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**USING COMMUNITY MEMBERS TO ASSIST LIFE-THREATENING EMERGENCIES IN VIOLENT,
DEVELOPING AREAS.**

By Jared Sun

Thesis presented for the degree of
Doctor of Philosophy
in the Division of Emergency Medicine
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August 2012

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Supervisor: Professor Lee Wallis

This thesis is presented to fulfill the requirements of the Doctor of Philosophy (PhD) degree in the Division of Emergency Medicine, Faculty of Health Sciences, University of Cape Town. This thesis consists of original research and has not been submitted for another degree at this or any other university, in whole or in part. All work in this thesis has been produced solely by the candidate, or with the candidate as the first author in cases where there was collaboration. The details of the candidate's contributions to multi-authored papers are further explained in the thesis introduction and at the beginning of each relevant paper.

Jared Sun

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ABSTRACT

Over the next few decades, many countries will see a dramatic increase in death and permanent injury due to increasing emergencies caused by the inevitable development of under-resourced countries. As these countries develop, industrialization and urbanization will lead to increased crime, poor sanitation, violence and accidents, and adoption of Western lifestyles that lead to obesity and chronic conditions. This trend has already been documented, and as many as 90% of all trauma-related deaths already occur in under-resourced countries, with an overwhelming proportion occurring in the pre-hospital setting and with the rates increasing as these nations develop. Already, trauma is the second leading cause of death among fifteen to forty-four year olds and third for five to fifteen year olds in under-resourced countries. The most widely used general solution for mass emergencies in a population is the government's implementation of a fully functional emergency care system. A popular method to establish emergency care systems in developing countries is to model its system after a Western country's. However, until now Western models have been too expensive for under-resourced nations to fully implement, and often push the under-resourced nations to distract too many resources towards a system model it cannot afford to sustain and can actually be ineffective for the country anyway. A new model is needed for under-resourced countries to implement and sustain emergency care systems, one that can be done within an under-resourced country's limited means.

One promising solution is the use of community members to participate in and support a new emergency care system until it is fully matured. However, very little is known about the efficacy of using community members of an under-resourced country in its emergency care system, including their ability to provide care, their impact on local morbidity and mortality, and how they are to be integrated into a greater emergency care system. The aims of this thesis were to 1) further understand the context of emergencies in a developing area, 2) develop a model of pre-hospital emergency care that uses community members, 3) determine the functionality of such a system, and 4) measure the effects of the system. To perform our study, we first designed and implemented a community-based first-responder system in a violent, developing township just outside of Cape Town, South Africa, while tracking markers of functionality, measuring the

effects of the system, and surveying community members to understand the context of emergencies in the area. We then expanded the system to multiple locations to refine the model and implementation strategy for more general use in theoretically any under-resourced location.

The results chapter of the thesis is presented in the form of published or submitted papers. The first paper describes the emergency first aid responder (EFAR) system model, our developed community-based first responder system, which we first designed and implemented in the township of Manenberg just outside of Cape Town, South Africa. The first paper also shows evidence of the EFAR personnel rendering proper care to the rest of their community, a marker for system functionality. The second paper shows that community members in a violent, developing area can have a distressed view of emergencies in their area and of the emergency response and personnel. The second paper also shows that the community members desire to help during emergencies, but are primarily discouraged due to lack of ability, and that emergency care training in the community can lead to improved confidence and a desire to help during emergencies. The third paper shows that community members in a developing area are able to learn and retain emergency response training, another mark of system functionality. The fourth paper recognizes the lack of a usable measurement to directly and quantifiably measure the impact of an emergency care intervention in a developing area, and presents a new methodology that could potentially do this. Finally, the fifth paper presents a more generalized EFAR system model and implementation strategy, one that can be adapted and used in various developing areas to provide pre-hospital emergency care in an under-resourced area.

The thesis concludes that the emergency first aid responder (EFAR) system is a promising model to bring more effective pre-hospital emergency care in developing areas, and that in South African conditions and possibly beyond, the system can function with EFARs coordinating with the greater emergency care system to provide emergency care to patients in an organized way. It capitalizes on local community members' drive to help during emergencies, for which they typically feel helpless during due to a lack of ability to help. The EFAR system is also scalable and can be implemented in a stepwise manner within an under-resourced area's means. Additionally, a quantifiable measurement is needed to directly measure the efficacy of pre-hospital emergency care in a developing area, which can be used to measure the EFAR system's

effects on an area's morbidity and mortality. We present the TEWS methodology as a potential way to do this, though it has yet to be validated.

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PREFACE

This thesis consists of publications, as indicated in provision 6.7 of the General Rules for the Degree of Doctor of Philosophy (PhD) at the University of Cape Town, and with the approval of the University Doctoral Degrees Board in 2011. The following five papers are included in the thesis:

1. Sun JH, Wallis LA. The emergency first aid responder system model: using community members to assist life-threatening emergencies in violent, developing areas of need. *Emergency Medicine Journal*, 2012;29:673-678 doi:10.1136/emered-2011-200271.
2. Sun JH, Wallis LA. Learning and retention of emergency first aid skills in a violent, developing South African township. *Emergency Medicine Journal*, 2012; doi:10.1136/emered-2011-200619.
3. Sun JH, Wallis LA. The psychological effects of widespread emergencies and a first responder training course on a violent, developing community. *African Journal of Emergency Medicine*, 2011;1(4):166-173.
4. Sun JH, Twomey M, Tran J, Wallis LA. The need for a usable assessment tool to analyse the efficacy of emergency care systems in developing countries: proposal to use the TEWS methodology. *Emergency Medicine Journal*, 2011; doi:10.1136/emered-2011-200429.
5. Sun JH, Shing R, Twomey M, Wallis LA. A strategy to implement and support pre-hospital emergency medical systems in developing, resource-constrained areas of South Africa. *Injury*, 2012, doi:10.1016/j.injury.2012.08.015.

TABLE OF ABBREVIATIONS

AED – automated external defibrillator

ALS – advanced life support

BLS – basic life support

CPR – cardiopulmonary resuscitation

DALYs – disability adjusted life years

EFAR – emergency first aid responder

EMS – emergency medical services, or emergency medical system

EMT – emergency medical technician

TEWS – Triage Early Warning Score

TRISS – Trauma Injury Severity Score

University of Cape Town

CHAPTER 1: INTRODUCTION

BACKGROUND AND LITERATURE REVIEW

EMERGENCY MEDICINE AS AN INTERNATIONAL NEED

Over the next few decades, many countries will see a dramatic increase in death and permanent injury due to traumatic injuries and other critical emergencies.¹⁻⁹ As a result, emergency care will play an increasingly critical role for global public health in the near future,^{10, 11} and the field of emergency medicine will thus have to either expand to carry this burden, devise more effective ways to meet the new demand, develop preventative policies to make the burden more manageable, or pursue a combination of these.

The impending rise of medical and traumatic emergencies is largely due to the inevitable development of developing countries.^{1-5, 7, 12, 13} It is important to note that development does not necessarily lead to increased violence and illness, and that the causal link can potentially be avoided with proper preparation and management.¹⁴ However, because many developing cities lack resources, the vast majority of them will be unable to adequately prepare and will thus still experience increases in morbidity and mortality.

The typical pathway from development to violence and illness is through urbanization. As emerging economy countries develop, their cities eventually modernize and industrialize—becoming attractive to rural populations seeking employment, means and a more comfortable lifestyle. This will lead to mass migrations towards urban centres, which typically result in massive slums and shantytowns that breed unregulated crime, poor sanitation and violence.⁴ Once these urban centres dramatically increase in size and concentration, individuals become more exposed to gangs, drugs, weapons, machinery and diseases than before.^{3, 4} Additionally, many populations will come into contact with other groups that are different in norms, values and behaviours, and consequently disputes may occur.⁷ These factors, in addition to the income gap inherent between the new migrants and the established wealthy and employed,³ and the

increased mobility and anonymity per each individual,⁷ lead to rampant violence and contagion throughout the different populations and between the rich and poor.

Researchers have already documented the increasing trend between development and emergency incidents, and have noted that traumatic deaths have become an accelerating problem worldwide.^{8,9} Already, the majority of the world's population resides in urban areas, with these numbers increasing the most dramatically in developing regions such as Africa.^{1,12} It is not surprising then, that increases in violent crime, motor vehicle accidents and traumatic injuries significantly increased after developing cities being studied became more densely populated.¹² In fact, at least twenty countries from all major landmasses have already been retrospectively analysed, and researchers found that as they developed economically their rates of trauma-related injury increased proportionately.^{2,5,8} Also, many of these researchers expect the problem to only get worse throughout the next several decades as more cities further industrialize and urbanize.^{5,8,13}

Regardless of the emergency situation of developing nations getting worse, the problem is already fairly bleak. The bulk of the traumatic burden is disproportionately borne by low and middle-income nations. As many as 90% of all trauma-related deaths occur in developing countries, with an overwhelming proportion of these deaths occurring in the pre-hospital setting.¹⁰ Numerous studies have even reported traumatic death rates in poorer nations to be as high as 40-50%,¹⁵⁻¹⁷ which is over double than what is reported in cities of developed nations.¹⁸ With such high medical emergency rates and high chances of mortality per each emergency (in addition to improving infectious-disease mortality rates across the developing world due to sanitation and vaccinations), trauma has become the second leading cause of death among fifteen to forty-four year olds in low to middle-income countries, being only surpassed by HIV/AIDS.¹⁰ For children between the ages of five and fifteen years in these same countries, trauma is the third leading cause of death.¹⁰

Policy makers and academics also point out the far reaching impact of prevalent trauma and the consequent high morbidity and mortality rates. In 2000, Krug warned that in the developing world traumatic injuries frequently affect individuals who would otherwise be able to

work and add to the local economy.^{3,7,10} Therefore, rampant emergencies that lead to morbidity and mortality would especially impede development and income in an already struggling nation.^{3,7,10} In addition, high levels of accidents, disease and violence lead to their acceptance as regional norms either because of desensitized apathy or desperate protection. Of the thirty million small arms and even more numerous non-firearm weapons on the African continent, 80% are owned by civilians, and the percentage is growing.¹⁹ Already in South Africa, where guns are more readily available to the public due to relative wealth and import, firearms are owned and used in crimes more than any other African country in almost every category of crime. In South Africa, 18.3% of households claim to own a firearm, and firearms are used in 48% of homicides, 58.5% of robberies, 28.3% of assaults, and 14% of rapes.¹

Putting all of this together leads to traumatic injuries alone making up 15.2% of disability adjusted life years (DALYs) lost in the entire world, more than almost every other single disease and condition.¹¹ This led Murray to conclude in 1996 that, "compared with the research and policy attention devoted to other top 30 contributors to burden, injuries are remarkably neglected... They are a legitimate foci for research and action."¹¹

For the most part, much of what can be done to address the problem of increasing emergency needs in developing countries has yet to be researched and implemented, in part because of the developing world's other development needs and the acceptance of trauma as normal. After Murray in 1996, Nantulya went on to observe in 2002 that many populations of developing regions perceive increased morbidity and mortality due to trauma as inevitable and natural to city life. As a result, "public policy responses to this epidemic have been muted at national and international levels."⁵ The pervasive indifference and inaction contribute to a poor public health infrastructure, and so emergency patients do not receive prompt or appropriate care. Nantulya dutifully noted that, "This delay can compromise the patient's recovery, as there is a strong correlation between the time taken to receive appropriate treatment and the likelihood of adverse health outcomes and long-term disability occurring."⁵ However, the path from urbanization to increased morbidity and mortality is not absolute, and possible interventions can occur at the preventative or primary care level.

THE POTENTIAL OF BASIC LIFE SUPPORT AND FIRST RESPONDERS

The most widely used general solution to deal with widespread emergencies occurring throughout a population is the government's implementation of a fully functional emergency medical system (EMS). In high-income western countries, the implementation of a trauma system led to a consequential 15-20% reduction in their national morbidity and mortality rates.²⁰⁻²²

The prototypical model for an emergency medical system consists of two parts, which are traditionally referred to in EMS nomenclature as the "basic life support" (BLS) and "advanced life support" (ALS) components. The basic life support component generally consists of the ambulances, their dispatch, and any other pre-hospital emergency personnel, while the advanced life support component generally consists of hospitals, trauma centres, triage nurses, specialized emergency doctors, and other high level emergency room personnel. The BLS's primary mission is to rescue emergency patients and expedite them alive to the ALS. Once the patients are handed over to the ALS, the ALS's chief role is to permanently stabilize the patients so that they can be either discharged or transferred to other medical departments for further recovery.²³

However, at the moment, fully complete emergency medical systems only exist in wealthy countries, with few exceptions. Many low-income countries do have a network of hospitals and clinics, but many of them are not specialized for advanced life support, and a pre-hospital basic life support EMS are still non-existent in those countries.²⁴ This creates a bottleneck of death and permanent injury in developing nations, as pre-hospital emergency medical systems have been found to be essential in preventing emergency deaths.¹⁸

Given that emergency medical systems are widely successful in addressing critical patients, many developing nations are moving towards the development of their own. However, many governments are facing obstacles with deciding the details of how to structure their country's personalized EMS. A current popular strategy is to model the emergency medical system after a Western country's, particularly that of the United States.²⁵ However, Western models are often very expensive and therefore too taxing on a low-income country's scarce resources, and they often push the developing nation to distract too much of its crucial resources

towards an advanced life support component that it cannot yet sustain and can actually be ineffective for the country.²⁵ Under-resourced countries are already struggling to meet their higher emergency demands, and have to do so with less infrastructural and financial resources. Therefore, under-resourced countries must use the limited resources they have wisely, and they cannot afford spending resources on EMS models or components that are too expensive or will not be cost-effective.

The reason why focusing too many resources on advanced life support too early can be ineffective is because it is often not the limiting factor for public emergency health problems. Often, developing countries already have a network of hospitals that can adequately treat most emergencies despite being less advanced than hospitals in developed nations.²⁴⁻²⁷ The life-or-death paradigm isn't the existence or not of sufficient care, but the access to it. This is often why the expansion of advanced life support, without the improvement of pre-hospital basic life support, has diminishing returns. For example, in 1995 and 1997 Nicholl et al and Coucanour et al found that using helicopters in American EMS did not typically lead to widespread reductions in transport times or mortality.^{28, 29}

In addition, in 2008 Steill et al analyzed Canada's movement to provide pre-hospital advanced life support through the use of very highly trained paramedics. Steill et al found that since the implementation of paramedics there was no improvement to patient survival or morbidity, and sometimes the patient populations even fared worse. They concluded that the availability of mobile ALS units had no advantage, and though it was likely that individual patients treated by paramedics received better care, the paramedics were not cheap enough to be dispatched en masse, treat enough patients, and show a widespread effect. In fact, they believed that because the ALS units were so expensive, having too many of them actually detracted from the potential benefit of having many more BLS units instead.³⁰ This is consistent with a study in Malaysia, which reported that implementing a full EMS with a complete ALS component would only save seven cardiac patients per year at the cost of two and a half million US dollars, and was therefore too costly.³¹ Summing this all together, a review in 2007 found that after a threshold of decent care, more advanced life support has decreasing beneficial returns,

and after a point the addition of more advanced life support units can be ineffective if not detrimental.³²

That being said, in general the addition of more advanced care can be beneficial and should always be considered. However, given that expanding advanced life support components can be very expensive for developing countries, and their benefits are limited by the proficiency of the BLS, it is often much more cost-effective in saving lives to invest small amounts in establishing cheaper pre-hospital BLS emergency medical systems than investing a tremendous amount in improving an in-hospital ALS or its extensions.^{26, 27} Simply using fancier ambulances or more modern facilities may not be effective enough to deal with the emergency needs of developing nations; no matter how advanced an advanced life support unit is, it will make little difference if a pre-hospital basic life support network cannot bring patients to it alive. In general, for developing nations a viable solution for prevalent emergency incidents may be to increase emergency patients' access to a basic level of care instead of making the available care more complex.

