain
    - Trauma
    - Maternal Health

Please answer to the best of your ability, providing as much detail and comments as possible. Feel free to ask questions throughout the survey.

We would like to speak to one senior physician, one senior nurse, and one other clinical provider.

All information is strictly confidential and the results will not include any identifying information on the health facility questioned or the participant.

If you have any questions about the survey or the study itself, please contact Crystal Bae at programs@afem.info. Thank you for your cooperation!

*****For the following survey, please assume that Emergency Centre refers to emergency department, accident & emergency, trauma unit, casualty department, or emergency room*

Investigator: _____ Date: _____
Region: _____ Hospital: _____

Person Undertaking Assessment

Name of person participating in assessment	
Date of assessment	
Title of participant (doctor, nurse, etc)	
Signature of participant	
Contact Telephone/Cell number	

Background of Health Care Facility

Name of Health Care Facility	
Address of Health Care Facility	
Country	
Region	
Type of Health Care Facility*** (*Please circle one)*	Entry level Mid-level Referral level Private Other: _____
Patient population seen in the EC *(Please circle one)*	Adult only Paediatric only Adult and Paediatric
How many patients does your emergency centre see? *(Please circle one)*	_____ per year/month/week/day

Please indicate the number of health staff:	
Doctors	
Specialist Trained EM Providers	
Nurses	
Clinical or Health Officers	
Technicians	
Paramedical Staff	
Other staff	

Please indicate the number of hospital beds:	
In the Emergency Centre	
In the hospital	
In the intensive care unit	

****Please note that entry level facility can include clinics or basic level facility. Mid-level facilities include regional and district level facilities. Referral level includes academic/university level facilities.*

Appendix 4 Barriers to delivery reference document

Emergency Care Assessment Tool- Foundation Signal Functions

Please note the following definitions to keep in mind during the survey:

1. Policies
   - Lack of policies and processes that facilitate optimal patient care (e.g. triage system, timely patient movement to definitive care, automatic financial provision for emergent patient)

2. Human Resources
   - Insufficient number of authorized cadre of health care workers to perform the desired function.

3. Health Care Worker Training (HCW training)
   - Authorized cadre is available but not trained, or there is lack of confidence in providers' skills.

4. Supplies, equipment, medication
   - Supplies or equipment are not available, not functional or broken, or needed drugs are unavailable.

5. Infrastructure
   - Critical facility based infrastructure - such as electricity, lab, blood bank, x-ray, CT, ICU – are not available or not functional.

6. No indication
   - No client needing this procedure comes to this facility.

Appendix 5 Instructions to administer ECAT

Instructions to administer ECAT

Before Administering ECAT

1. Be sure the participant has read the background information, and signed the consent form.
2. Be sure the participant has completed the "Basic Information" document for his/her health facility.
3. Explicitly explain what each "barriers to delivery" means and be sure participant has access to these designations (on survey itself) at all times throughout the interview to reference easily.
4. Explicitly explain to the participant that if he/she is unsure of an item, to ask for an explanation.
5. Explicitly explain that this is not an assessment of the participant's knowledge base or a comprehensive regional analysis of health facilities.

During ECAT

1. Every survey should be administered separately!
2. Be sure to read each item of the survey.
3. Explain to participant that questions and comments throughout administering of the survey are encouraged.
4. Explain that answering "yes" is under the assumption that the signal function is available all the time.
5. ECAT is a prospective study so please administer the survey with appropriate language.
    a. For example, "If a patient with *(sentinel condition)* entered your health facility right now, would you be able to *(signal function*)."
    b. You may provide clarification and explanation regarding a certain item if the participant is not sure.
    c. Please be sure to take note of every footnote.
6. If an item is marked "No," be sure to ask why, mark the appropriate box for "category of failure," and document any further details under the "comments" section. The more information collected the better.
7. Note that ECAT is assessing the capability of the health facility and not the knowledge base of the participant.

After Administering ECAT

1. Be sure to thank the participant for participating
2. Ask if the participant would like a copy of the completed ECAT for their reference.
3. Be sure that all of the contact information is correct and complete.

Appendix 6 HREC approval letter

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

Room E52-24 Old Main Building
Groote Schuur Hospital
Observatory 7925
Telephone [021] 406 6492 • **Facsimile** [021] 406 6411
Email: Sumayah.ariefdien@uct.ac.za
Website: www.health.uct.ac.za/fhs/research/humanethics/forms

17 April 2015

HREC/REF: 858/2014

Prof L Wallis
Division of Emergency Medicine
Private Bag X 24
Bellville 7535

Dear Prof Wallis

Project Title: EMERGENCY CARE ASSESSMENT TOOL (MSc candidate Crystal Bae)

Thank you for your response, addressing the issues raised by the Human Research Ethics Committee (HREC).

It is a pleasure to inform you that the HREC has **formally approved** the above mentioned study.

Approval is granted for one year until the 28 April 2016.

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

We acknowledge that the following student:-Crystal Bae is also involved in this project.

Please note that the on-going ethical conduct of the study remains the responsibility of the principal investigator.

Please quote the HREC REF in all your correspondence.

Yours sincerely

PROFESSOR M BLOCKMAN
CHAIRPERSON, HSF HUMAN ETHICS

Federal Wide Assurance Number: FWA00001637.
Institutional Review Board (IRB) number: IRB00001938

Hrec/ref:858/2014

Appendix 7 Local ethics approval letters

COMITE NATIONAL D'ETHIQUE DE LA RECHERCHE POUR LA SANTE HUMAINE

Arrêté N° 0077/A/MINSANTE/SESP/SG/DROS/ du 18 avril 2012 portant création, organisation et fonctionnement des comités d'éthique de la recherche pour la santé humaine au sein des structures relevant du Ministère en charge de la santé publique

N° 2015/06/609/CE/CNERSH/SP

Yaoundé, le 22 juin 2015

Cnethique_minsante@yahoo.fr

CLAIRANCE ETHIQUE

Le Comité National d'Ethique de la Recherche pour la Santé Humaine (CNERSH), en sa session ordinaire du 16 mai 2015, a examiné le projet de recherche intitulé **«Emergency Care Assessment Tool for Health Facilities»** soumis par le **Professeur LEE Alan WALLIS**, Investigateur Principal, University of Cape Town, Stellenbosch University (South Africa).

Le projet est d'un grand intérêt scientifique et social. Le but de cette étude est d'affiner l'Outil d'Evaluation du Soin d'Urgence pour améliorer la prise en charge des patients et la gestion de la majorité des conditions menaçant le pronostic vital. La procédure de l'étude est bien documentée et claire. Les risques liés à l'étude sont précisés ainsi que les mesures prises pour les éviter et les minimiser. La notice d'information et le formulaire de consentement éclairé, en français et en anglais, sont bien élaborés et simples à comprendre. Les mesures prises pour garantir la confidentialité des données collectées sont présentes dans le document. Les CVs des investigateurs les décrivent comme des personnes compétentes, capables de mener à bien cette étude. Pour toutes ces raisons, le Comité National d'Ethique approuve pour une durée d'un an, la mise en œuvre de la présente version du protocole.

Les Investigateurs sont responsables du respect scrupuleux du protocole approuvé et ne devraient y apporter aucun amendement aussi mineur soit-il, sans avis favorable du CNERSH. Les investigateurs sont appelés à collaborer pour toute descente du CNERSH pour le suivi de la mise en œuvre du protocole approuvé. Le rapport final du projet devra être soumis au CNERSH et aux autorités sanitaires du Cameroun.

La présente clairance peut être retirée en cas de non respect de la réglementation en vigueur et des recommandations susmentionnées.

En foi de quoi, la présente clairance éthique est délivrée pour servir et valoir ce que de droit.

Ampliations

- MINSANTE

Le Président

Pr Lucas KAPTUE

N.B : cette clairance éthique ne vous dispense pas de l'autorisation administrative de recherche (AAR), exigée pour mener cette étude sur le territoire camerounais. Cette dernière vous sera délivrée par le Ministère de la Santé Publique.

TELEPHONE: +256-41554008/1
HOSPITAL
FAX: +256-414-532559)
E-mail: admin@mulago.or.ug
Website: www.mulago.or.ug

IN ANY CORRESPONDENCE ON THIS SUBJECT PLEASE QUOTES NO...

MULAGO NATIONAL REFERRAL

P.O. Box 7051
KAMPALA, UGANDA

THE REPUBLIC OF UGANDA

31st Mar, 2015

Dr. Tonny Stone Luggya
Principal Investigator
Department of Anaesthesia and Critical Care
Mulago hospital.