The current popular method of developing emergency medical systems in the developing world is to model them after those of Western nations, which require more resources than developing countries can handle and were designed to address a different country's specific needs anyway.²⁵ Instead, it is much more cost-effective in low-income countries to take a community based approach and work within the already existing medical personnel and resources of the country, instead of imposing a Western model that will wastefully distract resources.²⁵

One such community-based method that works within a developing nation's means is a first responder system. First responders are community members trained in the most basic pre-hospital emergency procedures. Because they are already dispersed throughout a community, they are usually the first medically trained persons on an emergency scene. Ideally, they are able to keep a patient alive until further help is available, using no specialized medical equipment and being able to work at an instant's notice.

With this idea, in addition to the overwhelmed emergency medical personnel, it may be possible to teach other members of the community, such as police officers, teachers and bystanders, to provide some care themselves, thereby lightening the burden on the EMS until it establishes or expands. Given that bystanders are often present at emergency incidents before medical officers, teaching them to be care providers is promising—especially with the plethora of research showing that bystander care and quicker bystander initiation of higher care can improve pre-hospital mortality.³³⁻³⁷ This type of intervention can be used to both support an existing EMS or to lay the groundwork for the creation of one as suggested by the World Health Organization.³⁸ The establishment of a first responder system is also relatively easy for governments since the first responders are primarily volunteers without political red-tape, and governments can avoid violating strong political obligations to businesses that work within the country's primary healthcare.³⁹

However, very little is known about the efficacy of community first responder systems in general;³⁹⁻⁴⁴ hence this is the focus of the rest of this thesis. Some studies have already noted that there is great potential in using regular community members in emergency incidents. One early study done in Philadelphia found that police officers may have a contributory, impactful role in an area's emergency medical system, and that patients transported by police officers already had comparable survival rates to those transported by ambulances.⁴⁵ Other researchers noted that police officers are a potential resource for care because they frequently arrive on scene before any medical personnel.⁴⁶ As for bystanders, one study in Ghana found that bus and taxi drivers commonly stop to care for and transport victims of roadway accidents anyway.⁴⁷ Additionally, in one case, American laypersons trained in cardiopulmonary resuscitation (CPR) saved 36% of their patients, whereas ambulances only saved 8% of their patients.⁴⁸ It is doubtful that in that study the laypersons performed CPR more adequately than the ambulance workers, and it is much more likely that the shocking difference was due to factors such as the time between unresponsiveness and the care provider's CPR. Though, regardless of what the cause was, first responders can make a difference, and given that low-income communities are in desperate emergency need the establishment of first responder systems in developing regions is worth investigating.

LESSONS FROM PREVIOUS FIRST RESPONDER SYSTEMS

The establishment of first responder systems involves training non-medical personnel in emergency procedures. Previous projects that attempted to teach police officers, bystanders and others have shown great retention and results. In one study, 170 police officers were taught how to use AEDs. Six months after the course, almost all of the officers could still use and AED effectively when tested. There were also 128 instances during those six months that officers used AEDs, and their performance was comparable to and sometimes exceeded the performance of emergency medical technicians (EMTs) and paramedics.⁴⁹ These results were comparable to another study where 140 nurses not specialized in emergency medicine were given a two hour course on how to operate an automated external defibrillator (AED), and 95% of them could still effectively operate an AED nine months after the course.⁵⁰ These nurses were qualified healthcare personnel, and the police officers were able to acquire the basic life support skills just as the nurses did.

The impact of teaching police officers can also be seen on an emergency medical system's survival statistics. When examining the outcome of the patients treated by police officers specifically, Mosesso et al found that the police use of AEDs definitely saved patients who would have died otherwise.⁵¹ In another study in 1997, Florida's Miami-Dade county gave all of their police officers AEDs and training, and survival rates for cardiac arrest increased from 9% to 17.2% in five years.⁴⁶ However, the education is not just restricted to AEDs and cardiac arrest. Even lessons in triage, so that officers know the correct trauma centres to transport patients to, can lead to increases in survival.⁵² Though these studies were all focused on employed officers, the consequent increases in survival rates do show that individuals with no prior medical training or experience can be trained to save the lives of patients before transferring the victims to higher medical care.

Another population that researchers targeted for first responder training involved normal community bystanders. Starting in 1997, Husum et al went to villages in Cambodia and Iraq and trained a total of 44 health workers to be "paramedics". These health workers in turn

trained a total of 2,800 laymen responders. Over the next two years, 813 trauma patients were treated by the laymen, average pre-hospital time was reduced from 3.1 hours to two hours, and the system became sustainable by the community.^{16,53} When Husum et al returned to Iraq eight years after the start of the project, they found that 94.5% of patients showed improved morbidity and that trauma mortality rates had dropped from 28.7% to 9.4% over the eight years, with increasing improvements in subsequent years. Additionally, pre-hospital time was reduced from two hours in 1999 to 0.6 hours in 2004, there were now 88 “paramedics” and 6,000 laymen first responders in their Iraq population, and the retention rate from the original set of “paramedics” over the eight year period was 72%.⁵⁴ These statistics are also expected to get better over time, as other researchers affirm that increasing returns is typical of new emergency medical systems as the personnel gain more confidence and experience and the overall system matures.⁵⁴⁻⁵⁶

In addition to Iraq and Cambodia, Tiska et al trained 300 commercial drivers in Ghana to treat victims of roadway accidents. Tiska et al found that the Ghanaian drivers learned the emergency procedures effectively, and that the drivers reported frequent use of their skills, such as airway or haemorrhaging management, which they never considered before.⁵⁷ Further research on the trained Ghanaian drivers showed that after 10 months 61% of them had used their training.^{57, 58}

The skills learned can even be more complex than first response. Recently in Cambodia, Van Heng, Davoung and Husum trained 21 hospital assistants to be “non-doctor trauma surgeons” in five courses of 150 minutes each. The rate of post-operative infections in the community’s hospitals dropped from 22.0% to 10.3% and the trainees reported better confidence and coping skills when dealing with traumatic emergencies. The in-hospital mortality rates remained the same over the study period but they were already very low.⁵⁹ Additionally, in certain areas of Iran entire regions are highly exposed to mine fields.¹⁷ One study found that communities with additional trained personnel in pre-hospital BLS and in-hospital ALS led to significant improvements in patient mortality compared to other communities that didn't have the extra training.⁶⁰

The benefits of having a first responder system in developing areas of emergency need are not just restricted to patient morbidity and mortality. Aside from high skill retention among the trained, researchers also found a reported increase in the first responders' likeliness to get involved with an injured patient and in their confidence once involved with the emergency.^{16, 53, 54, 57, 59} Tiska et al were able to identify at least one reason why. The Ghanaian commercial drivers they trained reported to them that they felt more confident and willing to intervene in emergency situations because they now had a defined role and knew the important procedures.⁵⁷

Additionally, when Husum et al trained community members in Iraq and Cambodia, they found that 25% of trauma patients in the areas were treated by laymen first responders, and that 65% of the patients surveyed indicated that they knew they were being cared for by a first responder and that being treated by a familiar face gave them hope and confidence.⁵⁴ Husum et al's communities definitely recognized the benefit early on, and when Husum et al asked the local community members how they could improve the project the most predominate answer was to train more responders.^{16, 53}

Overall, the previous studies on training non-medical personnel and first responder systems show that there is a huge potential benefit to having local community members trained in emergency procedures. Additionally, though first responder systems are poorly understood, previous studies have begun the task of learning the details of new, developing emergency medical systems so that future first responder systems can be more impactful. For one, researchers recognize that because the first responder systems are mostly community and voluntary based, there may be a problem with a lack of incentive for responders to stop and help victims.⁵⁸ For others, they may be willing to help but are unable to due to occupational or financial obligations precluding them from doing the training.⁶¹ However, because training first responders is quite cheap, both of these problems can be overcome just by sheer numbers of trained first responders. Other lessons include the needed emphasis on stabilization and the BLS role. Husum et al found that the BLS first responder part of their system was much more effective solely because of their accessibility, and the pre-hospital ALS components were only able to treat 3% of the patients. They also found that stabilizing patients on scene before transport was more effective than simple "scoop and run" techniques that rushed patients without adequate

stabilization, and that longer evacuation times did not impact the survival rates of patients.¹⁶ This was confirmed by Nafissi et al in 2008. They found that patients arriving even three hours earlier without stabilization fared worse than patients who were stabilized first.⁶⁰

Though first responder systems are shown to have a potential benefit, and though some lessons have already been learned, further research is needed to fully understand how to most capitalize on this intervention. With more comprehension, policy makers, healthcare officials and academics can harness this promising solution--but there is still a lot more that needs to be known.

THE FUTURE NEED

Several topics that need to be researched about first responder systems include who exactly are the best targets for first responder training in a community, a quantifiable way to assess the impact of a specific first responder system for the long term, and whether that impact is specifically attributable to the first responder system or to general health improvements of the area.

As of now, researchers have mostly studied the effects of re-training professionals, such as police officers and nurses, for medical emergencies and not traumatic injuries. Additionally, the projects that have focused on training bystanders were typically done in rural areas with little to no pre-hospital care already present. In the near future as countries develop, the largest increases in emergency need will be in the cities where urbanization will ride on mass migrations towards cities. Because of the relative wealth of cities and the incoming commerce as the country develops, many of these cities may already have some semblance of a pre-hospital emergency medical system or even a newly established one. In spite of all this, there is virtually no research done on first responder systems in crowded, urban regions of developing areas, or what the relationship between the first responder system and the rest of the emergency medical system would look like.

Without suggested relationships between first responder systems and the rest of the emergency medical system, the progress of a city's emergency field could be stalled. Reports have stated that first responder systems are the most promising foundation upon which to build a full EMS in the future,³⁸ but how a full first responder system is to continue on to be a full pre-hospital EMS is still up for question. In another situation, if a pre-hospital emergency medical system is already present then the imposition of a first responder system could cause territorial disputes and unwanted political conflict between well-meaning first responders and already established pre-hospital systems. Instead, research should be done to determine how first responder systems can integrate with full emergency medical systems so that they cooperate and maximize each other's effects, and so that the first responder system will actually be capitalized upon and used to support a maturing EMS rather than become a burden.

In addition to the lack of research in urban areas, possibly with an already existing EMS, nobody has yet developed a method of sufficiently tracking the first responder systems' long term impacts. Though the results from Husum et al's study in Iraq and Cambodia and Tiska et al's study in Ghana show promising results of their first responder systems' success, much of their study only provides secondary evidence of their medical personnel providing a benefit. Both studies presented evidence that their first responders retained their training and were using their skills.^{16, 53, 57, 58} Though these results are an excellent way of showing that the system is working and providing a benefit, the results shed little light on the extent of the impact and how long it occurs for.

The fact that there is no quantifiable or long term way to measure a first responder system's impact is not surprising, given the typically poor record keeping infrastructure of developing areas that need this intervention.⁶²⁻⁶⁴ To make things more complicated, even if the data were adequately recorded, their scrutiny would also not necessarily lead to the conclusion that improvements in mortality and morbidity were due to first responders. Husum et al did attempt some quantifiable method at assessing their systems through the use mortality and morbidity statistics, but their study lacked a cohort and so one could argue that the improvements were due to widespread changes throughout the area and not because of the first responder system.^{16, 53, 54}

Long term methods of tracking emergency medical systems have already been developed, such as the widely used Trauma Injury Severity Score (TRISS) measurement.^{65, 66} However, these methods were developed for and by Western countries with more consistent record keeping. TRISS scores heavily rely on variables that are not typically recorded in hospitals in the developing world, such as abbreviated injury scores of body parts. In order for first responder systems in developing countries to be tracked adequately, researchers must use an outcome variable that is much more accessible for developing world hospitals to record and calculate. Finally, once a variable is identified, a methodology must be developed to determine how exactly the variable will measure a first responder system's impact.

AIMS AND OBJECTIVES

In this study, our primary aim was to develop a model of pre-hospital emergency care that uses community members and can be used in an under-resourced area.

In order to achieve this we also had the following objectives:

- 1) Understand the context of where such a care system could exist (such as how the community members perceive emergencies and emergency response in a developing area);
- 2) Determine whether or not the model developed functions (in that community members are delivering the care intended, in an organized way; and,
- 3) Measure the effects of the model on the communities it is implemented in (ideally on morbidity and mortality).

METHODS AND ETHICS OVERVIEW

One low-income developing area in which we could study this was the township of Manenberg, just outside of Cape Town, South Africa. As with other informal settlements, Manenberg has high rates of crime, accidents and violence, and the inhabitants face a heavy cost

from traumatic injury and emergency incidents. As a result, the township's desperate needs overwhelm the Cape Town METRO EMS, the provincial government's ambulance system for the area. According to township members, ambulances often arrive hours after patients die. Other times, language barriers between the caller and the dispatcher delayed life-saving help. Crime, gangs and catastrophes overrun Manenberg, and the victims had inadequate emergency medical care. In effect, Manenberg had conditions similar to those that could be found in many other communities in the Cape Town region, and had an especially high emergency load. Because of this, Manenberg was an ideal place to investigate pre-hospital emergency care solutions in a low-resource area of South Africa. Additionally, Manenberg was infamous throughout the Cape Town region for crime violence that was frequently publicized in the media, and so many people believed that Manenberg could especially benefit from our study.

We first designed and implemented an emergency first aid responder (EFAR) system in Manenberg. We designed the system based off community member input and a community- and hospital/clinic-based needs assessment in the area. As we implemented the system, we used skill assessments and exams to track the responders' learning and retention of their training, and utilized surveys, interviews and focus groups to track usage of their skills and the training's effects on their confidence, likeliness to help during an emergency, and their opinions on emergencies and emergency response in the area.

After implementing the system in Manenberg, we developed a potential methodology to directly and quantifiably measure emergency care efficacy in a developing area, based on resources available to the Cape Town area and theoretically in most developing settings.

At a later point in time, we expanded Manenberg's system to other areas so that we could compare the system in different areas for similarities and difference. From the comparisons, we developed a more generalized model that we then subjected to rounds of critique and modification by local officials, healthcare providers and community members until consensus was achieved on a universal model. We then used a consensus approach to obtain input on how to plausibly establish the model given any area's level of development, which we drafted into an implementation strategy that was also subjected to rounds of critique and

modification by local officials, healthcare providers and community members until consensus was achieved. Through this process, we developed a more generalized model and implementation strategy to expand pre-hospital emergency care to other parts of South Africa and possibly beyond.

ETHICS

Ethical approval for all research was granted by the University of Cape Town (REF: 174/2010). Some of our research was also done in collaboration with either Stanford University or Yale University, in which case ethical approval was also granted by that university.

In addition to institutional approval from the University of Cape Town, Yale University, and Stanford University, the premise of our study was also well received and believed-in by the emergency care providers involved and the locals that knew about the project. At all levels of socioeconomic statuses throughout Cape Town, local South Africans were amazed that such an endeavour had not been done earlier. Cape Town's townships' high rates of emergencies, coupled with limited options for township community members to protect themselves, was viewed by South Africans as a travesty that led to an unacceptable level of suffering and loss of human life. Even if we were to be unable to develop a solution to this problem, at least investigating possible solutions was an ethical obligation and a step in the right direction for the public at large.

CHAPTER 2: THE EMERGENCY FIRST AID RESPONDER SYSTEM

MODEL: USING COMMUNITY MEMBERS TO ASSIST LIFE-

THREATENING EMERGENCIES IN VIOLENT, DEVELOPING AREAS OF

NEED.

Declaration by candidate

In the case of Chapter 2, the nature and extent of my contribution to the work was the following:

Nature of contribution	Extent of contribution (%)
The candidate was the primary author and responsible for the literature review, study and model design, piloting the EFAR system, and collecting data. The candidate also analysed all of the data and wrote all drafts of the manuscript while under the supervision of the co-author. The candidate accepts overall responsibility for the publication.	80%

The following co-authors contributed to the work. Co-authors who are students at the University of Cape Town must also indicate the extent of their contribution in percentage terms:

Name	Nature of contribution	Extent of contribution (%) for student co-authors only
Lee Wallis	Co-developed the study design and helped interpret the data. Contributed to the final article.	

Candidate's Signature

Signed by candidate

Declaration by co-authors

The undersigned hereby certify that:

- (1) the above declaration correctly reflects the nature and extent of the candidate's contribution to this work, and the nature of the contribution of each of the co-authors.
- (2) they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;
- (3) they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
- (4) there are no other author of the publication according these criteria;
- (5) potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and
- (6) the original data are stored at the following location(s) and will be held for at least five years from date indicated below:

Location(s):Date

University of Cape Town Division of Emergency Medicine : August 2012

[Please note that the location(s) must be institutional in nature, and should be indicated here as a department or division.]

Lee Wallis	u
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To begin to tackle the problem of more effectively providing emergency care in low-resource areas, we needed to first develop a pre-hospital emergency care system model. Up until this time, only two prominent models of pre-hospital care existed. Both of these models have their merits, and have been shown to work very well in certain locations, but they also have their limitations that prevent under-resourced areas from establishing a fully functional system.

THE TOP-DOWN APPROACH

The first model is the traditional, centralized emergency medical system, which is the model typically used by highly developed countries. In this centralized model, pre-hospital care is provided through a top-down approach. During an emergency, bystanders contact a hospital, private company, or government supported central dispatch centre. From this point at the top of the pre-hospital emergency care system, the central dispatch centre would send an emergency care unit, which is almost always in the form of an ambulance with highly trained emergency medical technicians and paramedics, or sometimes doctors.

In Western countries such as the United States or United Kingdom, this model works well. Community members of either country are well informed of the emergency phone number to contact the central dispatch centre. Additionally, the hospitals, private companies, or governments are able to support and coordinate a large fleet of ambulances and emergency personnel. As a result, pre-hospital emergency care is effectively delivered and typically within minutes for critical emergencies. Community members, including bystanders and those experiencing the emergency, do not have to take an active role in the emergency response and can fully rely on the centralized emergency care system reaching out to them.

The problem with this model for under-resourced countries is that for a centralized, top-down approach to work there must be a strong, well-endowed centre to support and coordinate the entire pre-hospital system. For developing areas, this can be near impossible. Even if the area can afford a central dispatch centre and emergency communication line, it may be limited in the number of ambulances and personnel it can sustain, and such vehicle units and personnel can be expensive. A major city in a resource-constrained country could have less than a handful of

ambulance units to cover its entire population. Highly developed countries do not have this problem because they have enough resources to support many ambulance units, enough to properly cover entire areas without being overwhelmed. In fact, such countries typically have enough resources to even move in the opposite direction from scaling down, and can purchase advanced life support units or helicopter ambulances and employ ever more highly trained and specialized personnel.

Even if a resource-constrained country finds the means to obtain a large fleet of ambulances that responded under a central control system, the centralized emergency care system faces the obstacles of a developing area's lack of infrastructure. In a low-resource country, a lack of education or coordination means that there are not enough qualified candidates to be personnel, no universal emergency number for community members to call, or, if a number does exist, most community members don't know what that emergency number is. A lack of communication infrastructure can also mean that community members won't be able to call the central dispatch centre even if they knew how to. Additionally, in developing areas the geography can limit the ability of the ambulances to reach emergencies. Such is the case in parts of Cape Town, South Africa, where many of the informal settlements do not have officially marked streets or addresses, making ambulance arrival logistically frustrating. These obstacles do not just arise in isolated cases—because of the violence, illness, and accidents correlated with poverty, many of the emergencies happen in these settlements. In other cases, such as the rural outskirts of Kintampo, Ghana, un-paved roads are not only un-marked but also transient. Rainy seasons can turn pathways into rivers or marshes, making entire communities inaccessible to ambulances for weeks or months at a time.

THE BOTTOM-UP APPROACH

In contrast to the centralized, top-down pre-hospital emergency care model is the second prominent model, the community-based lay-person approach. In this approach, community members are trained to care for themselves and each other during an emergency. That is, whereas in the centralized approach the community members did not have to actively

participate in the emergency response, in this model the community members are the primary response.

The model is typically established through a “shotgun” approach, where a training organization educates as many individuals as possible within a community with the hope of saturating that community with enough trained lay people so that at least one is on-scene during an emergency. This is a typical strategy of lay-person CPR training organizations, such as the Red Cross of South Africa. Community members are trained en-masse so that one could potentially be available when a patient becomes unresponsive in the pre-hospital setting, as opposed to training community members with the intent of including them in a coordinated emergency response.

The community-based lay-person model is being used in both low-resourced and highly developed countries, and has even been promoted by the World Health Organization as a viable model for areas with no formalized ambulance system.³⁸ However, the model has complications and dangers for developing areas. Though the model is very affordable for low-resource areas, it provides for an unorganized emergency response. If a trained community member is present during an emergency, he or she can be of great benefit to the patient. However, that benefit relies on the chance that a trained person is actually on-scene; there is no system in place to direct a trained community member to the patient. Additionally, the shotgun approach of training community members en-masse and then releasing them into the community means that the trained individuals are un-regulated, which could lead to damaging effects on the community due to lack of control or un-rectified mistakes. A system should be in place where at least some of the trained community members can be organized and managed, not only so a coordinated response could be possible but also so that care is not being rendered in a completely anarchic fashion.

Another problem that the community-based lay-person model has for a low-resource area is that the care provided is stunted both for individual emergency responses and in terms of future growth of a pre-hospital emergency care system. For individual emergency cases, community-based lay-person care is not coordinated with higher care. Because of the lack of coordination, if a formalized emergency care system is already in place then the community-

based model typically runs parallel to it. This could lead to mishaps due to misunderstandings, whilst coordination between the two can lead to even greater patient care. For example, vigilante community members could attempt to transport patients on their own, rather than utilize a nearby, available, and officiated ambulance. Lack of coordination could also lead to community members not taking advantage of hospital staff member's guidance, or well-meaning trained community members unnecessarily dumping non-critical patients onto the greater emergency care system or hospital due to a misunderstanding of patient loads or what should reach the hospital. In most cases in the developing world, higher care may not even be available. As a result, patients may only have first responder care, which is better than no care at all, but without an avenue to bring the patient to higher care this may not be enough.

As for stunting the future growth of a low-resource area's pre-hospital emergency care system, the current community-based model as it stands does not provide a way for the community-based lay-person system to upgrade and improve into a more rigorous, comprehensive pre-hospital emergency care system. This is already inherent in the un-regulated nature of such a system, without control of at least some of the trained community members they can neither be prepared for nor guided into a more formal system. In effect, the community-based lay-person system turns into a loose network of uncoordinated first responders that remains that way with no pathway to formalization. Even if more resources become available, a community would not know how to advance their lay-person system, except by training ever more community members.

Both the centralized, top-down and the community-based lay-person approaches are able to provide a level a care for low-resource areas, but the complications they face make them unacceptable as final solutions for establishing pre-hospital emergency care systems in low-resource areas. Developing areas do not have the resources to either establish or sustain the centralized approach, and until a centralized system is fully established it can only provide delayed, spotty, or inaccessible care. On the other end, developing areas can afford the community-based lay-person approach, but this leaves them with an un-organized system that cannot be coordinated or upgraded because of the lack of control.

A NEW WAY FORWARD

For the past couple of decades, the most creative tactic was to run the two approaches in parallel.⁶⁷ However, this typically just leads to the community-based approach becoming an un-integrated temporary fix for a low-resource area to have some level of pre-hospital emergency care while the region waits for a centralized, top-down system to expand (which can be extremely slow or stalemated for the reasons described). The story then becomes the two systems running side by side without being able to move: the centralized system cannot expand quickly enough due to lack of resources, the community-based approach does not have enough control to upgrade itself, and the two are neither coordinated nor able to meet in the middle. This tactic has left a large, perpetual gap in pre-hospital emergency care. Thus, a new model is needed.

Both of the previous models described have great qualities for different reasons, so we wanted to see if we could retain these qualities in our model development. The centralized approach provides well-controlled and professional care, but is too expensive and isn't accessible enough to community members. In any case, our model needed a place for centralized ambulances since many developing areas have already begun to establish them. On the other hand, the community-based model is more affordable and accessible to community members, but isn't controlled or integrated with higher care, and does not have a path to being upgraded. We surmised that a new model should include both community member responders and centralized ambulances, but that the community responders be organized and fully integrated with a greater emergency care system. In addition, the new model had to have the quality of being able to be established within a developing area's means.

With these concepts in mind, we used our primary research site, Manenberg, to determine the details and design of the new model. Instead of designing a universal theoretical model, we believed that it would be more effective to target a specific community at first, and design a model that was specifically for that community and met the community's own needs before adapting it and expanding it out to other areas. The idea was to develop a prototype that we knew worked and then expand from there, instead of honing in from a theoretical model.

The following paper is the result of our initial work in the township of Manenberg. It describes the design and model of the first emergency first aid responder (EFAR) system prototype. The result of the study was the Manenberg EFAR system, which utilized community members to respond to and care for emergency patients in crime-violent areas. It also observed community members' usage of emergency skills, costs of the system, and the appropriateness of using community members as emergency responders.

University of Cape Town

The emergency first aid responder system model: using community members to assist life-threatening emergencies in violent, developing areas of need

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ABSTRACT

Background As many as 90% of all trauma-related deaths occur in developing nations, and this is expected to get worse with modernisation. The current method of creating an emergency care system by modelling after that of a Western nation is too resource-heavy for most developing countries to handle. A cheaper, more community-based model is needed to establish new emergency care systems and to support them to full maturity.

Methods A needs assessment was undertaken in Manenberg, a township in Cape Town with high violence and injury rates. Community leaders and successfully established local services were consulted for the design of a first responder care delivery model. The resultant community-based emergency first aid responder (EFAR) system was implemented, and EFARs were tracked over time to determine skill retention and usage.

Results The EFAR system model and training curriculum. Basic EFARs are spread throughout the community with the option of becoming stationed advanced EFARs. All EFARs are overseen by a local organisation and a professional body, and are integrated with the local ambulance response if one exists. On competency examinations, all EFARs tested averaged 28.2% before training, 77.8% after training, 71.3% 4 months after training and 71.0% 6 months after training. EFARs reported using virtually every skill taught them, and further review showed that they had done so adequately.

Conclusion The EFAR system is a low-cost, versatile model that can be used in a developing region both to lay the foundation for an emergency care system or support a new one to maturity.

As many as 90% of all trauma-related deaths occur in developing countries, with the majority of these deaths occurring in the prehospital setting.¹ Over the next few decades, these countries will experience even greater rates of death and injury from emergency incidents as the countries develop further, urbanise and industrialise.^{2–9} As a result, emergency care will play an increasingly critical role for global health.^{1 10}

The impending rise of emergencies is largely due to the inevitable development of low-income countries.^{2–7 11 12} As impoverished nations develop, their cities will modernise and industrialise—becoming attractive to rural populations seeking employment, means and a more comfortable lifestyle. This leads to mass migrations towards urban centres, which typically result in massive slums and shanty towns that breed unregulated crime, accidents, poor sanitation and violence.⁵

Once these urban centres increase dramatically in size and concentration, individuals become more exposed to gangs, drugs, weapons, machinery and diseases than before.^{4 5}

To meet this emergency need, many nations are developing emergency care systems. A current popular strategy is to model the system after that of a Western country, particularly that of the USA.¹³ However, Western models are often too taxing on the scarce resources of a low-income country, and they often push the developing nation to distract too many of its crucial resources towards a system that it cannot sustain and that may be ineffective for the country.¹³

As a result, a new strategy is needed to help establish emergency care systems in developing areas, and to support them until full maturity. One component of this solution may be the employment of first responders:¹⁴ community members trained in the most basic prehospital emergency procedures. Because they are already dispersed throughout a community, they are able to be the first medically trained persons on a scene. Ideally, they are able to keep a patient alive until further help is available, using no specialised medical equipment and being able to work at an instant's notice—studies have already found that first responders can be effective at reducing morbidity and mortality.^{15–17} In addition, training first responders is relatively easy because they are primarily volunteers without political red-tape, and governments can avoid violating obligations to businesses that work within the country's formal healthcare system.¹⁸

However, not enough work has been done with first responders,^{18–22} and to date they have been mainly imposed as a standalone health intervention. We aimed to design a first responder system model with the intention of having it be able to integrate into and support young emergency care systems (or to lay the foundation for an entirely new emergency care system in a developing area).

METHODS

Target area

To set up a first responder model, we targeted the community of Manenberg, an area of approximately 55 000 residents that sits just outside of Cape Town, South Africa.²³ Manenberg is notorious for its high rates of assault, accidents and crime violence, and it has 'long been synonymous with gangsterism in the public mind'.²⁴ In addition, residents report that the severely overwhelmed ambulances are typically delayed arriving on scene,

and that patients often die while waiting for an ambulance. The Cape Town METRO emergency medical services (EMS) official statistics indicate that in the greater Cape Town area only 65% of life-threatening emergencies are responded to within 15 min, with approximately 250 life threatening incidents per day and up to 25 000 total life-threatening and non-life-threatening calls per month (SD Vries, personal communication, 2011). However, Manenberg residents report that in poorer areas, such as Manenberg, response times are almost always delayed and can sometimes take hours, even for critical patients.

Training

To design the first responder training curriculum, we consulted with doctors and nurses at Manenberg's GF Jooste Hospital's emergency centre as well as the primary care clinics located nearby. At these locations, we undertook a preliminary assessment of what types of medical and traumatic emergencies are most common, and which are the most fatal. In addition, because the proportion of injuries treated at the clinics may be different from that of the injuries inflicted on the streets, we also consulted with local Manenberg community members on their perceived experiences. We held multiple discussions with the Manenberg Health Committee, a local non-governmental organisation (NGO) composed of representatives from other Manenberg NGOs, and also assembled several focus groups consisting of individuals not on the committee.

Between the expressed concerns of the Manenberg people and the official records of the emergency centre and clinics, we identified the most frequent and most serious injuries in Manenberg and tailored the course to address these identified needs. The resultant curriculum was accredited by the University of Cape Town Division of Emergency Medicine. A certified trainee was referred to as an emergency first aid responder (EFAR).

Model design

We designed the model for EFAR service delivery by consulting with local community leaders, who instructed us to assess already existing community-based services in Manenberg (such as the neighbourhood watch, or the HIV/AIDS awareness campaigns) that were the most effective and how they were delivered. We modelled a basic EFAR service delivery after these services for a baseline, basic foundation.

We added to the model's design by adding an additional layer: an advanced EFAR system that was a community-based version of the local METRO EMS. After designing both layers of the EFAR system model, we identified the appropriate governing bodies that could oversee these levels and integrate them with the greater Cape Town METRO EMS.

Monitoring the programme

All basic EFAR trainees were given a pretraining exam and a final exam to test for learning. Trainees who scored at least 75% on the final exam were certified as EFARs and were re-tested at 4 and 6 months to test for retention. At 4 and 6 months, certified EFARs were also surveyed for usage of their skills. Patient care report forms were also collected from EFARs, who were encouraged to fill one out after every incident. EFAR reports of skill usage at 4 and 6 months were carefully reviewed to prevent double reporting of the same incident.