Dear Luggya,

Re: Approval of Protocol MREC: 725: "Emergency Care Assessment Tool for Health Facilities".

The Mulago Hospital Research and Ethics Committee reviewed your proposal referenced above and hereby grant approval for the conduct of this study for a period of (1) year from 31st Mar, 2015 to 30th Mar, 2016.

This approval covers the protocol and the accompanying documents listed below:

- Consent form
- Questionnaire

This approval is subjected to the following conditions.

1. That the study site may be monitored by the Mulago research and ethics committee at any time.
2. That you will be abide by the regulations governing research in the country as set by the Ugandan National Council for Science and Technology including abiding to all reporting requirements for serious adverse events, unanticipated events and protocol violations.
3. That you will submit this approved protocol and all accompanying documents for approval to UNCST before starting the study. In case of studies involving drug and medical devices, approval must be obtained from the National Drug Authority before starting the study.
4. That no changes to the protocol and study documents will be implemented until they are reviewed and approved by the Mulago Research and Ethics Committee.
5. That you provide annual progressive reports and request for renewal of approval at least 60 days before expiry of the current approval.
6. That you provide an end of study report upon completion of the study including a summary of the results and any publications.

APPROVED
APPROVAL DATE EXPIRY DATE
31 MAR 2015 30 MAR 2016
MULAGO RESEARCH ETHICS COMMITTEE
IREC

I wish you the best in this Endeavour.

Signed by candidate

DR. NAKWAGALA FREDERICK NELSON
CHAIRMAN- MULAGO RESEARCH & ETHICS COMMITTEE.

Vision: "To be the leading centre of Health Care Services"

October 6 University
Faculty of Medicine

جامعة ٦ أكتوبر
كلية الطب

January 2015

To whom it may concern:

Thank you for applying for permission to undertake an assessment of your survey in our hospital. We have the pleasure in writing in support of you administering of the survey entitled, "Emergency Care Assessment Tool" (ECAT) at this facility. We have received all of the proper documentation and grant permission to conduct this survey.

We are aware that ECAT is not an assessment of our health facility, but is rather a way to determine the applicability and feasibility of using this toolkit for future use and context appropriateness.

We understand that all information is strictly confidential and results will not include any information on the interviewees or any of the facilities. We also know that participation in this study is voluntary and all that agree are free to withdraw at any time.

By agreeing to this study, we hope that your study will lead to further studies aimed at improving patient care and a facility's ability to handle major life threatening conditions.

Sincerely,

Prof.Dr . Dawlat Al-Millay

Dean, Faculty of Medicine

October 6 University
Faculty of Medicine

Signed by candidate

Dear respectable professor,

we hope that your study will lead to further studies aiming at improvement in patient care and facilities abilities to handle major life threatening condition we agree to apply the survey of AFEM in our hospital as a part of more future communications and support.

we agree to perform the survey in suez canal university hospital ismailia Egypt

Prof Dr. Mohammad Selch

Head of emergency medicine

Manager of SCU hospital

Signed by candidate

June 2015

To whom it may concern:

Thank you for applying for permission to undertake an assessment of your survey in our hospital. We have the pleasure in writing in support of you administering of the survey entitled, "Emergency Care Assessment Tool" (ECAT) at this facility. We have received all of the proper documentation and grant permission to conduct this survey.

We are aware that ECAT is not an assessment of our health facility, but is rather a way to determine the applicability and feasibility of using this toolkit for future use and context appropriateness.

We understand that all information is strictly confidential and results will not include any information on the interviewees or any of the facilities. We also know that participation in this study is voluntary and all that agree are free to withdraw at any time.

By agreeing to this study, we hope that your study will lead to further studies aimed at improving patient care and a facility's ability to handle major life threatening conditions.

Sincerely,

21/6/2015

Signed by candidate

TELEPHONE: 363 2766
FAX: 391 0647
TELEGRAMS: RADIOGAKA
TELEX: 2818 CARE BD

Republic of Botswana

MINISTRY OF HEALTH
PRIVATE BAG 0038
GABORONE

REFERENCE NO: HPDME 13/18/1 IX (407) 22 April 2015

Health Research and Development Division

Notification of IRB Review: New application

Prof. Lee Wallis
P.O. Box 901
Wellington,
7654, South Africa

Protocol Title: **EMERGENCY CARE ASSESSMENT TOOL**

HRDC Approval Date:	17 April 2015
HRDC Expiration Date:	16 April 2016
HRDC Review Type:	HRDC reviewed
HRDC Review Determination:	Approved
Risk Determination:	Minimal risk

Dear Prof. Wallis

Thank you for submitting new application for the above referenced protocol. The permission is granted to conduct the study.

This permit does not however give you authority to collect data from the selected sites without prior approval from the management. Consent from the identified individuals should be obtained at all times.

The research should be conducted as outlined in the approved proposal. Any changes to the approved proposal must be submitted to the Health Research and Development Division in the Ministry of Health for consideration and approval.

Furthermore, you are requested to submit at least one hardcopy and an electronic copy of the report to the Health Research, Ministry of Health within 3 months of completion of the study. Approval is for academic fulfillment only. Copies should also be submitted to all other relevant authorities.

Continuing Review
In order to continue work on this study (including data analysis) beyond the expiry date, submit a Continuing Review Form for Approval at least three (3) months prior to the protocol's expiration

date. The Continuing Review Form can be obtained from the Health Research Division Office (HRDD), Office No. 7A.7 or Ministry of Health website: www.moh.gov.bw or can be requested via e-mail from Mr. Kgomotso Motlhanka, e-mail address: kgmmotlhanka@gov.bw As a courtesy, the HRDD will send you a reminder email about eight (8) weeks before the lapse date, but failure to receive it does not affect your responsibility to submit a timely Continuing Report form.

Amendments

During the approval period, if you propose any change to the protocol such as its funding source, recruiting materials, or consent documents, you must seek HRDC approval before implementing it. Please summarize the proposed change and the rationale for it in the amendment form available from the Health Research Division Office (HRDD), Office No. 7A 7 or Ministry of Health website: www.moh.gov.bw or can be requested via e- mail from Mr. Kgomotso Motlhanka, e-mail address: kgmotlhanka@gov.bw . In addition submit three copies of an updated version of your original protocol application showing all proposed changes in bold or "track changes".

Reporting

Other events which must be reported promptly in writing to the HRDC include:

- Suspension or termination of the protocol by you or the grantor
- Unexpected problems involving risk to subjects or others
- Adverse events, including unanticipated or anticipated but severe physical harm to subjects.

If you have any questions please do not hesitate to contact Mr. P. Khulumani at pkhulumani@gov.bw, Tel +267-3914467 or Lemphi Moremi at lamoremi@gov.bw or Tel: +267-3632754. Thank you for your cooperation and your commitment to the protection of human subjects in research.

Yours sincerely

Signed by candidate

MINISTRY OF HEALTH RESEARCH DIVISION 2015 -04- 22 P/BAG 0038 GABORONE REPUBLIC OF BOTSWANA

P. Khulumani

For Permanent Secretary

MINISTRY of HEALTH

Vision: *Model of Excellence in Quality Health Services*

Values: *Botho, Equity, Timeliness, Customer Focus, Teamwork, Accountability*

BOTSWANA

Appendix 8 ECAT version 4

Signal Function Management

Respiratory Failure

Signal Function	Available 24/7	Usually Available	Occasionally Available	Never Available	Unknown	Comments
Managing the airway – Ask how the provider would address a patient who is not breathing						
Manual manoeuvres[12]						
Rescue breathing						
Bag valve mask ventilation						
Insertion of oral airway[13]						
Oxygen administration						
Supraglottic device						
Definitive Airway						
Non-invasive mechanical ventilation						
Invasive mechanical ventilation						
Relief of obstruction – Ask how the provider would manage a foreign body airway obstruction						
Heimlich manoeuvre						
Mechanical manoeuvres[14]						
Use of suction						
Pneumothorax management- Ask how the provider would manage a pneumothorax causing respiratory distress						
Three way dressing application (for sucking chest wound)						
Needle decompression[15]						
Chest tube insertion						
Management of reactive airway disease						
Administration of critical therapeutics[16]						

Any additional comments on "Respiratory Failure"

[12] Head tilt/chin lift, jaw thrust
[13] If not specifically mentioned, ask if available
[14] e.g. Magills forceps
[15] If not specifically mentioned, ask about needle availability
[16] e.g. any bronchodilators, adrenaline, steroids

Signal Function Management

Shock

Signal Function	Available 24/7	Usually Available	Occasionally Available	Never Available	Unknown	Comments
Managing haemorrhage – Ask how the provider manages haemorrhage						
Physical manoeuvers for control of haemorrhage[17]						
Arterial tourniquet						
Pelvic wrapping						
Packing and suturing for control of haemorrhage						
Delivery and administration of critical therapeutics						
Peripheral percutaneous intravenous access						
Intraosseous access						
Venous cutdown						
Administration of isotonic IV fluids[18]						
Administration of IM adrenaline[19]						
Administration of IV antibiotics &/or antimalarials						
Administration of critical therapeutics[20]						
Pathogen screened blood transfusion						
Central venous access						
Administration of IV medications that require advance monitoring[21]						
Managing cardiogenic shock – Ask how the provider would manage cardiogenic shock?						
ECG interpretation						
Automated external defibrillation						
Cardioversion						
Pericardiocentesis						

Any additional comments on "Shock"

[17] e.g. Direct pressure, pressure bandage, pressure points
[18] e.g. Hartmann's solution, Ringers Lactate, Plasmalyte, Normal Saline
[19] indication anaphylaxis
[20] e.g. txa, oxytocin
[21] e.g. vasopressors, thrombolytics

Signal Function Management

Altered Mental Status

Signal Function	Available 24/7	Usually Available	Occasionally Available	Never Available	Unknown	Comments
General – Ask the provider about the approach to the patient with altered mental status?						
Protect from secondary injury - Basic nursing care[22] - Advanced medical care [23]						
Check and/or administer glucose						
Administer mental status exam						
Rule out organic causes of altered mental status[24] - Clinical assessment - Lab test - Imaging						
Perform laboratory investigation[25]						
Perform Lumbar Puncture						
Perform Head CT						
Administration of Critical Therapeutics						
Administer benzodiazepine for seizure or sedation[26]						
Administer therapeutics for acute psychiatric illness						
Administer magnesium sulphate for pregnant seizing patient						
Administer insulin for hyperglycaemia						
Administer locally appropriate antidote/ antivenom for toxic cause						

Any additional comments on "Altered Mental Status"

[22] Specifically, is there adequate personnel/infrastructure to monitor the patient closely, including: head-tilt chin-lift, jaw thrust, recovery position, elevate head of the bed, protection from fall

[23] Specifically, is there adequate personnel/infrastructure to monitor blood pressure and avoid hypotension, avoid hyperthermia and cooling if necessary, avoidance of hypoxia, NGT to reduce aspiration risk

[24] i.e. assessment for hypoglycemia, hyponatremia, uremia, thyroid abnormalities, hypertensive emergency, cerebral hypoperfusion, sepsis, meningitis/encephalitis, seizure, stroke, space occupying lesion.

[25] Note which labs mentioned: e.g. LP analysis, malaria RDT, NH3, LFTs, electrolytes, salicylate level, acetaminophen level, BUN/Cr, UA

[26] specify whether PO/IM/PR vs. IV

Signal Function Management

Severe Pain/Trauma

Signal Function	Available 24/7	Usually Available	Occasionally Available	Never Available	Unknown	Comments
General – Ask the provider about the approach to the patient with severe pain						
Administer analgesic agent						
Perform ultrasound						
Perform X-ray imaging[27]						
Perform CT imaging[15]						
Chest pain – Ask the provider about the approach to the patient with chest pain						
Administration of aspirin if ACS likely						
EKG interpretation[15]						
Abdominal pain – Ask the provider about the approach to the patient with abdominal pain						
Foley placement for urinary retention						
Paracentesis						
Trauma – Ask the provider about the approach to the patient with trauma (ortho vs. general)[28]						
Appropriate wound care[29]						
Basic immobilization for fracture[30]						
Cervical spine immobilization						
Reduction of fracture if neurovascular compromise						
Fasciotomy for compartment syndrome						
Auto transfusion from chest tubes						
Thoracotomy						
Burn Care						
Cooling care [31]						
Escharotomy						
Critical treatment algorithms						
Adult trauma						
Paediatric trauma						
Burn Resuscitation						
Access to definitive surgical services – Are surgical services available within XX hours?						

[27] specify emergency personnel interpretation or specialist
[28] Note: signal functions for critical penetrating trauma interventions noted in respiratory distress. For each function, please note if performed by emergency personnel or specialist
[29] irrigate with potable water or sterile solution, surgically close clean acute wounds, dress, infection control as needed
[30] sling, splint, inline immobilization for thoracic or lumbar fracture
[31] remove charred clothing, immerse burned area (for TBSA <9%) in 1-5 °C water within 30 minutes of burn

Neurosurgery						
Thoracic surgery						
Orthopaedic surgery						
General surgical services						
Obstetric surgery						
Critical Therapeutics						
Tetanus vaccine and IVIG as indicated						
Parenteral antibiotics for open fracture						
Rabies IVIG/vaccine						

Any additional comments on "Severe Pain/Trauma"

Signal Function Management

Dangerous Fever[32]

Signal Function	**Available 24/7**	**Usually Available**	**Occasionally Available**	**Never Available**	**Unknown**	**Comments**
General – Ask the provider about the approach to the patient with dangerous fever						
Temperature management[33]						
Source control with bedside techniques[34]						
Source control requiring operating theatre (deep abscess)						
Rule out organic causes of altered mental status[35]						
Treatment algorithms						
Adult sepsis protocol						
Paediatric sepsis protocol						

[32] fever and one or more of the following: stiff neck, very weak/not able, to stand, lethargy, unconscious, convulsions, severe abdominal pain, respiratory distress, HIV, infant, immunocompromise (chemo, liver failure etc.)
[33] via antipyretic if febrile or external means if hypo/hyperthermic
[34] e.g. abscess or empyema drainage
[35] i.e. assessment for hypoglycemia, hyponatremia, uremia, thyroid abnormalities, hypertensive emergency, cerebral hypoperfusion, sepsis, meningitis/encephalitis, seizure, stroke, space occupying lesion.

Administration of Critical Therapeutics[36]						
Parenteral therapeutics for sympathomimetic toxidrome or ethanol withdrawal						
Parenteral antibiotics within one hour of presentation for those with severe sepsis or septic shock						

Any additional comments on "Dangerous Fever"

[36] Note that some essential interventions were covered in Shock

Facility Infrastructure

Instructions: For each of the following, rate each item as:

N/A = not applicable at that level
0 = absent (and should be present)
1 = inadequate
2 = partially adequate (present, but use not assured; present, but not all the time; present, but not readily available)
3 = adequate (present and used appropriately)

Facility Attribute	3	2	1	0	N/A	Comments
Vehicle Accessible						
Security Personnel Available						
Triage Area with multiple patient capability						
Obstetric Area/Cart						
Isolation Room						
Waiting area for family						
Quiet space for family discussions						
Point of Care Laboratory Services						
Safe area for victims of intimate partner violence						
Dirty Utility Room						
Ambulance Accessible						
Paediatric Area/Cart						
24 hour laboratory services						
Procedure Room/Cart						
Decontamination area						
Education/Conference Room						
24 hour Services						
Pharmaceutical Dispensing for critical therapeutics						
Pharmacist-staffed pharmacy near ED						

X-Ray in immediate proximity						
Ultrasound						
Specialized Resuscitation Area						
Safe psychiatric room						
Management centre with communications						
CT scan						
Dental Area/Cart						
ENT Area/Cart						
Ophthalmologic Area/Cart						

Any additional comments on “Facility Infrastructure”

Materials by Signal Function

Instructions: For each of the following, rate each item as:

NA= not applicable at that level
0 = absent (but should be present)
1 = inadequate
2 = partially adequate (present; but use not assured; present, but not all the time; present, but not readily available)
3 = present and functional (available at time of survey and used appropriately)

General Materials	3	2	1	0	N/A	Comments
Stethoscope						
Clock						
Scalpels						
Non-invasive blood pressure monitoring devise including paediatric and adult cuffs						
Thermometer including low reading capability						
Glucometer						
Paediatric scale						
Gloves						
Personal protective equipment – surgical masks, gloves, gowns						
Crutches						
Documentation						
N95 mas or equivalent[37]						
Pulse oximeter with adult & paediatric probes						
Xeroform or equivalent dressing[38]						
Plaster of paris						
Sterile surgical protective equipment						