Ethics

Data entries were stripped of identifiable markers and stored on secure Excel files and computers. Ethics approval was granted by both the University of Cape Town and Stanford University.

RESULTS

Basic EFAR training curriculum

We identified four major categories of need, which became the basis of the four modules of the course: emergency scene management; unconscious patients; violent injuries and medical emergencies (see table 1).

In order for a trainee to qualify for certification, they had to score a minimum of 75% on the final exam. Upon qualification, students received a personalised certificate and an ID card to use at a scene. Both the certificate and ID card were valid for 2 years.

The course lasted 1 day and was PowerPoint based with practical sections. Because a laptop and LED projector were not always available, we created a lecture on DVD in which the instructor only needs to facilitate and run the practicals. Also, when qualified, local community members were used to instruct the course. Trainees appeared visibly to be more comfortable and to have higher comprehension rates than when foreigners or Cape Town doctors taught the course.

Aside from the projector and other presentation equipment, the materials used to run the course included the handout, the

Table 1 Basic EFAR training needs assessment and curriculum design

Module	Needs assessment	Curriculum design
(1) Emergency scene management	Interviewees reported emergency incidents as usually chaotic with mass confusion. In addition to untrained individuals attempting to help, there are frequently a number of people panicking and people attempting to exploit the patient—such as robbery, taking pictures, or blackmailing. Also, knowledge of emergency phone numbers was extremely low.	Responsibilities of an 'emergency first aid responder', scene safety and control (SAF-T), calling for help/ambulance, mass casualty incidents, overview of ABCs. Extrication methods were excluded.
(2) Unconscious patients	Choking and unconsciousness were a frequent occurrence. Drowning cases were minimal.	Shock, choking, lay-person CPR, recovery position. There was both a lecture and a practical section.
(3) Violent injuries	Gunshots, stabs and traffic accidents are rampant in Manenberg and are the most recognised emergencies. Community members almost universally identified both drugs and gangs as the main causes of all traumatic injuries.	Handling trauma patients, spinal management, bleeding control (DeEP), bandaging burns and bloody wounds, evisceration, impalement, amputations, splinting. There was a lecture, a practical and a case study section.
(4) Medical emergencies	Interviewees reported drug and alcohol abuse, seizures, diabetic shock, heart attacks and stroke as the most prevalent medical emergencies. Anaphylactic shock, animal attacks/bites/stings, hypothermia and hyperthermia were reported as minimal. Midwives are readily available in the area, and so infant delivery was not included.	Drug and alcohol overdose, seizures, diabetes, dehydration, heart attacks, stroke, abdominal pain and shortness of breath.

CPR, cardiopulmonary resuscitation; EFAR, emergency first aid responder.

final exam, the certificates, the ID and splints and bandages. As community bystanders do not have access to professional equipment, the splints and bandages used for training were made from items readily available in the community, including cardboard, cling wrap, blankets, sweaters, coat hangers, sticks and newspaper. Expenses are explained later.

The emergency first aid responder system model

Once community members are certified as EFARs, they are integrated into the general emergency system as the most basic, community-level emergency personnel. Their purpose is to fill the current gap between emergency patients on scene and the rest of the emergency system, thereby reducing the time until first medical contact and keeping patients alive until more formal emergency care is available (see figure 1). Each EFAR starts off as a basic EFAR, with the option of receiving further training to become an advanced EFAR.

The difference between basic and advanced EFARs is that basic EFARs are spread throughout the community with at least one per region (which we defined as an area where the inhabitants recognise one another). They are mostly accessed by already being present at an emergency scene or being nearby and recognised by the locals as a certified EFAR. Due to their high number and prevalence throughout the community, the basic EFAR response is almost instantaneous.

Advanced EFARs are a part of our model design, and we are currently in the process of establishing their part of the system. They will be formally posted in strategically placed stations throughout the community, will be notified by dispatch when the ambulance is called, will have access to more advanced medical equipment at the station, and will be trained in extrication and oxygen tank delivery methods. We expect that advanced EFARs will typically arrive more slowly than basic EFARs, but because they are already in the community, and are specialised for extremely quick response to their regions, they should arrive on scene before the METRO EMS ambulances. Both types of EFARs will work together to arrive on scene before the ambulance does, and either keep the patient alive until

a METRO EMS ambulance arrives or properly transport the patient themselves to the nearest hospital if necessary. In addition, each basic EFAR region will be grouped together into a greater area that is served by one EFAR station. The advanced EFARs who staff this station will be responsible for overseeing and supporting their corresponding basic EFARs.

Basic EFARs are invited to a monthly support group meeting where they are organised, re-stocked and provided with additional advanced training. The meetings are open to the public but are primarily for the EFARs. When the advanced EFARs become available they will also be invited.

In Manenberg, the running of the system required the partnership of an academic or official institution for accreditation and quality control, a community-based organisation to manage the system and a body of instructors to implement it. The academic and official institution for us was the University of Cape Town, the community-based organisation was the Manenberg Health Committee, and the body of instructors comprised both locals and medical professionals.

The cost of running the system is minimal. For a full summary of the Manenberg basic EFAR training costs see table 2. The following estimates are based on 100 expected trainees a month, with a 75% pass rate. We have also included all optional expenditures in the cost, such as a laptop, LED projector and first aid kits (these prices were contingent on the local prices and needs of the Cape Town region). First aid kits for our basic EFARs included a semi-occlusive chest seal, two bandages and a pair of gloves packaged in a key-ring pouch. More advanced medical supplies for the advanced EFARs are much more variable and will depend on the available resources of the area; mobile phones for EFARs were not needed as almost all adult residents in Manenberg already own such phones or can easily obtain one.

Learning, retention and usage of skills

In the first 6 months, 628 individuals took the training. The mean score for all trainees was 28.2% before the training, and 77.8% for the final exam, confirming improvement ($p < 0.0001$). Four hundred and twenty-three individuals (67%) qualified for

Figure 1 The Manenberg emergency first aid responder (EFAR) system model. During an emergency, bystanders are able to personally contact a nearby basic EFAR for a near instantaneous response. Bystanders can also call an emergency number which will activate both local advanced EFARs and METRO EMS ambulances, with advanced EFARs typically arriving much quicker. All EFARs are supported by an official, academic body and an organization within the community. EMS, emergency medical services.

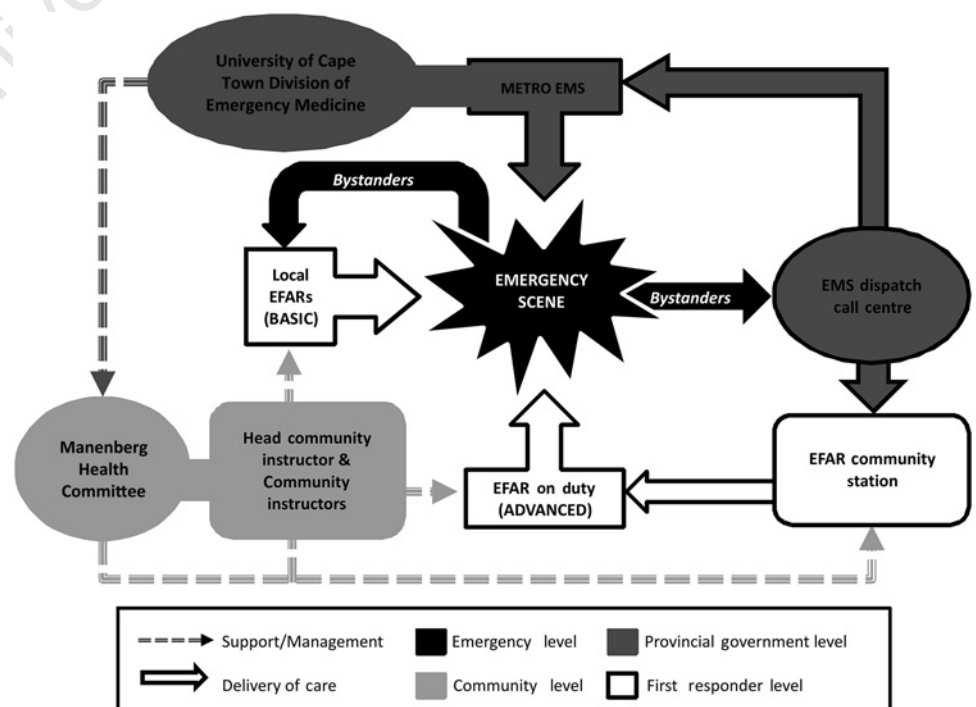


Table 2 Total potential costs of the basic EFAR training

Basic EFAR training	Items	Cost	Recurrence	Expected total
Start-up costs	Netbook laptop	US\$300	ONCE	US\$700
	LED projector	US\$400	ONCE	TOTAL
	Splints/bandages	US\$000	ONCE	
Ongoing costs				
Instructor's wages	Per course taught	US\$60.00	4 per month	US\$3120
	Per additional day	US\$20.00	1 per month	per YEAR
Course costs	Per handout	US\$00.25	100 trainees per month	US\$3450
	Per final exam	US\$00.25	100 trainees per month	per YEAR
	Per certificate + ID	US\$00.50	75 trainees per month	
	Per first aid kit	US\$02.00	75 trainees per month	
	Extra costs	US\$50.00	1 per month	

EFAR, emergency first aid responder.

certification; 179 (42%) of those certified were followed up 4 months after certification. They averaged 28.3% before training, 85.8% after training and 71.3% 4 months later, indicating that certified EFARs retained a large proportion of the training. One hundred and sixty-nine (40%) of those certified were followed up 6 months after certification. They averaged 31.3% before training, 82.0% after training and 71.0% 6 months after training, which was similar to the scores of those tested at 4 months, and suggests that skill loss after training is not continuous ($p=0.9004$). Seventy-four trainees were present for both follow-up sessions. They averaged 31.4% before training, 88.8% after training, 74.8% 4 months after training and 77.0% 6 months after training, again suggesting that skill loss after training is not continuous ($p=0.3351$ between 4 and 6 months).

In addition, EFARs self-reported using their skills by 4 and 6 months after certification (see figures 2–4). We also randomly selected and assessed 29 patient care reports from certified EFARs. They ranged from minor burns and fractures, to cases of anaphylactic shock and seizures, to violent physical assaults and motor vehicle accidents. Throughout the reports, the EFARs showed deductive skills in identifying what was wrong with the patient, and consistently gave adequate treatment. The EFARs also showed a high degree of understanding and flexibility in dealing with various emergencies, which was evident when the EFARs were able to handle emergencies variant from the textbook examples used during training. Overall, the EFARs gave sufficient quality of care within their scope, and even exceeded our expectations. They handled novel emergencies well, secured their scenes, gave proper treatments, avoided inappropriate interventions, and stayed with the patients until the patient recovered or higher care was available.

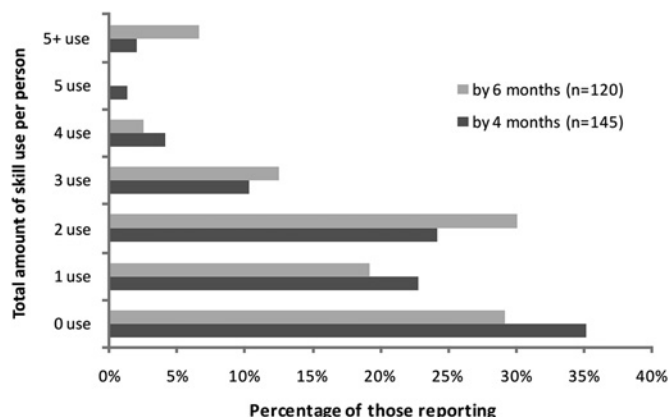


Figure 2 Reported number of times training used by emergency first aid responders.

DISCUSSION

The emergency first aid responder system is a very cheap and easy to establish intervention, and can be adapted to a specific area's needs. The system can be implemented in any area with a high volume of emergencies and inadequate emergency care. Therefore, although our system was in an urban area the system could theoretically also be established in rural locations. To sustain the system, the main requirements are a stable population from which to recruit community instructors and EFARs, a local community organisation to perform day-to-day administration, and an academic or official body to provide accreditation to the training. These roles could also be combined and performed by single entities, depending on the available organisations in an area. In addition, we emphasise that locals as close to the community as possible be used for the majority of contacts. The success of the Manenberg EFAR system was most likely because we relied on the knowledge of local community leaders, and the trust the locals had in them. This was also clear in the training: local community instructors were able to explain concepts in local terms and language, and were much better at engaging trainees, gaining their trust, and producing higher exam scores than local doctors or foreign instructors were able to. Because of this, we recommend using community instructors as much as possible, and having trained professionals present or on call to support the instructor with advanced technical knowledge if needed.

However, before training begins and the system is established, a thorough needs assessment to determine the emergency needs of the area is essential so that the course can be specifically tailored to the community and so the model can be altered to serve the region. In our system, it is evident that certified EFARs are using their training for all sorts of emergencies, continuously over time, and that they are using their training in various settings especially on the streets and in their homes. We believe that the EFARs reporting usage of almost every skill we taught them was no

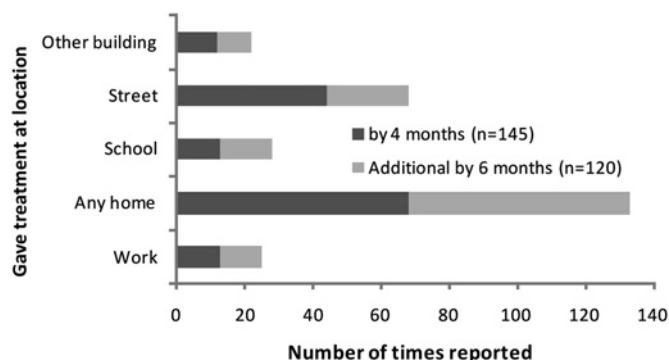
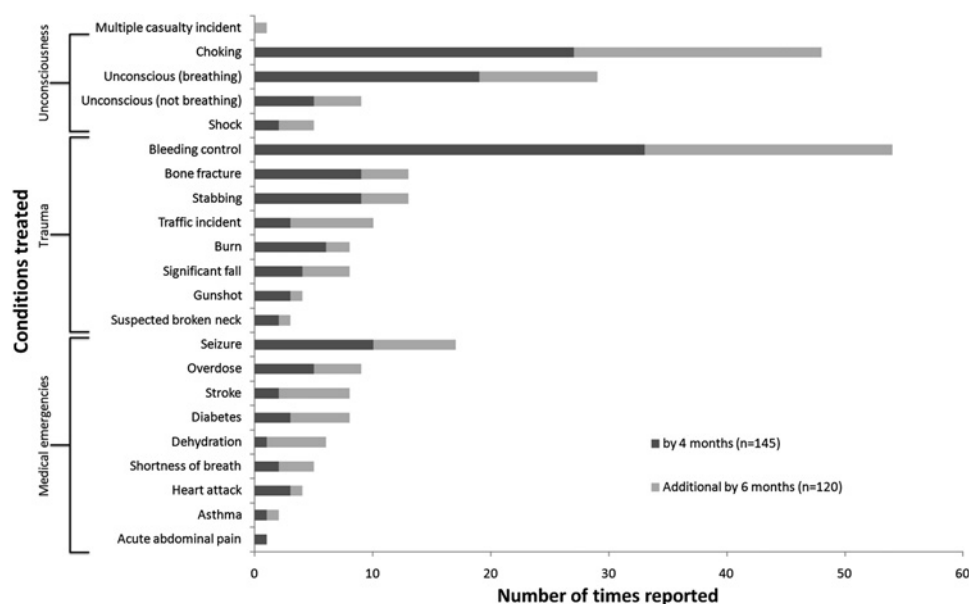


Figure 3 Location emergency first aid responders reported using their training.