[37] Appropriate mask that filters 95% of microns
[38] Vaseline-impregnated gauze that prevents air leaks

Materials to Treat Respiratory Failure	3	2	1	0	N/A	Comments
Water-soluble lubricant						
10ml Syringe						
Tape						
Gauze						
Meconium adaptor/aspirator						
Nasogastric tube						
Oropharyngeal airway sizes 000-5						
Nasopharyngeal Airways size 3-7						
Bag Valve Mask with different mask sizes (infant, paediatric, adult)						
Nebulization						
Oxygen Concentrator (Oxygen source)						
Stylets						
Gum elastic bougie adult and paediatric						
Suction devise and suction catheters rigid & flexible tips						
14 gauge catheters[39]						
Non auscultory ET tube assessment device[40]						
Oxygen Masks						
Tracheal tubes, uncuffed (size 2.4-5.5mm), Cuffed (size 3.0-8.5mm)						
Laryngoscope set with adult and paediatric blades, spare bulb & spare battery						
Cricothyroidotomy Set						

[39] Indication-needle decompression for
[40] Way to assess placement without listening such as colorimeter

Tracheostomy Tube sizes 00-6						
Ventilator						
Laryngeal Mask Airway						
Oxygen bottle, regulator, flowmeter						
Supraglottic Airway						
Non-ascultatory intubation detector Device						
Chest thoracostomy sets						

Materials to Treat Shock	3	2	1	0	N/A	Comments
Sharps Container						
Sutures						
Basic Surgical Kit						
Needles and syringes 1-50ml						
Paediatric & Adult intraosseous access						
IV administration sets including blood administration sets						
Umbilical vein catheters						
Drip Stand or equivalent hanging device						
Cardiac Arrest Board						
12 lead ECG Monitor						
Fluid warmer						
Packs and lines for central venous access						
High flow infusion catheters 8.5F						
ECG monitor defibrillator with conductive paste or pads, paddles, electrodes & razors						

Transcutaneous pacing ability						
Crystalloids						
IV cannula 14-24G and appropriate strapping						

Materials to Treat Altered Mental Status	**3**	**2**	**1**	**0**	**N/A**	**Comments**
Blood Glucose Monitor						
Collection tubes						

Materials to Severe Pain	**3**	**2**	**1**	**0**	**N/A**	**Comments**
Blankets & towel rolls						
Pregnancy testing kits						
C-spine immobilization devices						
Urinary Catheters sizes 8-18						
Limb Traction device						
Ultrasound						

Materials to Treat Dangerous Fever	**3**	**2**	**1**	**0**	**N/A**	**Comments**
Lumbar Puncture Kit						

Any additional comments on “Materials”

Appendix 9 ECAT version 6

Signal Function	Perform at all times?	If not, why?	If yes….?	Additional Comments
Respiratory Failure				
Can your facility manage an obstructed airway?	☐ Yes ☐ No	☐ 1. System management (triage system, processes for patient flow, financial provision for emergent patient) ☐ 2. Human resources ☐ 3. Health care worker training ☐ 4. Supplies, equipment, medications ☐ 5. Local policies mandating care ☐ 6. Facility infrastructure (water, power, blood bank, CT, X-ray) ☐ 7. No indication ☐ 8. Other	☐ 1. Heimlich manoeuvre ☐ 2. Mechanical manoeuvre ☐ 3. Use of suction	
Can your facility manage acute respiratory distress?	☐ Yes ☐ No	☐ 1. System management (triage system, processes for patient flow, financial provision for emergent patient) ☐ 2. Human resources ☐ 3. Health care worker training ☐ 4. Supplies, equipment, medications ☐ 5. Local policies mandating care ☐ 6. Facility infrastructure (water, power, blood bank, CT, X-ray) ☐ 7. No indication ☐ 8. Other	☐ 1. Manual manoeuvres ☐ 2. Rescue breathing ☐ 3. Bag valve mask ventilation ☐ 4. Insertion of oral airway ☐ 5. Oxygen administration ☐ 6. Supraglottic device ☐ 7. Definitive airway ☐ 8. Non-invasive mechanical ventilation ☐ 9. Invasive ventilation	
Shock				
Can your facility manage a patient with haemorrhagic shock?	☐ Yes ☐ No	☐ 1. System management (triage system, processes for patient flow, financial provision for emergent patient) ☐ 2. Human resources ☐ 3. Health care worker training ☐ 4. Supplies, equipment, medications ☐ 5. Local policies mandating care ☐ 6. Facility infrastructure (water, power, blood bank, CT, X-ray) ☐ 7. No indication ☐ 8. Other	☐ 1. Physical manoeuvers for control of haemorrhage ☐ 2. Arterial tourniquet ☐ 3. Pelvic wrapping ☐ 4. Packing and suturing for control of haemorrhage	
Can your facility	☐ Yes ☐ No	☐ 1. System management (triage system, processes for patient flow, financial provision for	☐ 1. ECG interpretation ☐ 2. Automated	

manage a patient with other shock?		emergent patient) ☐ 2. Human resources ☐ 3. Health care worker training ☐ 4. Supplies, equipment, medications ☐ 5. Local policies mandating care ☐ 6. Facility infrastructure (water, power, blood bank, CT, X-ray) ☐ 7. No indication ☐ 8. Other	external defibrillation ☐ 3. Cardioversion ☐ 4. Pericardiocentesis	
Can your facility manage severe sepsis/septic shock?	☐ Yes ☐ No	☐ 1. System management (triage system, processes for patient flow, financial provision for emergent patient) ☐ 2. Human resources ☐ 3. Health care worker training ☐ 4. Supplies, equipment, medications ☐ 5. Local policies mandating care ☐ 6. Facility infrastructure (water, power, blood bank, CT, X-ray) ☐ 7. No indication ☐ 8. Other	☐ 1. Peripheral percutaneous intravenous access ☐ 2. Intraosseous access ☐ 3. Venous cutdown ☐ 4. Administration of isotonic IV fluids ☐ 5. Administration of IM adrenaline ☐ 6. Administration of IV antibiotics and/or antimalarials ☐ 7. Administration of critical therapeutics ☐ 8. Pathogen screened blood transfusion ☐ 9. Central venous access ☐ 10. Administration of IV medications that require advance monitoring	
Altered Mental Status				
Can your facility manage a patient with seizure?	☐ Yes ☐ No	☐ 1. System management (triage system, processes for patient flow, financial provision for emergent patient) ☐ 2. Human resources ☐ 3. Health care worker training ☐ 4. Supplies, equipment, medications ☐ 5. Local policies mandating care ☐ 6. Facility infrastructure (water, power, blood bank, CT, X-ray) ☐ 7. No indication ☐ 8. Other	☐ 1. Administer benzodiazepine for seizure or sedation ☐ 2. Administer therapeutics for acute psychiatric illness ☐ 3. Administration magnesium sulphate for pregnant seizure patient ☐ 4. Administer insulin for	

			hyperglycaemia ☐ 5. Administer locally appropriate antidote/antivenom for toxic cause	
Can your facility manage the unconscious patient?	☐ Yes ☐ No	☐ 1. System management (triage system, processes for patient flow, financial provision for emergent patient) ☐ 2. Human resources ☐ 3. Health care worker training ☐ 4. Supplies, equipment, medications ☐ 5. Local policies mandating care ☐ 6. Facility infrastructure (water, power, blood bank, CT, X-ray) ☐ 7. No indication ☐ 8. Other	☐ 1. Protect from secondary injury (basic nursing care, advanced medical care) ☐ 2. Check and/or administer glucose ☐ 3. Administer mental status exam ☐ 4. Rule out organic causes of altered mental status (clinical assessment, lab testing, imaging) ☐ 5. Perform laboratory investigation ☐ 6. Perform lumbar puncture ☐ 7. Perform head CT	
Severe Pain				
Can your facility administer the appropriate analgesia?	☐ Yes ☐ No	☐ 1. System management (triage system, processes for patient flow, financial provision for emergent patient) ☐ 2. Human resources ☐ 3. Health care worker training ☐ 4. Supplies, equipment, medications ☐ 5. Local policies mandating care ☐ 6. Facility infrastructure (water, power, blood bank, CT, X-ray) ☐ 7. No indication ☐ 8. Other	☐ 1. Administration of aspirin if ACS likely ☐ 2. EKG interpretation ☐ 3. Foley placement for urinary retention ☐ 4. Paracentesis ☐ 5. Perform ultrasound ☐ 6. Perform X-ray imaging ☐ 7. Perform CT imaging	
Trauma				
Can your facility manage a patient with poly trauma?	☐ Yes ☐ No	☐ 1. System management (triage system, processes for patient flow, financial provision for emergent patient) ☐ 2. Human resources ☐ 3. Health care worker training ☐ 4. Supplies, equipment,	☐ 1. General surgery ☐ 2. Neurologic surgical services ☐ 3. Orthopaedic surgical services ☐ 4. Appropriate	

		medications ☐ 5. Local policies mandating care ☐ 6. Facility infrastructure (water, power, blood bank, CT, X-ray) ☐ 7. No indication ☐ 8. Other	wound care ☐ 5. Basic immobilization for fracture ☐ 6. Cervical spine immobilization ☐ 7. Reduction of fracture if neurovascular compromise ☐ 8. Fasciotomy for compartment syndrome ☐ 9. Autotransfusion from chest tubes ☐ 10. Thoracotomy ☐ 11. Burn care (cooling care & Escharotomy) ☐ 12. Critical treatment algorithms (adult trauma, paediatric trauma, burn resuscitation) ☐ 13. Critical therapeutics (tetanus vaccine & IVIG as indicated) ☐ 14. Parenteral antibiotics for open fracture ☐ 15. Rabies IVIG/vaccine	
Maternal Health				
Can your facility manage obstructive labour?	☐ Yes ☐ No	☐ 1. System management (triage system, processes for patient flow, financial provision for emergent patient) ☐ 2. Human resources ☐ 3. Health care worker training ☐ 4. Supplies, equipment, medications ☐ 5. Local policies mandating care ☐ 6. Facility infrastructure (water, power, blood bank, CT, X-ray) ☐ 7. No indication ☐ 8. Other		

Appendix 10 ECAT version 8

Emergency Care Assessment Tool- Foundation Signal Functions

Signal Function	Perform at all times?	**IF NOT, WHY?**	Policies	Human Resources	HCW training	Supplies equipment medication	Infrastructure	No indication	Other/Comments
Respiratory Failure									
I. Obstructed airway- Can your facility manage an obstructed airway?	☐ Yes *- If yes, answer questions below.* ☐ No *- If no, please indicate why not.*								
Manual manoeuvres[41]	☐ Yes ☐ No								
Relief of obstruction[42]	☐ Yes ☐ No								
Use of suction	☐ Yes ☐ No								
Surgical airway	☐ Yes ☐ No								
II. Respiratory Distress - Can your facility manage a patient in respiratory distress?	☐ Yes *- If yes, answer questions below.* ☐ No *- If no, please indicate why not.*								

[41] Includes head tilt, chin lift, jaw thrust
[42] Includes abdominal thrusts if conscious, CPR if unconscious, chest thrusts and back blows for infant

Signal Function	Perform at all times?	**IF NOT, WHY?**	Policies	Human Resources	HCW training	Supplies equipment medication	Infrastructure	No indication	Other/Comments
Rescue breathing	☐ Yes ☐ No								
Three-way dressing	☐ Yes ☐ No								
Insertion of oral airway	☐ Yes ☐ No								
Bag valve mask ventilation	☐ Yes ☐ No								
Supraglottic device placement	☐ Yes ☐ No								
Administer critical therapeutics for reactive airway disease[43]	☐ Yes ☐ No								
Oxygen administration	☐ Yes ☐ No								
Endotracheal intubation	☐ Yes ☐ No								
Cricothyrotomy	☐ Yes ☐ No								
Non-invasive mechanical ventilation	☐ Yes ☐ No								
Invasive mechanical ventilation	☐ Yes ☐ No								

[43] E.g. any bronchodilators, adrenaline, steroids

Signal Function	Perform at all times?	**IF NOT, WHY?**	Policies	Human Resources	HCW training	Supplies equipment medication	Infrastructure	No indication	Other/Comments
Shock									
I. Haemorrhagic Shock - Can your facility manage a haemorrhagic shock?	☐ Yes *- If yes, answer questions below.* ☐ No *- If no, please indicate why not.*								
Physical manoeuvers for control of haemorrhage[44]	☐ Yes ☐ No								
Arterial tourniquet	☐ Yes ☐ No								
Pelvic wrapping	☐ Yes ☐ No								
Packing and suturing for control of haemorrhage	☐ Yes ☐ No								
Peripheral percutaneous intravenous access	☐ Yes ☐ No								
Intraosseus access	☐ Yes ☐ No								
Venous cutdown	☐ Yes ☐ No								

[44] Direct pressure, pressure bandage, pressure points

Signal Function	Perform at all times?	**IF NOT, WHY?**	Policies	Human Resources	HCW training	Supplies equipment medication	Infrastructure	No indication	Other/Comments
Pathogen screened blood transfusion	☐ Yes ☐ No								
Central venous access	☐ Yes ☐ No								
II. Other Shock - Can your facility manage other shock?	☐ Yes *- If yes, answer questions below.* ☐ No *- If no, please indicate why not.*								
ECG interpretation	☐ Yes ☐ No								
External defibrillation	☐ Yes ☐ No								
Needle decompressio of tension pneumothorax	☐ Yes ☐ No								
Administration of adrenaline (for anaphylactic shock)	☐ Yes *- If yes, circle one:* *IM IV* ☐ No								
Administration of IV medications that require advance monitoring[45]	☐ Yes *- If yes, circle one:* *IM IV* ☐ No								
Cardioversion	☐ Yes ☐ No								

[45] E.g. vasopressors, thrombolytics

Signal Function	Perform at all times?	**IF NOT, WHY?**	Policies	Human Resources	HCW training	Supplies equipment medication	Infrastructure	No indication	Other/Comments
Pericardiocentesis	☐ Yes ☐ No								
III. Severe Sepsis/Septic Shock - Can your facility manage severe sepsis/septic shock?	☐ Yes *- If yes, answer questions below.* ☐ No *- If no, please indicate why not.*								
Administration of isotonic IV fluids	☐ Yes ☐ No								
Administration of IV antibiotics and/or antimalarials	☐ Yes *- If yes, circle one: PO IM IV* ☐ No								
Altered Mental Status									
I. Unconscious Patient - Can your facility manage an unconscious patient?	☐ Yes *- If yes, answer questions below.* ☐ No *- If no, please indicate why not.*								
Protect from secondary injury[46]	☐ Yes ☐ No								

[46] Specifically, is there adequate personnel/infrastructure to monitor blood pressure and avoid hypotension, avoid hyperthermia and cooling if necessary, avoidance of hypoxia, NGT to reduce aspiration risk)

Signal Function	Perform at all times?	**IF NOT, WHY?**	Policies	Human Resources	HCW training	Supplies equipment medication	Infrastructure	No indication	Other/Comments
Check and/or administer glucose if required.	☐ Yes ☐ No								
Administer insulin for hyperglycemia	☐ Yes ☐ No								
Perform head CT	☐ Yes ☐ No								
Perform lumbar puncture	☐ Yes ☐ No								
II. Seizure - Can your facility manage seizures?	☐ Yes *- If yes, answer questions below.* ☐ No *- If no, please indicate why not.*								
Administer benzodiazepine	☐ Yes *- If yes, circle one:* *PO IM IV* ☐ No								
Administration of parenteral magnesium sulphate for pregnant patient	☐ Yes ☐ No								
Administer locally appropriate antidote for toxic cause[47]	☐ Yes ☐ No								

[47] E.g. antivenom

Signal Function	Perform at all times?	**IF NOT, WHY?**	Policies	Human Resources	HCW training	Supplies equipment medication	Infrastructure	No indication	Other/Comments
III. Other - Can your facility manage other altered mental status conditions?	☐ Yes *- If yes, answer questions below.* ☐ No *- If no, please indicate why not.*								
Administer mental status examination	☐ Yes ☐ No								
Management of extremes of temperature	☐ Yes ☐ No								
Severe Pain									
I. General Severe Pain- Can your facility manage patients in severe pain?	☐ Yes *- If yes, answer questions below.* ☐ No *- If no, please indicate why not.*								
Administer opiate based analgesia	☐ Yes ☐ No								
II. Abdominal Pain - Can your facility manage abdominal pain?	☐ Yes *- If yes, answer questions below.* ☐ No *- If no, please indicate why not.*								