Figure 4 Conditions reported to be treated by emergency first aid responders. By 6 months after training, care for eviscerations was the only part of the training curriculum not reported to have been used.



mistake. We tailored the curriculum to the Manenberg locals' expressed needs, and based the care delivery on NGO and government models already well established in the area.

Even within Cape Town, we are cautious to expand the curriculum to certain townships without doing a needs assessment to determine if our current course is appropriate or should be modified. Of particular importance is the determination of whether emphasis should be placed on the quantity of EFARs trained or the intensity of their individual training. In Cape Town, the major problems were access to the delayed yet en-route ambulances. A highly intense training would have been redundant with the already existing ambulances and emergency centres. Therefore, we focused on training a greater number of EFARs to address the much more prevalent problem of the numerous patients waiting without any medical care. As a result, our course was purposely much shorter in duration than most other first responder training programmes, so that more EFARs could be trained in a shorter amount of time. In rural areas, where ambulances are less available and emergency incidents occur less frequently, it may be that greater training of each individual EFAR is more important than having a greater number of total EFARs.

In addition, we understand that Cape Town and much of South Africa is unique in that it is relatively more developed than other parts of Africa, and so our system had access to resources that other regions will not. If this is the case, we suggest that administrators construct the EFAR system at the basic level first, and then build the advanced level when the technology and supplies become available (this is the order we are taking to establish the complete system, and it is working well as the basic EFARs do not need the advanced EFARs to operate). Sometimes, if the region has no official EMS already in place, the advanced EFARs can be established with the intention of upgrading them to an ambulance system in the future.

Limitations

Current methods of comprehensively assessing the system's effects on morbidity and mortality are too complex for regions that would typically need this sort of intervention. Further research is needed to develop a simpler, less cumbersome methodology to analyse emergency care systems in developing areas.

In addition, further research is needed to test the EFAR system in other locations, and to perfect a universal strategy to bring the system to new places of different contexts and needs.

CONCLUSION

With the system's versatility and low costs, and the evident retention and usage of skills of the EFARs, we believe that the EFAR system model can be a viable supplement to a developing nation's emergency care system that has not yet met the community's needs, or an essential stepping stone to the establishment of an emergency care system where it does not yet exist. Either way, as long as there is an emergency need in a developing community, the EFAR system can potentially save lives.

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Competing interests None.

Ethics approval Ethics approval was provided by the University of Cape Town and Stanford University.

Contributors JS and LW contributed to study design, data interpretation and writing of the article. JS also collected and managed the data, searched for articles, drafted the figures and analysed the data.

Provenance and peer review Not commissioned; externally peer reviewed.

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This paper was the first article to describe the use of lay-person emergency responders in an organized way that was fully coordinated and integrated with the rest of the EMS and provided a frontline upon which the professional EMS of a developing area could build upon. Previous studies have described the use of lay-person emergency responders in low-resource areas, but only in an uncoordinated way such as the community-based model described before or in parallel with a centralized ambulance model. The novelties of the Manenberg EFAR system model were that the EFARs were coordinated and integrated with the ambulance services of the Cape Town metropolitan. In addition, we were able to indicate that the system was operational, and that community members were capable of being EFARs and providing their skills to treat emergency patients in the community.

In particular, not only were the EFARs streamlined with the rest of the emergency care system, they were indirectly organized and managed by the same institutions that oversaw the centralized ambulance system, the University of Cape Town Division of Emergency Medicine and METRO EMS (the locally provided government ambulance service), thus providing a unifying order amongst typically detached centralized ambulances and unorganized first responders. Furthermore, the EFARs were managed in a novel way: when we first went into Manenberg to develop a new pre-hospital emergency care model, we had our concerns; we were aware of other similar institutions attempting to do what we had (creating organized community first responders) and come out unsuccessful. This concern translated into an acceptance that we were probably no different, and so we started the project believing we had a poor understanding of how to organize community responders. This led to a heavy reliance on community leaders, community members, and the Manenberg Health Committee, whose members became our primary informants in regards to Manenberg's people, culture, and context.

We realized that the Manenberg Health Committee was starting to effectively manage the EFAR system on its own, and that they were not only just suggesting what we should be doing in Manenberg but were telling us what to do. Once the Manenberg Health Committee was confident in our support, and trusted that our intentions were truly to bring more effective pre-hospital emergency care to the community, the members no longer felt that they needed to coax us for our resources but instead knew that for the best interests of Manenberg that they had to

use us as a tool. At that point, the Manenberg Health Committee used their local knowledge and expertise about Manenberg to instruct us how to use our medical training, academic knowledge, and financial resources to effectively carry out the project. The Manenberg Health Committee was a key contribution in the design and execution of the Manenberg EFAR system model.

As we followed the community members and Manenberg Health Committee's instructions, we saw that the system was indeed working. As mentioned in the paper, it came as no surprise to us that EFARs were using their training because community members themselves told us what emergencies they needed to be able to address the most, and the Manenberg Health Committee helped us make our training understandable and relevant for community members (learning and skill retention of EFARs is further discussed in chapter four). Because of its knowledge of the local people and culture, the Manenberg Health Committee was also extremely effective at identifying and recruiting motivated community members to keep the Manenberg EFAR system running, all under its supervision. In the end, whereas we began the project using local community members as consultants for the project, we later understood that using a community based organization to manage a community's EFARs on our behalf could be critical. We continued with the model of having the Manenberg Health Committee manage the EFAR system in Manenberg, and the system has remained successful since then in that EFARs are being trained, they are retaining their skills, they are providing care to their community, and the local residents believe in the program.

After successfully establishing the Manenberg EFAR system, we needed to understand in more detail what had happened or what could happen in the future. In order to expand the EFAR system to other areas, we needed to understand the system better. This included a greater appreciation of the context that we had been working with in Manenberg, how the Manenberg EFAR system was working, and what the effects of the Manenberg EFAR system was.

To begin to further analyse the EFAR system, we made it a priority to understand the settings in which EFAR systems would take place, particularly in regards to community members' sentiments towards emergencies and emergency response. We also wanted to know community members' opinions of our project, since we had established that community member

input, and thus support, were critical for the EFAR system to function. These questions became the subject of our next investigation.

CHAPTER 3: THE PSYCHOLOGICAL EFFECTS OF WIDESPREAD EMERGENCIES AND A FIRST RESPONDER COURSE ON A VIOLENT, DEVELOPING COMMUNITY.

Declaration by candidate

In the case of Chapter 3, the nature and extent of my contribution to the work was the following:

Nature of contribution	Extent of contribution (%)
The candidate was the primary author and responsible for the literature review, study and methodology design, data collection, and analysis. The candidate also wrote all drafts of the manuscript while incorporating input from the co-authors. The candidate accepts overall responsibility for the publication.	80%

The following co-authors contributed to the work. Co-authors who are students at the University of Cape Town must also indicate the extent of their contribution in percentage terms:

Name	Nature of contribution	Extent of contribution (%) for student co-authors only
Lee Wallis	Co-developed the study and analysis, and helped interpret the data. Contributed to the final article.	

Candidate's Signature

<div style="border: 1px solid black; padding: 5px; display: inline-block;">Signed by candidate</div>
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Declaration by co-authors

The undersigned hereby certify that:

- (1) the above declaration correctly reflects the nature and extent of the candidate's contribution to this work, and the nature of the contribution of each of the co-authors.
- (2) they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;
- (3) they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
- (4) there are no other author of the publication according these criteria;
- (5) potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and
- (6) the original data are stored at the following location(s) and will be held for at least five years from date indicated below:

Location(s):Date

University of Cape Town Division of Emergency Medicine : August 2012

[Please note that the location(s) must be institutional in nature, and should be indicated here as a department or division.]

Lee Wallis	u
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As we developed and implemented the EFAR system in Manenberg, we believed that it was important to understand the context of emergencies in Manenberg, how the community members felt about them, and how first responder training was psychologically affecting the community members. One reason the research was critical was because of our obligation to hear community members' sentiments about their conditions. No previous studies have recorded community members' feelings and opinions of emergencies in a developing area. As community members around the world could be the recipients of emergency care system interventions, we wanted to expand upon the current literature and document a snapshot of what the community members could be thinking before and while we carried out the project.

While working in Manenberg, we learned and were informed by the Manenberg Health Committee that the locals loved sharing their stories with outsiders, both because expressing their feelings was a part of their culture and because they believed that by sharing their sentiments with us we would remember them and continue to share what we had learned with others outside their community. Before we even began asking community members for their thoughts, on a regular basis many individuals were already openly sharing with us what they felt. The stories we heard were generous gifts from the community members, and they helped guide us during the project. We knew that to not record some of these opinions would have been a waste.

Surveying community members would also provide us with valuable insight into the community's context. We deemed it appropriate to ask the community members what they thought about emergencies and emergency response in their area, since they were readily available experts on their community and what happened there. Performing research in a developing area is also associated with a lack of data infrastructure, which means that other research methods to understand the community's context were unavailable.

Understanding the context and how community members felt about emergencies in their area was of utmost importance to us for designing the EFAR system model. We wanted to know what the perceived problems in the community were, so that we could properly address them. In addition, it was important to know what the community members thought so that we could tailor

the model to how they felt and advised. Adapting the EFAR system model to community members' opinions was not just important so we could ensure that we were addressing the community members' expressed needs, but also because community support of our project was critical for its success since it would be what they could be left with and what they would ultimately end up managing. We were also collecting the community members' feedback about our project so that we could adapt it to their requests as we were implementing it, in addition to quantitatively measuring some of the effects of the project's training course so that we could further understand what it was doing to the community members.

The following paper is the result of our attempt to gauge community members' perceptions of emergencies, death, violence, and emergency personnel in crime-violent, developing communities. It also gathers their narratives on how they feel about their situations and what relevant improvements they believed would increase their quality of life. The paper also analyses the psychological effects of an emergency first aid responder training course on trainees, such as how it affects their confidence and likeliness to help during emergencies. This information became critical for our understanding of the community we were implementing the EFAR system in, and how it was affecting the community members.



The psychological effects of widespread emergencies and a first responder training course on a violent, developing community [☆]

Les effets psychologiques d'une formation généralisée sur les urgences et pour les premiers intervenants sur une communauté violente et en développement

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KEYWORDS

Violence;
Psychology;
First responder;

Abstract *Background:* Most of the world's trauma-related deaths are borne by developing countries in the pre-hospital setting, with trauma mortality rates over double than those in developed nations and predictions that the situation will get even worse. However, very little is reported about how community members in these settings feel about the violence and emergencies themselves. We

[☆] JS and LW designed the study. JS collected the data and analyzed it. JS and LW both interpreted the data. JS wrote the first draft of the article. Both authors edited the final paper.

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Training;
Emergency care system

aimed to catalogue how community members in one area felt about emergencies and emergency personnel, and how they would psychologically respond to first responder training, a possible intervention to relieve community stress.

Methods: The Emergency First Aid Responder training course was taught to community members in the Cape Flats region of Cape Town, South Africa. We administered before and after surveys that asked questions about emergencies, emergency personnel, likeliness to help in an emergency (initiative), confidence in helping skills, and in feelings about the training course.

Findings: The community members felt very negative about emergencies in their area, and most residents feel that emergency personnel are not doing their job adequately. Lack of ability to help is the most prevalent and largest barrier to help during an emergency, and the course was the most effective at addressing this barrier.

Conclusion: Violence and emergencies are having a deep, negative impact on the psychology of the Cape Flats' community members. First responder training is one intervention that can provide stress relief to the community, increase the likeliness community members will help each other during an emergency, and increase their confidence while helping. This was true even for those who were not trained voluntarily, and the more a trainee learned in the course the more likely they improved in initiative and confidence.

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Abstract *Contexte:* La plupart des décès liés à des traumatismes dans le monde se produisent dans des pays en voie de développement dans le contexte préhospitalier, les taux de mortalité liés au traumatisme étant plus de deux fois supérieurs à ceux des nations développées, la situation devant s'aggraver encore davantage. Cependant, très peu de choses sont rapportées quant à la façon dont les membres des communautés vivent la violence et les urgences dans de tels contextes. Nous avons cherché à cataloguer la façon dont les membres d'une communauté d'une région vivent les urgences et le personnel d'urgence, et la façon dont ils répondraient psychologiquement à une formation pour les premiers intervenants, constituant une intervention possible pour alléger le stress de la communauté.

Méthodes: Le programme de formation des premiers intervenants d'urgence a été enseigné aux membres d'une communauté dans la zone des Cape Flats du Cap, en Afrique du Sud. Nous avons organisé des sondages de type avant/après qui s'intéressaient aux urgences, au personnel d'urgence, à la probabilité d'aider dans une situation d'urgence (initiative), à la confiance en les compétences d'aide et aux sentiments sur le programme de formation.

Résultats: Les membres de la communauté étaient très négatifs quant aux urgences dans leur zone, et la plupart des résidents estimaient que le personnel d'urgence ne faisait pas son travail correctement. Le manque de capacité à aider constitue la barrière la plus courante et la plus importante à l'apport d'une aide lors d'une urgence, et le cours s'avérait des plus efficaces pour surmonter cette barrière.

Conclusion: La violence et les urgences ont un impact profond et négatif sur la psychologie des membres des communautés des Cape Flats. La formation des premiers intervenants est une intervention pouvant alléger le stress de la communauté, augmenter la probabilité que les membres de la communauté s'entraident lors d'une urgence, et renforcer leur confiance lorsqu'ils apportent de l'aide. Cela s'est vérifié même pour ceux qui n'avaient pas été volontairement formés, et plus un stagiaire apprenait pendant le cours, plus il était probable qu'il gagne en prise d'initiatives et en confiance.

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What's new:

- Violence deeply distresses community members in South Africa.
- The community has a generally poor opinion of emergency personnel.
- Lack of ability is the largest barrier to helping during an emergency.
- Emergency training increases community members' initiative and confidence.
- Improvements can be seen even in those trained involuntarily.

African relevance:

- Developing African cities will experience increased violence.
- The perspective of African community members is important but often ignored.
- Community member buy-in will be essential for developing emergency care in Africa.
- Emergency first aid training is a cheap intervention.
- The training used was tested and validated in South Africa.

Introduction

As many as 90% of all trauma-related deaths already occur in developing countries, with the majority of these deaths occurring in the pre-hospital setting.¹ Numerous studies have even reported trauma mortality rates in poorer nations to be as high as 40–50%,^{2–5} which is over double than what is reported in cities of developed nations.⁶ In addition, trauma is already the second leading cause of death among fifteen to forty-four year olds in middle to low income countries, being only surpassed by HIV/AIDS.¹ For children between the ages of five and fifteen years in these same countries, trauma is the third leading cause of death.¹ These statistics are also projected to get even worse as low-income nations develop and urbanize.^{7–13}

However, amidst all of these objective descriptions of the growing violence and trauma in the developing world, very little is reported on how the community members of these impoverished, urbanizing regions feel about the situation themselves. In 2002, Nantulya and Reich suggested that many populations of developing regions may perceive increased morbidity and mortality due to trauma as inevitable and natural to city life, and thus have little ambition to address it.¹¹ In another study, researchers found that community members avoided areas of their community due to fear.^{14,15} To our knowledge, there has not been a more comprehensive assessment of how community members feel about the violence and the context of emergency incidents around them. In addition, previous studies have documented anecdotal evidence that emergency care first responder training provided a boost in confidence for those trained.^{4,16–18} We are not aware of any studies detailing the effects of such training in depth.