Signal Function	Perform at all times?	**IF NOT, WHY?**	Policies	Human Resources	HCW training	Supplies equipment medication	Infrastructure	No indication	Other/Comments
Urine dipstick/HCG	☐ Yes ☐ No								
Oral hydration	☐ Yes ☐ No								
Placement of Foley catheter for urinary outlet obstruction	☐ Yes ☐ No								
Therapeutic paracentesis	☐ Yes ☐ No								
Ultrasound	☐ Yes ☐ No								
III. Chest Pain - Can your facility manage chest pain?	☐ Yes *- If yes, answer questions below.* ☐ No *- If no, please indicate why not.*								
Administration of aspirin if ACS likely	☐ Yes ☐ No								
Chest x-ray	☐ Yes ☐ No								
Trauma									
I. General Trauma - Can your facility manage general trauma?	☐ Yes *- If yes, answer questions below.* ☐ No *- If no, please*								

	indicate why not.								
Signal Function	Perform at all times?	**IF NOT, WHY?**	Policies	Human Resources	HCW training	Supplies equipment medication	Infrastructure	No indication	Other/Comments
Trauma protocol implementation	☐ Yes ☐ No								
Initial appropriate wound care[48]	☐ Yes ☐ No								
Basic immobilization for fracture	☐ Yes ☐ No								
Reduction of fracture	☐ Yes ☐ No								
Cervical spine immobilization	☐ Yes ☐ No								
Tetanus vaccine & IVIG as indicated	☐ Yes ☐ No								
Antibiotics for open fracture (PO/IM vs IV)	☐ Yes *- If yes, circle one:* *PO IM IV* ☐ No								
Fasciotomy for compartment syndrome	☐ Yes ☐ No								
Rabies IVIG/ vaccination as appropriate	☐ Yes ☐ No								
Access to general definitive surgical services	☐ Yes ☐ No								

[48] irrigate with potable water or sterile solution, surgically close clean acute wounds, dress, infection control as needed

Signal Function	Perform at all times?	**IF NOT, WHY?**	Policies	Human Resources	HCW training	Supplies equipment medication	Infrastructure	No indication	Other/Comments
Access to orthopaedic surgical services	☐ Yes ☐ No								
Access to neurosurgical services	☐ Yes ☐ No								
Chest tube insertion	☐ Yes ☐ No								
Thoracotomy	☐ Yes ☐ No								
Autotransfusion from chest tubes	☐ Yes ☐ No								
II. Burns *- Can your facility manage burns?*	☐ Yes *- If yes, answer questions below.* ☐ No *- If no, please indicate why not.*								
Cooling care	☐ Yes ☐ No								
Escharatomy	☐ Yes ☐ No								

Signal Function	Perform at all times?	**IF NOT, WHY?**	Policies	Human Resources	HCW training	Supplies equipment medication	Infrastructure	No indication	Other/Comments
Maternal Health									
I. Obstructive Labour - Can your facility manage obstructive laboury?	☐ Yes *- If yes, answer questions below.* ☐ No *- If no, please indicate why not.*								
Administer uterotonic drugs (i.e. parenteral oxytocin)	☐ Yes ☐ No								
Perform assisted vaginal delivery	☐ Yes *- If yes, circle one: Routine Vacuum extraction forceps* ☐ No								
Perform newborn resuscitation (e.g. with bag and mask)	☐ Yes ☐ No								
Access to surgical services (e.g. caesarean section)	☐ Yes ☐ No								

Appendix 11 ECAT version 10 (final)

The interview time will only take no more than 45 minutes.

Taking part in this study is completely voluntary. You may skip any questions that you do not want to answer. If you decide not to take part or to skip some of the questions, it will not affect your current or future relationship with AFEM. If you decide to take part, you are free to withdraw at any time.

Emergency Care Assessment Tool- Foundation Signal Functions

Signal Function	Perform at all times?	**IF NOT, WHY?**	Policies	Human Resources	HCW training	Supplies equipment medication	Infrastructure	No indication	Other/Comments
Respiratory Failure									
I. Obstructed airway									
Manual manoeuvres[49]	☐ Yes ☐ No								
Relief of obstruction[50]	☐ Yes ☐ No								
Use of suction	☐ Yes ☐ No								
Surgical airway	☐ Yes ☐ No								
II. Respiratory Distress									
Rescue breathing	☐ Yes ☐ No								

[49] Includes head tilt, chin lift, jaw thrust
[50] Includes abdominal thrusts if conscious, CPR if unconscious, chest thrusts and back blows for infant

Signal Function	Perform at all times?	**IF NOT, WHY?**	Policies	Human Resources	HCW training	Supplies equipment medication	Infrastructure	No indication	Other/Comments
Three-way dressing	☐ Yes ☐ No								
Insertion of oral airway	☐ Yes ☐ No								
Bag valve mask ventilation	☐ Yes ☐ No								
Supraglottic device placement	☐ Yes ☐ No								
Administer critical therapeutics for reactive airway disease[51]	☐ Yes ☐ No								
Oxygen administration	☐ Yes ☐ No								
Endotracheal intubation	☐ Yes ☐ No								
Cricothyrotomy	☐ Yes ☐ No								
Non-invasive mechanical ventilation	☐ Yes ☐ No								
Invasive mechanical ventilation	☐ Yes ☐ No								
Shock									
I. Haemorrhagic Shock									

[51] E.g. any bronchodilators, adrenaline, steroids

Signal Function	Perform at all times?	**IF NOT, WHY?**	Policies	Human Resources	HCW training	Supplies equipment medication	Infrastructure	No indication	Other/Comments
Physical manoeuvers for control of haemorrhage[52]	☐ Yes ☐ No								
Arterial tourniquet	☐ Yes ☐ No								
Pelvic wrapping	☐ Yes ☐ No								
Packing and suturing for control of haemorrhage	☐ Yes ☐ No								
Peripheral percutaneous intravenous access	☐ Yes ☐ No								
Intraosseus access	☐ Yes ☐ No								
Venous cutdown	☐ Yes ☐ No								
Pathogen screened blood transfusion	☐ Yes ☐ No								
Central venous access	☐ Yes ☐ No								
II. Other Shock									
ECG interpretation	☐ Yes ☐ No								
External defibrillation	☐ Yes ☐ No								

[52] Direct pressure, pressure bandage, pressure points

Signal Function	Perform at all times?	**IF NOT, WHY?**	Policies	Human Resources	HCW training	Supplies equipment medication	Infrastructure	No indication	Other/Comments
Needle decompressio of tension pneumothorax	☐ Yes ☐ No								
Administration of adrenaline (for anaphylactic shock)	☐ Yes *- If yes, circle:* *IM IV* ☐ No								
Administration of IV medications that require advance monitoring[53]	☐ Yes *- If yes, circle:* *IM IV* ☐ No								
Cardioversion	☐ Yes ☐ No								
Pericardiocentesis	☐ Yes ☐ No								
III. Severe Sepsis/Septic Shock									
Administration of isotonic IV fluids	☐ Yes ☐ No								
Administration of IV antibiotics and/or antimalarials	☐ Yes *- If yes, circle:* *PO IM IV* ☐ No								
Altered Mental Status									

[53] E.g. vasopressors, thrombolytics

Signal Function	Perform at all times?	**IF NOT, WHY?**	Policies	Human Resources	HCW training	Supplies equipment medication	Infrastructure	No indication	Other/Comments
I. Unconscious Patient									
Protect from secondary injury[54]	☐ Yes ☐ No								
Check and/or administer glucose if required.	☐ Yes ☐ No								
Administer insulin for hyperglycemia	☐ Yes ☐ No								
Perform head CT	☐ Yes ☐ No								
Perform lumbar puncture	☐ Yes ☐ No								
II. Seizure									
Administer benzodiazepine	☐ Yes *- If yes, circle:* *PO IM* *IV Rectal* ☐ No								
Administration of parenteral magnesium sulphate for pregnant patient	☐ Yes ☐ No								
Administer locally appropriate antidote for toxic cause[55]	☐ Yes ☐ No								

[54] Specifically, is there adequate personnel/infrastructure to monitor blood pressure and avoid hypotension, avoid hyperthermia and cooling if necessary, avoidance of hypoxia, NGT to reduce aspiration risk)

[55] E.g. antivenom

Signal Function	Perform at all times?	**IF NOT, WHY?**	Policies	Human Resources	HCW training	Supplies equipment medication	Infrastructure	No indication	Other/Comments
III. Other	.								
Administer mental status examination	☐ Yes ☐ No								
Management of extremes of temperature	☐ Yes ☐ No								
Severe Pain									
I. General Severe Pain-	.								
Administer opiate based analgesia	☐ Yes ☐ No								
II. Abdominal Pain									
Urine dipstick	☐ Yes ☐ No								
HCG testing	☐ Yes ☐ No								
Oral hydration	☐ Yes ☐ No								
Placement of Foley catheter for urinary outlet obstruction	☐ Yes ☐ No								
Therapeutic paracentesis	☐ Yes ☐ No								
Ultrasound	☐ Yes ☐ No								
III. Chest Pain									