We therefore undertook a study to assess how one city's impoverished residents feel about their ongoing development and concurrent violence, and to explore the psychological effect of a first responder course on community members.

Methods

EFAR course

A single instructor trained over 600 community members in the Emergency First Aid Responder (EFAR) curriculum which included scene management, unconsciousness, trauma, and medical emergencies along with a pre and post-course exam to track competency. The training was conducted in the Cape Flats, an impoverished, developing area of Cape Town, South Africa, that is known for high rates of crime, accidents and violence. The area is an example of the

increasing development, urbanization, population growth and trauma rates that many major cities in developing countries are experiencing.

Training sessions were advertised and open to any community member that wanted to attend. We also had training sessions at the request of schools, organizations and community centres, some of which allowed their members to take our training voluntarily whereas others required all their members to do so.

Before and after the course, all trainees completed anonymous surveys, with pre and post-training surveys tagged to each other with a unique number so that before and after responses could be tracked together. A smaller sample of surveys was done non-anonymously to see whether individuals' anonymity affected their responses, and so that we could correlate their responses to their exam scores.

Qualitative analysis

On the pre-training survey, participants were asked open ended questions on how they felt about violence and emergencies in their community, about emergency personnel, and about what should be done to improve the situation. Participants were also asked what factors would prevent them from helping a critical patient. After training, participants were surveyed with open ended questions on how they felt about the course.

The open ended survey answers were independently coded by two researchers, after which the coding schemes were compared to generate a final coding scheme. Two researchers then independently re-coded all answers according to the final coding scheme (with each answer being assigned all codes that applied), and then compared their codings to check for consistency. The main purpose was to identify the full range of opinions among the participants.

Quantitative analysis

On both the pre and post-training surveys, participants were asked to rate on a scale of 1 to 10 (A) How likely they would try to treat a patient with a moderate emergency (initiative during a moderate emergency) (1 = Not at all, 5 = Maybe, 10 = Definitely yes), (B) How likely they would try to treat a patient with a severe emergency (initiative during a severe emergency) (1 = Not at all, 5 = Maybe, 10 = Definitely yes), and (C) How confident they would be in helping a patient of any severity once involved (1 = Not at all/I'll harm them more, 5 = Unsure/I'll have no effect, 10 = Very/No chance of dying). Before the course, participants were also asked if they had any prior medical training, and after the course they were asked how much they were interested in receiving further medical training (None, A little, or A lot).

Averages of the initiative and confidence ratings were compared to each other using the Statistical Analysis Software (SAS) to perform simple *t*-tests and logistical regression analysis both with a 95% confidence interval. For the logistical regression, the calculations used the odds of a trainee improving their ratings versus no improvement or a decrease in ratings, and survey ratings that reported a maximum 10 for both before and after the training were excluded as there was no room for improvement.

Ethical considerations

Ethics approval was granted by the University of Cape Town and Stanford University.

Results

Community perspective of emergencies

Emotionally, the community members feel strongly negative about the state of emergencies in their community (see Table 1). Out of 681 responses, only a very small minority reported not being emotionally affected at all ($n = 25$), and out of those individuals the majority reported that they are actually desensitized and now accept crime violence and emergencies as a normal, everyday part of life ($n = 16$ out of 25). No-one reported a positive emotion.

157 responses provided information about how the community members feel about their level of empowerment (see Table 1). Most individuals feel charged to take action, and that somebody should be able to do something to alleviate emergencies ($n = 106$). There is a significant number who also feel helpless ($n = 92$), but many of those that feel helpless reported that the reason they feel that way is because they don't know what to do during an emergency ($n = 41$).

When asked which emergencies they see most frequently, the most common answers were violence and trauma, particularly assaults, traffic incidents, gangsterism, gunshots, and stabbings (see Table 2). Some medical emergencies were mentioned as well, particularly heart attacks and stroke.

Community perspective of emergency personnel

Out of 498 responses, there was an even split between those who described the ambulance service as doing a good job ($n = 145$) and those who described them as doing a poor job ($n = 154$) (see Table 3). However, there was a very prevalent sentiment that the ambulances take too long to arrive on scene ($n = 213$), even among those who described the ambulances as doing a good job. A number of individuals attributed the ambulances' slow response to being understaffed or overwhelmed; some individuals were forgiving and said that the ambulances were trying their best with the limited resources they have.

Out of 466 responses, community members mostly described the police as not helpful for emergency patients ($n = 171$) (see Table 3). Some also said that the police were detrimental for dying patients ($n = 61$). Unlike the ambulances, community members blamed police officers more for their performance on-scene rather than for their slow response. Community members particularly identified police officers as not knowing what to do and as caring more about arresting criminals than about helping a dying person. In addition, the community members were not forgiving of the police; whereas for the ambulances many people acknowledged that the ambulances were understaffed, overwhelmed, and trying their best, very few people said the same for the police ($n = 19$). However, not all individuals viewed the police negatively. There was a significant number of community members that described the police as helpful for emergency patients ($n = 104$), particularly when the police controlled the scene or paid any kind of attention to the patient.

Barriers preventing an individual from helping an emergency patient

When we asked community members what would stop them from helping an emergency patient in need, out of 676 responses the most common answer was not knowing what to do ($n = 178$) (see Table 2). This was affirmed by a second highly common answer which was a fear of hurting the patient more ($n = 68$). Other common answers involved concerns of personal safety, such as a violent scene or risk of HIV infection. Though, the second most common answer was that nothing would stop the individual from helping a person in need, and that they would always try to help ($n = 120$).

Suggestions on how to relieve the community of preventable death and violence

Out of 661 responses, the most common suggestion to alleviate death and violence in the community was to give emergency training to the community and to local police officers ($n = 189$) (see Table 2). Other common responses included increasing community cohesiveness and involvement ($n = 145$), enhancing security ($n = 122$), and implementing awareness campaigns ($n = 100$). Very few people suggested improving the standard of living of the area ($n = 7$), or removing weapons ($n = 4$).

Improvements in initiative and confidence due to EFAR training

The average pre-course ratings in initiative and confidence started off already fairly high, and showed significant additional increases after training for all three measurements ($p < .0001$). Additionally, initiative ratings for moderate emergencies were significantly higher than for severe emergencies both before and after training ($p < .0001$ before, $p = 0.002$ after), meaning that even after training the trainees were more willing to get involved with a moderate emergency than a severe one.

The *t*-test and logistical regression analysis revealed that anonymity on the survey had no effect on ratings (see Table 4). In contrast, individuals who were required to take the training started off with significantly higher ratings than voluntary trainees in all three measurements before training, but were more likely than voluntary trainees to increase their ratings in initiative during moderate emergencies ($p = 0.0143$) and in confidence ($p = 0.0426$), and were only slightly insignificant in being more likely to increase in initiative during severe emergencies ($p = 0.0638$). In addition, the logistical regression also showed that a greater improvement between the pre and post-course exams correlated with a higher chance in improving initiative during moderate emergencies ($p < .0001$) and severe emergencies ($p = 0.0474$). However, greater improvements in exam scores had no effect on confidence improvement ($p = 0.8564$).

Additionally, when we correlated the reported barriers to helping with initiative and confidence ratings, likeliness to help in a moderate emergency and confidence while helping were lowest before the course among those who reported a lack of ability as a barrier (see Table 4). They were also the most likely to improve in initiative during both moderate and severe emergencies ($p < .0001$ and $p = 0.0235$, respectively) and in confidence ($p < .0001$), and after the course their ratings were similar to others.

Table 1 Sentiments and levels of empowerment felt by community members about violence and emergencies in their area. Responses were given all codes that applied.

Emotional effects of community emergencies (681 responses) and examples	
<i>Introverted negative feelings</i>	
Sad ($n = 109$)	I feel very depressed because innocent people are getting hurt and killed everyday.
Overwhelmed by prevalence ($n = 98$)	It happens everyday. I feel that there is no end. We as the people in the community can do nothing to prevent it, not even the police.
Ashamed ($n = 19$)	I feel really ashamed because when people from other communities see the violence happening in my place they will think that all the people here are like that.
Discouraged ($n = 2$)	These situations causes problems in the community, it feels like being optimistic is hard in my community.
<i>Extroverted negative feelings</i>	
Angry ($n = 103$)	I feel so angry about violence in our community because you can't even go to the shop without getting hurt if your not careful. I feel unsafe in my community.
Scared, unsafe ($n = 97$)	I don't feel safe in my own home. I'm afraid for the children in the community who think things must be this way. You're supposed to feel safe in your own community.
Nervous, anxious ($n = 22$)	It is something that worries me especially because you never know when the police or ambulance will arrive.
<i>Disrupted</i>	
Destroying community ($n = 33$)	It's something that tears apart families and friends. It destroys our community.
Uncomfortable, disturbed ($n = 23$)	I find violence very disturbing I would like for it to stop as it is heartbreaking and unnecessary
Painful, sick ($n = 21$)	Very painful because the violence and accidents are destroying peoples' lives.
<i>Other feeling</i>	
Deep concern for others ($n = 153$)	I feel so bad when I see someone is stabbed and waiting for ambulance and keep bleeding, the people just watch and they don't know what to do.
Un-specific negative feeling ($n = 91$)	I feel terrible, especially when you stand there useless and watch how it happens.
Longing for better future ($n = 11$)	I feel that there is more that we can do to save the patient. We should be able to know the basics.
<i>Minimal feeling</i>	
De-sensitized ($n = 16$)	There is a lot of violence in my community so to me violence is an everyday thing. I don't get surprised by it. . .
Not impacted ($n = 9$)	I don't hear much of the violence.
Sense of empowerment (196 responses) and examples	
Want to or would take action ($n = 106$)	Manenberg is full of violence so it's up to us as the community to learn more about saving lives instead of destroying them.
Helpless (general) ($n = 51$)	Just heard about a violent incident last night. Leaves one feeling helpless.
Helpless (because they lack training) ($n = 41$)	I feel helpless, I don't have the knowledge or skills to respond to emergencies. PLEASE HELP!

Response to the EFAR training

The response to the course was very positive. After the course, 77.1% of trainees reported a lot of interest in receiving further medical training, 17.7% expressed a little interest, and only 5.2% expressed no interest. To put this into context, 79% of trainees reported having no prior medical training, 8% reported having prior first aid training, and 13% reported having only received prior medical training that wasn't first aid.

In the open ended survey questions, all respondents had an overall positive view of the course. Many trainees found the course empowering, inspirational, didactic, and fun. Nobody had an overall negative view of the course, but some trainees did report that the course was too short, or that they wanted more practicals.

When trainees were asked how we could improve the project, the most common answer was to train more first responders. Other suggestions included making more advanced

training available and to provide experience opportunities for those trained. When we asked who we should target in the community for training, the most popular response was "everyone", with the youth being the next most prevalent answer.

Discussion

It is clear that the violence, emergencies, and suboptimal emergency response in the Cape Flats have an active and ongoing negative impact on the psychology of the residents. Expressions by the community members were strongly negative. Most individuals feel charged to do something, but are unclear about what exactly to do, and many of those who feel helpless say it is because they don't know how to handle emergencies.

In addition, the community members' sentiments towards emergency personnel are not encouraging. Community members blame both the ambulances and police for arriving too

Table 2 Context of emergencies in the area, as described by community members. Responses were given all codes that applied.

<i>Medical emergencies/injuries seen most often (182 responses)</i>		
<i>Trauma</i>	<i>Medical</i>	<i>Other</i>
Motor vehicle accidents (<i>n</i> = 80)	Heart attack (<i>n</i> = 24)	Injured children, obstetrics (<i>n</i> = 11)
Stab wounds (<i>n</i> = 65)	Stroke (<i>n</i> = 15)	Unconsciousness (<i>n</i> = 5)
Gunshot wounds (<i>n</i> = 47)	Seizures (<i>n</i> = 7)	Choking (<i>n</i> = 4)
Fights, assaults (<i>n</i> = 39)	Alcohol poisoning (<i>n</i> = 4)	Rape (<i>n</i> = 3)
General trauma (<i>n</i> = 17)	Diabetes (<i>n</i> = 3)	Suicide (<i>n</i> = 1)
Gang violence (<i>n</i> = 14)	Shortness of breath, asthma (<i>n</i> = 3)	
Burns (<i>n</i> = 11)	Drug overdose (<i>n</i> = 2)	
Fractures (<i>n</i> = 5)	Poisoning (<i>n</i> = 1)	
Stone throwing (<i>n</i> = 5)		
Falls (<i>n</i> = 2)		
<i>Factors that stop an individual from helping (676 responses)</i>		
<i>Lack of ability</i>	<i>Fear of risks to self</i>	<i>Patient's outcome won't be affected</i>
Not knowing what to do (<i>n</i> = 178)	Nearby violence (<i>n</i> = 78)	Someone already helping (<i>n</i> = 21)
May harm patient more (<i>n</i> = 68)	Fear of HIV or TB (<i>n</i> = 55)	Patient is doomed anyway (<i>n</i> = 18)
Lack of equipment (<i>n</i> = 26)	Fear of blame if patient dies (<i>n</i> = 13)	<i>Help not allowed</i>
<i>Emotional restrictions</i>	Patient is a criminal (<i>n</i> = 9)	Police/others restrict access (<i>n</i> = 17)
Aversion to blood and gore (<i>n</i> = 88)	Patient could be malicious (<i>n</i> = 3)	Patient will not trust help (<i>n</i> = 4)
Panic (<i>n</i> = 39)	<i>Nothing</i>	
Lack of confidence (<i>n</i> = 8)	Nothing stops the helper (<i>n</i> = 120)	
<i>Suggestions for alleviating death and violence (661 responses)</i>		
<i>Improve emergency response</i>	<i>Improve security/enforcement</i>	<i>Economic development</i>
Train more people in emergency care (<i>n</i> = 189)	Better police presence/competence (<i>n</i> = 122)	Increase standard of living (<i>n</i> = 7)
Better emergency medical system (<i>n</i> = 44)	Address gangs & violent criminals (<i>n</i> = 46)	<i>Nothing</i>
<i>Cultural change</i>	Address drug/alcohol abuse (<i>n</i> = 31)	Nothing can be done (<i>n</i> = 6)
Increase community cohesiveness (<i>n</i> = 145)	Stricter legislation and enforcement (<i>n</i> = 26)	
Safety awareness campaigns (<i>n</i> = 100)	Eliminate weapons (<i>n</i> = 4)	
Change attitude/values of community (<i>n</i> = 42)	<i>Reduce idleness</i>	
Increase religious activities (<i>n</i> = 8)	Activities to keep the youth busy (<i>n</i> = 29)	
Emphasize personal responsibility (<i>n</i> = 7)	Jobs for the unemployed (<i>n</i> = 13)	

late on scene, but the ambulances are more infamous for arriving even later than the police. The slow response time of the ambulances is resented by the community, and though many residents are somewhat forgiving of the ambulances' inadequacies it seems that their patience is growing thin.

As for the police, it seems that the root of much resentment towards the police is due to a gap between what the police are trained to do and what the community believes they should do in an emergency. Individuals believe that police officers are not properly trained to deal with emergency patients in the absence of an ambulance, and that the police only know how to secure a perimeter around the patient and then search for criminals. If this is true, then police officers that do not go beyond their trained duty find themselves doing nothing while waiting for delayed ambulances to come or for the patient to die, and this could be what is giving the impression to community members that police officers do not care about patients' lives, are hostile, and care only about arresting someone. This is consistent with how reverent community members were of police officers that did provide first aid, transport, or any attention for patients.

Taken together, all of these sentiments suggest that the community members are deeply troubled by the prevalence of emergencies and that they lack general trust in the reliability of government services to take full control. Because of this, many of them believe that they must be prepared to do something for themselves—yet many feel helpless because they don't

know what they can do. It is not surprising then that emergency care training for community members was the most suggested way to alleviate death and violence in the community, or that those who reported a lack of ability to help had the lowest pre-training initiative and confidence ratings.

When we explored community emergency care training further, we found that the first responder EFAR training did improve the likeliness that a community member would try to help an emergency patient, as well as improve their confidence in their ability to help. In addition, the absolute improvements and odds of improving in initiative and confidence ratings were indeed the highest among those who reported a lack of ability as a barrier to help. We also found that the more a trainee learned in the course, the more likely they were to improve their likeliness to help during an emergency. This shows that psychological improvements are attributable to more than just a placebo effect, and that an actual gain of knowledge has an impact on a community member's sense of empowerment.

The course even has a psychological benefit for those who did not take the course voluntarily. Though those who were required to take the course had higher pre-training ratings, they were more likely to improve their initiative during moderate emergencies and their confidence than were voluntary trainees, and the greater odds that forced trainees would improve their initiative during severe emergencies was only slightly insignificant compared to voluntary trainees.

Table 3 Community members' perspective of emergency personnel. Responses were given all codes that applied.

<i>Perspective of ambulance performance (498 responses)</i>	
<i>Positive</i>	<i>Sympathetic</i>
Good (n = 145)	Trying their best with limited resources (n = 24)
Professional and skilled (n = 11)	Overwhelmed, understaffed (n = 16)
Prompt, available (n = 6)	<i>Other</i>
<i>Average</i>	Good only when they arrive on time (n = 20)
Mediocre (n = 145)	Don't know (n = 14)
<i>Negative</i>	Sometimes good, sometimes bad (n = 12)
Too slow, don't arrive at all (n = 213)	
Poor (n = 154)	
Unprofessional, lazy (n = 16)	
<i>Perspective of police performance (466 responses)</i>	
<i>Positive</i>	<i>Negative</i>
Helpful for patients (n = 104)	Not effective for patients (n = 171)
Call ambulances faster (n = 23)	Too slow, don't arrive at all (n = 68)
Help with crowd control and scene management (n = 17)	Don't care about dying patients, only care about criminals (n = 62)
Prompt, available (n = 15)	Need medical knowledge/equipment (n = 62)
Help by providing first aid or transport for patient (n = 14)	Detrimental for patients (n = 61)
They do care about the patients (n = 10)	Stand around and do nothing (n = 35)
Help by investigating the crime (n = 7)	Incompetent (n = 27)
Help with scene safety (n = 7)	Hostile, rude, trigger-happy (n = 25)
<i>Sympathetic</i>	Cause delays, waste time while patient is dying (n = 18)
Trying their best with limited resources (n = 12)	Presence adds stress (n = 18)
Overwhelmed, understaffed (n = 7)	Corrupt (n = 10)
<i>Other</i>	Restrict access to the patient while the patient dies (n = 3)
Sometimes good, sometimes bad (n = 29)	
Don't know (n = 15)	

Table 4 Average community member ratings (1 lowest – 10 highest) of their likeliness to help a patient during an emergency and their confidence while doing so, and the log(odds) of an individual's rating increasing after the course.

	Initiative during moderate emergencies			Initiative during severe emergencies			Confidence in ability to help		
	Before course mean	After course mean	Log(odds) of improvement	Before course mean	After course mean	Log(odds) of improvement	Before course mean	After course mean	Log(odds) of improvement
Total (n = 361)	7.23	9.07	1.3766	6.54	8.72	1.2637	6.23	8.78	1.3444
<i>Voluntary or not</i>									
Voluntary (n = 198) (ref)	6.62	8.94	1.0275	5.86	8.64	1.0313	5.60	8.62	1.0986
Forced (n = 163)	*7.72	9.17	*1.8191	*7.10	8.79	1.5667	*6.76	8.92	*1.6740
<i>Survey anonymity</i>									
Anonymous (n = 318) (ref)	7.18	9.02	1.3328	6.53	8.69	1.2307	6.26	8.75	1.3601
Not-Anonymous (n = 43)	7.58	9.42	1.6580	6.62	8.93	1.4271	6.05	9.03	1.1350
<i>Exam score improvement +1% (ref)</i>			*+0.0726			*+0.0296			+0.00267
<i>Reported barrier to helping</i>									
Nothing can stop (n = 56) (ref)	8.21	9.00	0.4924	6.75	8.71	1.0116	6.89	8.71	1.0703
Emotional restrictions (n = 49)	7.49	9.06	1.3545	7.08	8.67	0.9932	6.69	8.80	1.0033
Fear of risks to self (n = 68)	*7.28	8.87	1.1221	6.79	8.41	0.7732	6.68	8.18	0.9045
Lack of ability (n = 150)	*6.57	9.21	*2.8716	6.16	8.76	*1.6864	*5.03	8.67	*2.1517

* Statistically significant from ref in category. For exam score improvement, the logistical regression analysis reveals the increase in the log(odds) of improvement for every 1% increase in exam score improvement between the pre and post exams.

These improvements in initiative and confidence ratings among the trainees are confirmed by their written reviews of the course. Response to the EFAR training was highly positive, with no overall negative impressions of the course. Trainees found it empowering and enlightening, and many said they wanted to learn more. Many trainees also believed that the course should be a must for everyone in the community. In the face of extreme anxiety over the state of emergencies in the community, such sentiments would only be expressed

by community members whose psychologies were positively impacted by the course.

Limitations

The opinions expressed by the community members do not necessarily reflect what is actually happening with emergencies in the community, only how the community members who took part in this study feel about them. In addition, any of

the sentiments expressed by the community members in the open-ended responses may have been under-expressed. Community members may have held back their true feelings but we have no way of quantifying this effect.

Conclusion

Violence and other emergencies in the Cape Flats are having a profoundly negative impact on the psychology of the community members. The community has a generally poor opinion of emergency personnel: ambulances are perceived as slow, and the police are perceived as untrained and uncaring. From the possible interventions suggested by residents, emergency care training for the community was the most prevalent, and a lack of ability is the most prevalent and deep barrier to helping during an emergency.

EFAR training, a type of emergency care training, improves community members' confidence and likelihood to help during emergencies, especially if they actually learn more. The benefit can even be seen in those that did not take the course voluntarily. In addition, community members responded well to the course, and they described it as empowering, inspirational, and making them want to learn more.

Competing interests

The authors report no competing interests.

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Amidst the exponentially increasing emergency rates happening across the developing world, and research on solutions to the growing problem, the previous article was the first to document how community members in such affected areas felt about the problem that they had to live with. The story that the community members revealed was grim, and though we expected negative feelings towards high emergency rates and lack of emergency care in the community, the responses we received were stronger than predicted.

“Innocent people are getting hurt and killed everyday.” “I feel that there is no end.” “I don’t feel safe in my own home.” “It destroys our community.” “PLEASE HELP!” The responses we received were cries of desperation; they painted images of suffering amongst the community members. It was very clear to us that violence, accidents, and emergencies were a routine occurrence in the community. During our time in Manenberg, we would even see fatal car accidents on a regular basis, and on occasion we would arrive in the community only for the community members to tell us to turn around and go home because the gangs were fighting again (innocent people often get hurt in the crossfire).

The responses we received were a call to action for us to continue our work. The community members had also expressed to us that, in addition to the prevalent emergencies they experienced every day, the current emergency response was severely inadequate. For the sake of the people we were working with in the community, we wanted to develop and implement a model that truly worked for them.

However, the responses from the community members were not completely discouraging. Scattered amongst the responses, the community members were revealing a solution to us: “I feel so bad when I see someone is stabbed and waiting for ambulance and keep bleeding, the people just watch and they don’t know what to do.” “I feel helpless, I don’t have the knowledge or skills to respond to emergencies.” “I feel that there is more that we can do to save the patient.” “It’s up to us as the community to learn more about saving lives instead of destroying them.” Over two-thirds of the responses we received indicated that the community members wanted to be able to do something about the emergencies themselves, or that they felt helpless because they were unable to aid a patient during an emergency. The most common

response when we asked them what we should be doing to address the emergencies in their area was to educate community members how they could deal with the emergencies themselves; the biggest reported barrier to them helping a patient was that they didn't know what to do. With the scale of the problem in their community, and a lack of trust in the centralized ambulance system's ability to fully take care of them, the community members were revealing to us that they wanted to be able to respond to emergencies themselves.

The community members' response to our emergency first aid training only further confirmed this notion. The feedback for our training was very positive—the most prevalent response to when we asked who we should be training was “everyone”. We also saw that after we trained community members they felt more willing to help during an emergency and more confident about their abilities to help patients. More than ever, integrating community members into the greater emergency care system seemed like a promising idea.

With this encouragement that we were on the right track, we wanted to further understand the implications of the emergency first aid responder system model we were creating. A psychological benefit was not enough, we wanted to establish a model that helped save lives and reduce permanent injury for developing areas. However, in order to complete our work we needed to prove whether or not using a developing area's community members to give proper care during emergencies was even plausible. This became the subject of our next paper.

CHAPTER 4: LEARNING AND RETENTION OF EMERGENCY FIRST AID SKILLS IN A VIOLENT, DEVELOPING SOUTH AFRICAN TOWNSHIP.

Declaration by candidate

In the case of Chapter 4, the nature and extent of my contribution to the work was the following:

Nature of contribution	Extent of contribution (%)
The candidate was the primary author and responsible for the literature review, study and methodology design, data collection, and analysis. The candidate also wrote all drafts of the manuscript while incorporating input from the co-authors. The candidate accepts overall responsibility for the publication.	80%

The following co-authors contributed to the work. Co-authors who are students at the University of Cape Town must also indicate the extent of their contribution in percentage terms:

Name	Nature of contribution	Extent of contribution (%) for student co-authors only
Lee Wallis	Co-developed the study design and analysis. Contributed to the final article.	

Candidate's Signature

Signed by candidate

Declaration by co-authors

The undersigned hereby certify that:

- (1) the above declaration correctly reflects the nature and extent of the candidate's contribution to this work, and the nature of the contribution of each of the co-authors.
- (2) they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;
- (3) they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
- (4) there are no other author of the publication according these criteria;
- (5) potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and
- (6) the original data are stored at the following location(s) and will be held for at least five years from date indicated below:

Location(s):Date

University of Cape Town Division of Emergency Medicine : August 2012

[Please note that the location(s) must be institutional in nature, and should be indicated here as a department or division.]

Lee Wallis	u
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As it became more apparent that lay-person community members were going to be included in the pre-hospital emergency care system model we were developing, questions began to arise about its feasibility. For one, other healthcare providers we were working with raised concerns about community members' ability to effectively be trained. These individuals reasoned to us that life support was a highly complex subject, and that in a developing area community members typically have limited education and sometimes none at all. Therefore, finding qualified individuals to be trained would be exceedingly difficult. Additionally, as the rate of emergencies that a single community responder would face could be low, the lack of practice could mean that even if community members were trained they could easily forget over time all they had previously learned.

If such reasoning were true, the concept of community based EFARs would be heavily challenged. In order for EFARs to have an impact on their communities, the community members had to meet the following pre-requisites:

- 1) They had to be able to learn life support skills,
- 2) They had to be able to retain the skills they learned, and
- 3) They had to be able to use those skills correctly when providing care for other community members.

If any of these three pre-requisites were missing, then EFARs would not be able to provide a healthcare benefit for their communities, and any benefit that the entire EFAR system had on a community would not have been the result of community responder activity, thus making EFARs redundant.

In the first paper, we showed that the third pre-requisite was being met. According to our analysis and from the EFAR patient care reports we reviewed, when EFARs responded to an emergency they executed the proper skills as we had trained them to do. Thus, the community members were capable of using life support skills correctly when providing care for other community members. However, this was not enough; it was possible that the EFARs were only utilizing the skills that they happened to remember, and that many emergencies were not responded to because the available EFARs were unable to learn or retain the necessary skills to

respond to those particular emergencies. Therefore, before we could consider the EFAR system to be having a positive healthcare impact on a community, we had to confirm that community members were able to properly learn and retain their training.

The following paper was our investigation into the ability of community members in a developing area to learn and retain emergency life support training. We were not only investigating whether self-selected EFARs (who may be more motivated and confident in their abilities) could learn and retain the training, but also of community members in an under-resourced area in general. In addition to this, we analysed the process in which the community members learned the training, and what demographic and educational factors correlated with successful or failed learning and retention. With such information, not only could we confirm that the community members were meeting all the pre-requisites for EFARs to impact their community, but also begin to understand the way in which community members learned and remembered life-support training so that we could improve upon it and help others considering similar training.

University of Cape Town

Learning and retention of emergency first aid skills in a violent, developing South African township

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ABSTRACT

Community members in developing areas can effectively learn first responder training, and skill decay afterwards is not continuous. It is critical that training be done in the trainees' primary language, even if they speak other languages fluently. Making first responder training obligatory for employees and students may be an effective way to generate first responders.

INTRODUCTION

In an effort to address emergency needs in developing countries, several studies have suggested the use of community members as first responders.¹⁻⁹ However, even though one of the most critical prerequisites for first responders to reduce morbidity and mortality is that they have to learn and retain the skills long after certification, very little is known about how lay-persons in low-resource, developing areas learn and retain first responder training.

METHODS

In 2010, a single instructor taught the Emergency First Aid Responder (EFAR) training course to 628 community members from crime-violent, low-resource townships in Cape Town, South Africa. The course curriculum and format is elaborately described elsewhere.¹⁰ The course was taught in English. Some trainees were recruited by voluntary sign-up, and others were required to attend the training by their employers or school principals.

Trainees completed a skill examination both before and after each training session, and those scoring at least 75% on the post-course examination qualified for EFAR certification; they were re-tested 4 and 6 months later. Examination scores were correlated using SASV.9.1 with a 95% CI using univariate and multivariate regressions, which controlled for voluntary status, reported first

language, education level and prior medical training. Ethics approval was granted by the Stanford University and University of Cape Town ethics committees.

RESULTS

The EFAR training course significantly improved all trainees' basic life support skills (see table 1). After training, enough EFARs were followed-up to represent all certified EFARs with a confidence level of over 90%, and they had statistically similar pre- and post-training test scores and demographics compared with those we could not follow-up. Certified EFARs tested experienced significant skill decay by 4 months, but experienced no decay thereafter (see figure 1 and table 2).

In addition, trainees who were required to attend the course by an authority experienced no negative effect on pass rates or scores. By contrast, though all trainees spoke English fluently as a common language, those who did not report English as a first language had much lower pass rates and scores, and were the only population where certified EFARs continued to have skill decay between 4 and 6 months post-certification ($p=0.0018$).

DISCUSSION

It is evident that community members in a developing area are able to adequately learn and retain a first responder training course. In addition, the clearest trend in our study was that the decay of basic life support skills after training was not continuous. We recommend further research to confirm this trend for periods longer than 6 months.

Our data also show that it is critical for first responder training to be done in a trainee's primary language, even if they speak another language fluently. Finally, because trainees who were required to take the course scored just as well if not

Table 1 Learning scores of all trainees

	n	Pass rate	Before training			After training		
			Mean score	Univariate analysis p Value	Multivariate analysis p Value	Mean score	Univariate analysis p Value	Multivariate analysis p Value
Total	628	67.4%	28.3%			77.8%		
Voluntary status								
Voluntary	321	67.0%	27.8%	ref		77.0%	ref	
Required	307	67.8%	28.8%	0.3830	0.9899	78.7%	0.2863	0.6374
First language								
English	172	86.1%	33.5%	ref		88.2%	ref	
Not English	117	44.0%	29.7%	0.0355*	0.2203	75.8%	<0.0001*	<0.0001*

*Statistically significant from ref (reference).