Signal Function	Perform at all times?	**IF NOT, WHY?**	Policies	Human Resources	HCW training	Supplies equipment medication	Infrastructure	No indication	Other/Comments
Administration of aspirin if ACS likely	☐ Yes ☐ No								
Chest x-ray	☐ Yes ☐ No								
Trauma									
I. General Trauma									
Trauma protocol implementation	☐ Yes ☐ No								
Initial appropriate wound care[56]	☐ Yes ☐ No								
Basic immobilization for fracture	☐ Yes ☐ No								
Reduction of fracture	☐ Yes ☐ No								
Cervical spine immobilization	☐ Yes ☐ No								
Tetanus vaccine & IVIG as indicated	☐ Yes ☐ No								
Antibiotics for open fracture (PO/IM vs IV)	☐ Yes *- If yes, circle:* *PO IM IV* ☐ No								
Fasciotomy for compartment syndrome	☐ Yes ☐ No								

[56] irrigate with potable water or sterile solution, surgically close clean acute wounds, dress, infection control as needed

Signal Function	Perform at all times?	**IF NOT, WHY?**	Policies	Human Resources	HCW training	Supplies equipment medication	Infrastructure	No indication	Other/Comments
Rabies IVIG/ vaccination as appropriate	☐ Yes ☐ No								
Access to general definitive surgical services	☐ Yes ☐ No								
Access to orthopaedic surgical services	☐ Yes ☐ No								
Access to neurosurgical services	☐ Yes ☐ No								
Chest tube insertion	☐ Yes ☐ No								
Thoracotomy	☐ Yes ☐ No								
Autotransfusion from chest tubes	☐ Yes ☐ No								
II. Burns	.								
Cooling care	☐ Yes ☐ No								
Escharatomy	☐ Yes ☐ No								
Maternal Health									
I. Obstructive Labour	.								

Signal Function	Perform at all times?	**IF NOT, WHY?**	Policies	Human Resources	HCW training	Supplies equipment medication	Infrastructure	No indication	Other/Comments
Administer uterotonic drugs (i.e. parenteral oxytocin)	☐ Yes ☐ No								
Perform assisted vaginal delivery	☐ Yes *- If yes, circle: Routine; Vacuum extraction; Forceps* ☐ No								
Perform newborn resuscitation (e.g. with bag and mask)	☐ Yes ☐ No								
Access to surgical services (e.g. caesarean section)	☐ Yes ☐ No								

Appendix 12 Signal functions for sentinel conditions

Table 2 Signal functions for sentinel conditions

Sentinel condition	Signal function	Basic facility	Intermediate facility	Advanced facility
Respiratory failure	Manual manoeuvres	E	E	E
	Relief of obstruction	E	E	E
	Rescue breathing	E	E	E
	Three-way dressing	E	E	E
	Insertion of oral airway	D	E	E
	Bag valve mask ventilation	D	E	E
	Needle decompression		E	E
	Non-definitive advanced airway with supraglottic device		E	E
	Administration of critical therapeutics		E	E
	Oxygen administration		E	E
	Use of suction		E	E
	Definitive advanced airway		E	E
	X-ray interpretation		E	E
	Mechanical ventilation: invasive and non-invasive ventilation		D	E
	Chest tube insertion			E
	Surgical airway			E
Shock	Physical manoeuvres for control of haemorrhage	E	E	E
	Arterial tourniquet	E	E	E
	Pelvic wrapping	E	E	E
	Administration of oral rehydration	E	E	E
	Fracture splinting	E	E	E
	Treat with antimicrobial agents	E (oral/intramuscular)	E (intravenous)	E (intravenous)
	Traction splinting		E	E
	Peripheral percutaneous intravenous access		E	E
	Intraosseous access		E	E
	Venous cutdown		E	E
	Intravenous fluid administration		E	E
	Administration of critical therapeutics		E	E
	Packing and suturing for haemorrhage control		E	E
	External defibrillation/cardioversion		E	E
	ECG interpretation		E	E
	Needle decompression		E	E
	Administration of intramuscular adrenaline		E	E
	X-ray interpretation		*E*	*E*
	Ultrasound interpretation		D	E
	Pathogen-screened blood transfusion		D	E
	Administration of parenteral medication that requires advanced monitoring (eg, vasopressor agents, thrombolytics)			E
	Central venous access			E
	Chest tube placement			*E*
	Pericardiocentesis			E
Altered mental status	Protect from secondary injury	E	E	E
	Check glucose and/or administration of glucose	E	E	E
	Administration of benzodiazepines for seizure or sedation	E (oral/intramuscular)	E (intravenous)	E (intravenous)
	Rule out organic causes of altered mental status	E	E	E
	Administration of appropriate therapeutics for acute psychiatric illness	E	E	E
	Administration of empiric antimicrobial agents if febrile	E (oral/intramuscular)	E (intravenous)	E (intravenous)
	Magnesium sulfate for pregnant patients with seizure		E	E
	Perform laboratory investigations		E	E
	Administration of insulin for hyperglycaemia		E	E
	Administration of locally appropriate antidote/antivenom as clinically appropriate for toxic causes		E	E
	Lumbar puncture		D	E
	Administration of therapeutics for appropriate BP management		D (intravenous)	E (intravenous)
	ECG interpretation for metabolic abnormalities		*E*	*E*
	CT interpretation			E
Severe pain	Administration of an analgesic agent	E (oral/intramuscular)	E (intravenous)	E (intravenous)
	Administration of aspirin for chest pain	E	E	E
	Urine dipstick	E	E	E
	Administration of oral rehydration	*E*	*E*	*E*
	Paracentesis	D	E	E
	Placement of Foley catheter for urinary outlet obstruction	D	E	E
	Intravenous fluid administration		*E*	*E*
	ECG interpretation		*E*	*E*
	X-ray interpretation		*E*	*E*
	Ultrasound interpretation		*D*	*E*
	Definitive surgical services		D	E
	CT interpretation			*E*
Trauma	Trauma protocol implementation (adult and paediatric)	E	E	E
	Physical manoeuvres for control of haemorrhage	*E*	*E*	*E*

Continued

Table 2 Continued

Sentinel condition	Signal function	Basic facility	Intermediate facility	Advanced facility
	Arterial tourniquet	*E*	*E*	*E*
	Pelvic wrapping	*E*	*E*	*E*
	Appropriate wound care	E	E	E
	Protect from secondary injury	*E*	*E*	*E*
	Cervical spine immobilisation	E	E	E
	Basic fracture immobilisation (sling, splint, inline immobilisation for other spinal fracture)	E	E	E
	Immediate cooling care for burns	E	E	E
	Fracture reduction	*E*	*E*	*E*
	Antibiotic administration for open fracture	E (oral/intramuscular)	E (intravenous)	E (intravenous)
	Tetanus vaccination	E	E	E
	Traction splinting		*E*	*E*
	X-ray interpretation		*E*	*E*
	Fasciotomy for compartment syndrome		E	E
	Packing and suturing for haemorrhage control		*E*	*E*
	Peripheral percutaneous intravenous access		*E*	*E*
	Intraosseous access		*E*	*E*
	Venous cutdown		*E*	*E*
	Intravenous fluid administration		*E*	*E*
	Escharotomy		E	E
	Needle decompression		*E*	*E*
	Definitive surgical services		*D*	*E*
	Rabies IVIG/vaccination			E
	Chest tube placement			*E*
	Autotransfusion from chest tubes			E
	Thoracotomy			E
	CT interpretation			*E*
Dangerous fever	Management of extremes of temperature	E	E	E
	Treat with antimicrobial agent	*E (oral/intramuscular)*	*E (intravenous)*	*E (intravenous)*
	Sepsis protocol implementation (paediatric and adult)	D	E	E
	Therapeutics for sympathomimetic toxidromes or ethanol withdrawal	D (oral/by rectum)	E (intravenous)	E (intravenous)
	Intravenous fluid administration		*E*	*E*
	Source control with bedside techniques (eg, abscess, empyema)		E	E
	Source control requiring operating theatre (deep abscess)		*D*	*E*
	Administration of parenteral medication that requires advanced monitoring (eg, vasopressor agents)			*E*
	Lumbar puncture			*E*

All repeated signal functions are in italics.
Essential (E): the designated function should be assured at the stated level of the health facility in all cases.
Desirable (D): the designated function represents an increased capability that augments the probability of a successful outcome of appropriate emergency care.

Appendix 13 Preliminary scoring sheet

Emergency Care Assessment Tool- Foundation Signal Functions

Designation	Signal Function	Perform at all times?	Scoring
Respiratory Failure			
I. Obstructed airway			
Basic	Manual manoeuvres[57]	☐ Yes ☐ No	_____/2 Basic signal functions
Basic	Relief of obstruction[58]	☐ Yes ☐ No	
Intermediate	Use of suction	☐ Yes ☐ No	_____/1 Intermediate signal functions
Advanced	Surgical airway	☐ Yes ☐ No	_____/1 Advanced signal functions
II. Respiratory Distress			
Basic	Rescue breathing	☐ Yes ☐ No	_____/2 Basic signal functions
Basic	Three-way dressing	☐ Yes ☐ No	
Intermediate	Insertion of oral airway	☐ Yes ☐ No	_____/6 Intermediate signal functions
Intermediate	Bag valve mask ventilation	☐ Yes ☐ No	
Intermediate	Supraglottic device	☐ Yes ☐ No	
Intermediate	Administer critical therapeutics for reactive airway disease[59]	☐ Yes ☐ No	
Intermediate	Oxygen administration	☐ Yes ☐ No	
Intermediate	Endotracheal intubation	☐ Yes ☐ No	
Advanced	Cricothyrotomy	☐ Yes ☐ No	_____/3 Advanced signal function
Advanced	Non-invasive mechanical ventilation	☐ Yes ☐ No	
Advanced	Invasive mechanical ventilation	☐ Yes ☐ No	

[57] Includes head tilt, chin lift, jaw thrust

[58] Includes abdominal thrusts if conscious, CPR if unconscious, chest thrusts and back blows for infant

[59] E.g. any bronchodilators, adrenaline, steroids

Designation	Signal Function	Perform at all times?	Scoring
Shock			
I. Haemorrhagic Shock			
Basic	Physical manoeuvers for control of haemorrhage[60]	☐ Yes ☐ No	_____/3 Basic signal functions
Basic	Arterial tourniquet	☐ Yes ☐ No	
Basic	Pelvic wrapping	☐ Yes ☐ No	
Intermediate	Packing and suturing for control of haemorrhage	☐ Yes ☐ No	_____/4 Intermediate signal functions
Intermediate	Peripheral percutaneous intravenous access	☐ Yes ☐ No	
Intermediate	Intraosseous access	☐ Yes ☐ No	
Intermediate	Venous cutdown	☐ Yes ☐ No	
Advanced	Pathogen screened blood transfusion	☐ Yes ☐ No	_____/2 Advanced signal functions
Advanced	Central venous access	☐ Yes ☐ No	
II. Other Shock			
Intermediate	ECG interpretation	☐ Yes ☐ No	_____/4 Intermediate signal functions
Intermediate	External defibrillation	☐ Yes ☐ No	
Intermediate	Needle decompression of tension pneumothorax	☐ Yes ☐ No	
Intermediate	Administration of adrenaline (for anaphylactic shock)	☐ Yes ☐ ☐ No	
Advanced	Administration of IV medications that require advance monitoring[61]	☐ Yes ☐ No	_____/3 Advanced signal functions
Advanced	Cardioversion	☐ Yes ☐ No	
Advanced	Pericardiocentesis	☐ Yes ☐ No	
III. Severe Sepsis/Septic Shock			
Intermediate	Administration of isotonic IV fluids	☐ Yes ☐ No	_____/2 Intermediate signal functions
Intermediate	Administration of IV antibiotics and/or antimalarials	☐ Yes ☐ No	

[60] Direct pressure, pressure bandage, pressure points
[61] E.g. vasopressors, thrombolytics

Designation	Signal Function	Perform at all times?	Scoring
Altered Mental Status			
I. Unconscious Patient			
Basic	Protect from secondary injury[62]	☐ Yes ☐ No	_____/2 Basic signal functions
Basic	Check and/or administer glucose	☐ Yes ☐ No	
Intermediate	Administer insulin for hyperglycaemia	☐ Yes ☐ No	_____/1 Intermediate signal functions
Advanced	Perform head CT	☐ Yes ☐ No	_____/2 Advanced signal functions
Advanced	Perform lumbar puncture	☐ Yes ☐ No	
II. Seizure			
Basic	Administer non-parenteral benzodiazepine	☐ Yes ☐ No	_____/1 Basic signal functions
Intermediate	Administer parenteral benzodiazepines	☐ Yes ☐ No	_____/3 Intermediate signal functions
Intermediate	Administration magnesium sulphate for pregnant patient	☐ Yes ☐ No	
Intermediate	Administer locally appropriate antidote for toxic cause[63]	☐ Yes ☐ No	
III. Other			
Basic	Administer mental status examination	☐ Yes ☐ No	_____/2 Basic signal functions
Basic	Management of extremes of temperature	☐ Yes ☐ No	

[62] Specifically, is there adequate personnel/infrastructure to monitor blood pressure and avoid hypotension, avoid hyperthermia and cooling if necessary, avoidance of hypoxia, NGT to reduce aspiration risk)

[63] E.g. antivenom

Designation	Signal Function	Perform at all times?	Scoring
Severe Pain			
I. Analgesia Administration			
Basic	Administer opiate based analgesia	☐ Yes ☐ No	_____/1 Basic signal functions
II. Abdominal Pain			
Basic	Urine dipstick	☐ Yes ☐ No	_____/2 Basic signal functions
Basic	Oral hydration	☐ Yes ☐ No	
Intermediate	Placement of Foley catheter for urinary outlet obstruction	☐ Yes ☐ No	_____/2 Intermediate signal functions
Intermediate	Therapeutic paracentesis	☐ Yes ☐ No	
Advanced	Ultrasound	☐ Yes ☐ No	_____/1 Advanced signal functions
III. Chest Pain			
Basic	Administration of aspirin if ACS likely	☐ Yes ☐ No	_____/1 Basic signal functions
Advanced	Chest x-ray	☐ Yes ☐ No	_____/1 Advanced signal functions

Designation	Signal Function	Perform at all times?	Scoring
Trauma			
I. General Trauma			
Basic	Trauma protocol implementation	☐ Yes ☐ No	_____/6 Basic signal functions
Basic	Initial appropriate wound care[64]	☐ Yes ☐ No	
Basic	Basic immobilization for fracture	☐ Yes ☐ No	
Basic	Reduction of fracture	☐ Yes ☐ No	
Basic	Cervical spine immobilization	☐ Yes ☐ No	
Basic	Tetanus vaccine & IVIG as indicated	☐ Yes ☐ No	
Intermediate	Antibiotics for open fracture (PO/IM vs IV)	☐ Yes ☐ No	_____/2 Intermediate signal functions
Intermediate	Fasciotomy for compartment syndrome	☐ Yes ☐ No	
Advanced	Rabies IVIG/ vaccination as appropriate	☐ Yes ☐ No	_____/ 7 Advanced signal functions
Advanced	Access to general definitive surgical services	☐ Yes ☐ No	
Advanced	Access to orthopaedic surgical services	☐ Yes ☐ No	
Advanced	Access to neurosurgical services	☐ Yes ☐ No	
Advanced	Chest tube insertion	☐ Yes ☐ No	
Advanced	Thoracotomy	☐ Yes ☐ No	
Advanced	Autotransfusion from chest tubes	☐ Yes ☐ No	
IV. Burns			
Basic	Cooling care	☐ Yes ☐ No	_____/1 Basic signal functions
Intermediate	Escharatomy	☐ Yes ☐ No	_____/1 Intermediate signal functions

[64] irrigate with potable water or sterile solution, surgically close clean acute wounds, dress, infection control as needed

Designation	Signal Function	Perform at all times?	Scoring
Maternal Health			
I. Obstructive Labour			
Basic	Administer uterotonic drugs (i.e. parenteral oxytocin)	☐ Yes ☐ No	_____/3 Basic signal functions
Basic	Perform assisted vaginal delivery	☐ Yes ☐ No	
Basic	Perform newborn resuscitation (e.g. with bag and mask)	☐ Yes ☐ No	
Advanced	Perform surgery (e.g. caesarean section)	☐ Yes ☐ No	_____/ 1 Advanced signal functions