This study confirmed that community members in a low-resourced area were able to learn and properly retain emergency life support training. In particular, by testing the learning and retention of entire groups of individuals who were required to be trained by their superiors, we were able to confirm that the community members in general had learned and retained the training just as much as those individuals who were self-selected or hand-picked. Though this could not show that those who were required to be trained were just as likely to provide care in the future as those who chose to be trained, it showed that community members in general had the ability to be involved in assisting patients and to become emergency responders.

This study was also the first study to track the skill retention of a developing area's community members at different points in time. By doing so, we were able to observe that skill decay amongst responders was not continuous, and appeared to level off after a certain point. Though this part of the study could have benefitted from follow-up of more certified EFARs, we were still able to follow up on enough EFARs to make a conclusion. With the original 423 EFARs averaging a skill assessment score of 89.2% immediately after training we were able to follow up with 169 EFARs who averaged 71.3% four months later, indicating a 95% confidence interval of the average four month later score being between 69.7% and 72.8% for the original 423 EFARs. Six months after the course we were able to follow up with 169 EFARs who averaged a score of 71.1% six months after the course, indicating a 95% confidence interval of the average six month post-course score for the original 423 EFARs to be between 69.0% and 73.1%. After comparing the average scores between the three points in time, it appeared that the EFARs did have a statistically significant amount of skill decay between the course and four months later, but that there was no statistically significant drop measurable by six months. This provided further support that community members in under-resourced areas could be effectively used as emergency responders; the care they could provide would not be a completely depleting resource, and thus community members could be involved as emergency responders for an extended period of time even without refresher courses or follow up training.

However, the community members' ability to learn and retain the training came with a caveat. The course was taught in English, and the community members who did not consider English as their first language were less able to learn and retain the training. This may have

seemed rather intuitive, but when we considered our study population's context this finding had large implications. In Cape Town, even in the severely impoverished areas, almost everyone fluently speaks English as a common language; it was just a matter of whether or not an individual considered it his or her first language. Having English as a secondary language was enough to have an effect on how the individual learned and retained. Such community members had similar pre-training scores as those who considered English a primary language but then had lower post-training scores, indicating that they were not learning as much. They also consistently had lower retention scores, and were the only population that actually continued to have skill decay during the study period. In the future, it will not be uncommon for those establishing community responders in a developing area to not speak the native language of the area. Even in Cape Town, different townships have their own special dialect different from others. With this complication, we saw even more basis for the involvement of a community based organization to run the EFAR system on our behalf in a community—using community members to communicate with their own people for us would have led to more effective EFARs.

With our model continuing to develop, determination to create a system that was approved by the community members, and confidence in the EFARs learning, retaining, and using their emergency skills, we knew that the EFAR system model was functioning and looked promising. However, we also understood that just because an EFAR system was operational did not mean that it was having an effect. In order to truly validate the EFAR system's worth, we had to investigate its effects on the community's morbidity and mortality. As we performed this research, we realized that such a task had hardly ever been done before, and there were heavy complications. No quantitative methodology was readily available for developing areas to measure the efficacy of emergency care interventions, including the EFAR system. For the sake of researching the EFAR system further, and for emergency care research throughout the developing world, it became important to find this missing methodology. This became the subject of our next paper.

**CHAPTER 5: THE NEED FOR A USABLE ASSESSMENT TOOL TO
ANALYSE THE EFFICACY OF EMERGENCY CARE SYSTEMS IN
DEVELOPING COUNTRIES: PROPOSAL TO USE THE TEWS
METHODOLOGY.**

Declaration by candidate

In the case of Chapter 5, the nature and extent of my contribution to the work was the following:

Nature of contribution	Extent of contribution (%)
The candidate was the primary author and responsible for the literature review, study design, and analysis. The candidate also wrote all drafts of the manuscript while incorporating input from the co-authors. The candidate accepts overall responsibility for the publication.	70%

The following co-authors contributed to the work. Co-authors who are students at the University of Cape Town must also indicate the extent of their contribution in percentage terms:

Name	Nature of contribution	Extent of contribution (%) for student co-authors only
Michele Twomey	Co-developed the analysis. Contributed to the final article.	10%
Jeffrey Tran	Helped come up with the original concept. Contributed to the final article.	20%
Lee Wallis	Co-developed the analysis. Contributed to the final article.	

Candidate's Signature

<div style="border: 1px solid black; padding: 5px; display: inline-block;">Signed by candidate</div>
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Declaration by co-authors

The undersigned hereby certify that:

- (1) the above declaration correctly reflects the nature and extent of the candidate's contribution to this work, and the nature of the contribution of each of the co-authors.
- (2) they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;
- (3) they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
- (4) there are no other author of the publication according these criteria;
- (5) potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and
- (6) the original data are stored at the following location(s) and will be held for at least five years from date indicated below:

Location(s):Date

University of Cape Town Division of Emergency Medicine : August 2012

[Please note that the location(s) must be institutional in nature, and should be indicated here as a department or division.]

Michele Twomey	<div style="border: 1px solid black; padding: 5px; display: inline-block;">Signed by candidate</div>
Jeffrey Tran	<div style="border: 1px solid black; padding: 5px; display: inline-block;">Signed by candidate</div>
Lee Wallis	u

By the end of 2010, we had designed and implemented the Manenberg EFAR system, and had seen that the system was functioning. That is, after setting up the system's management and communication lines, community members were coordinated with the rest of the emergency care system and delivering care to pre-hospital emergency patients as we intended them to. However, though all of these observations triangulated a conclusion that the Manenberg EFAR system was having a positive effect, the ultimate test would be to see whether or not the system was having an effect on morbidity and mortality.

To begin this research, we reviewed the literature and sought out the advice of other academics on how we could measure the effects of the EFAR system. From the outset, colleagues referred us to the Trauma Injury Severity Score (TRISS) method, where patients' chance of survival was calculated based on their injury, age, and vital signs, and the calculated probabilities were then compared to the proportion of patients that actually did survive after emergency care.⁶⁵ We were already familiar with this method as it was the gold standard for measuring emergency care efficacy in the United States and United Kingdom.

We initially tried to use TRISS to assess the EFAR system. However, we found massive amounts of data missing from local hospital emergency notes. The medical staff were not filling out the patient records completely, too many variables needed for the TRISS method were omitted, and often patients' records were missing completely. In addition, the process of assigning the codes and doing the calculations for the TRISS method were quite complex, and even amongst the doctors the number of individuals we could find who could potentially do this bench-work was extremely small. All this put together, within our low-resource context the TRISS method was near impossible, and with the Manenberg hospital already being severely overwhelmed and under-resourced, the hospital simply did not have the resources to pursue the TRISS method.

With the failure of the TRISS method, we then attempted to look for alternative ways. We found other measurements similar to the TRISS method, such as the Injury Severity Score and the Abbreviated Injury Scale,^{68,69} but they were not as widely accepted as the TRISS method and also relied on a high number of complex variables and so would likely be unsuccessful for the same

reasons the TRISS method failed. We then considered secondary parameters, such as pre-hospital times. However, we realised that data collection for those were too difficult because of our area's weak data-keeping infrastructure. We needed a measurement that directly measured morbidity and mortality. We then started looking directly at previous studies that measured emergency care efficacy in developing countries, to see how those researchers overcame similar problems. We found that previous research only used secondary measurements to triangulate an intervention's success,^{16, 31, 53, 54, 57, 62, 70} as we had already. Apparently, there was no existing methodology to do what we wanted.

We were attempting to perform our research in Cape Town, South Africa, a relatively developed area compared to the rest of the developing world. If we were unable to quantitatively and directly measure emergency care efficacy in our location, then it was probably not happening either anywhere else in the developing world. There was a huge gap in the research, and meant that emergency care in under-resourced countries was more dependent on either secondary parameters, subjective research, or research performed in high-income nations where the conditions and resources were drastically different. It was clear to us that a new methodology to measure emergency care efficacy and emergency interventions' effects on morbidity and mortality was needed, one that could be done within a developing area's infrastructure. We made the development of a potential methodology our next goal.

The following paper is the result of that endeavour. It proposes a methodology to measure emergency care effectiveness in developing countries by using the Triage Early Warning Score (TEWS), a triage score designed for use in developing countries.⁷¹⁻⁷³ As of now, there is no accepted, usable method to directly and quantitatively measure emergency efficacy in under-resourced areas. We intended this study to be the first steps in establishing that method so that hopefully in the future researchers can observe the direct effects of emergency care in the developing world, including the EFAR system.

The need for a usable assessment tool to analyse the efficacy of emergency care systems in developing countries: proposal to use the TEWS methodology

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ABSTRACT

Background Ninety percent of emergency incidents occur in developing countries, and this is only expected to get worse as these nations develop. As a result, governments in developing countries are establishing emergency care systems. However, there is currently no widely-usable, objective method to monitor or research the rapid growth of emergency care in the developing world.

Methods Analysis of current quantitative methods to assess emergency care in developing countries, and the proposal of a more appropriate method.

Results Currently accepted methods to quantitatively assess the efficacy of emergency care systems cannot be performed in most developing countries due to weak record-keeping infrastructure and the inappropriateness of applying Western derived coefficients to developing country conditions. As a result, although emergency care in the developing world is rapidly growing, researchers and clinicians are unable to objectively measure its progress or determine which policies work best in their respective countries. We propose the TEWS methodology, a simple analytical tool that can be handled by low-resource, developing countries.

Conclusions By relying on the most basic universal parameters, simplest calculations and straightforward protocol, the TEWS methodology allows for widespread analysis of emergency care in the developing world. This could become essential in the establishment and growth of new emergency care systems worldwide.

INTRODUCTION

As much as 90% of all traumatic deaths worldwide occur in developing countries, with the majority of these fatalities occurring in the prehospital setting.¹ As these low-income nations further develop, their consequential urbanisation and industrialisation are expected to lead to even higher rates of violence, accidents and medical emergencies such as cardiac arrest.²⁻³ In response, governments in developing countries have attempted to establish emergency care systems or implement prehospital interventions.³⁻⁵ However, although these projects are often well intentioned and sustainable, to date there is no feasible method for most developing countries to quantitatively measure the effectiveness of emergency care systems. Consequently, although emergency care in the developing world is rapidly growing, little attention has been paid to assess emergency care systems in these areas.⁶

LIMITATIONS OF CURRENT MEASURES

In high-income nations, the accepted and most commonly used tool for analysing emergency care

systems is the Trauma Injury Severity Score (TRISS).⁷ TRISS is a validated score that can be retrospectively used to measure the effectiveness of trauma care.⁸⁻⁹ It calculates a patient's probability of survival through the equation: $P_s = 1 / (1 + e^{-b})$, where P_s is the probability of survival and $b = b_0 + b_1(RTS) + b_2(ISS) + b_3(A)$.⁸ RTS, the Revised Trauma Score, is calculated by the summation of fixed codes, based on physiological parameters, multiplied by previously published weight coefficients. ISS, the Injury Severity Score, is calculated by assigning injuries an Abbreviated Injury Scale code of 1–6, depending on the type and location of the injuries, and summing the squares of the highest codes of the three highest scoring anatomical regions.⁸ 'A' represents the patient's age code (0 if ≤ 54 years, and 1 if > 54), and b_0 , b_1 , b_2 and b_3 are prepublished coefficients based on regression analysis of thousands of patients from high-income nations, with a different set of coefficients for blunt and piercing injuries.⁸ Based on a population's calculated probabilities of survival, researchers can compare an emergency care system's expected outcomes with its actual outcomes to see if the system or an intervention is increasing or decreasing the patients' chances of survival and by how much.

However, although TRISS and its components are popular ways of measuring the success of emergency care in high-income nations, they present limitations that prevent developing countries from implementing their use.¹⁰⁻¹¹ TRISS and the scores it is based on involve complex algorithms that rely on a plethora of variables and codes, many of which require extensive training to assign.¹² For hospitals and healthcare systems in developing countries, many of these codes and variables are extremely difficult to reliably collect, due to the typically poor record-keeping infrastructure of developing countries.⁶⁻¹³⁻¹⁴ In such areas, healthcare workers often have limited training and supervision in data collection and management, which leads to frequently incomplete records and makes the implementation of complex measurements that rely on a high number of variables difficult.¹⁴ Even if healthcare workers consistently collected the necessary variables, healthcare facilities often lack the technology or administrative support to organise a high volume of patient records in a way that all records are traceable and can quickly be collected⁶⁻¹³; this greatly multiplies any extra time and effort required to do such research. Furthermore, healthcare facilities in developing countries are typically overwhelmed,⁶ making the chances for

healthcare workers to take the time to record and calculate complex measurements more unlikely. In addition, since the calculation of TRISS and its components involve assessments from various personnel, such complicated measurements require good cooperation and accuracy of multiple medical parties,¹⁵ which developing healthcare systems often lack.

Even if developing countries had the infrastructure to collect the data required for such scores, their implementation would still be inappropriate. TRISS and the scores it is based on rely on coefficients based on logistic regressions performed on populations from high-income nations. Between high-income nations, population demographics and emergency care may be similar enough to allow the use of such methodology. However, populations and emergency care can be dramatically different in developing countries, rendering the coefficients invalid.^{10 11} Additionally, determining a separate set of coefficients for developing countries would be moot, as such countries do not have the resources to perform such endeavours.¹³

HOW THESE LIMITATIONS CAN BE OVERCOME

Because most developing countries are unable to determine the effectiveness of emergency care systems within their own domains, it is common for clinicians and health officials from these areas to adopt the policies of high-income nations without testing them at home.¹⁶ Many health workers assume that if a high-income nation uses a certain strategy then it must be sufficient. This approach can be counterproductive, as Western models are often too expensive for developing countries to handle and may be ineffective in the conditions that exist in the developing world.¹⁶ To curb this, a methodology to assess the efficacy of emergency care interventions in developing countries must be established so that developing countries can determine what works best in their own respective areas and quickly improve their emergency care systems in response.

To develop an effective emergency care assessment for developing countries, the measurement must be, first and foremost, usable in a low-resource setting with severely limited infrastructure. This means that the assessment can only rely on variables that clinicians can reasonably collect in a developing country. In addition, such an assessment must employ only the most basic calculations and protocol. Since medical record keeping, research and coordination in developing countries can be limited,^{6 13 14} these low-resource areas cannot handle overly complex calculations or procedures. In effect, an emergency care assessment for developing countries will require complexity,

coordination, resource-use and effort to be kept to an absolute minimum. This is especially critical because if these criteria are not met, clinicians and health officials in the developing world will have no other choice but to resort to the convenience of adopting high-income nations' strategies that have not been verified for the developing countries.

A second necessity for an emergency care assessment in developing countries is that it must be applicable to a variety of developing contexts. As it is already difficult for one low-resource nation to develop a proper assessment, expecting each developing country to develop its own personalised assessment is implausible. Therefore, an effective measurement must rely on objective parameters universal to any location, rather than depend on population-specific coefficients or other variables that can change between the diverse settings of developing countries.

TEWS: A SUITABLE SYSTEM MEASURE?

The Triage Early Warning Score (TEWS) is a validated composite triage score and is a component of the larger South African Triage Scale (SATS).¹⁷⁻¹⁹ It is based on the Modified Early Warning Score (MEWS), a validated score that triages acutely ill emergency patients.²⁰ The MEWS was adapted to include mobility, trauma and AVPU components. AVPU reliably assesses the central nervous system as to whether a patient is alert ('A'), only responding to voice ('V'), only responding to pain ('P'), unresponsive ('U') or confused. The adapted MEWS was then validated against the need for hospital admission of the South African population with its unique burden of disease and renamed the TEWS.^{12 17-19}

To calculate TEWS for an individual emergency case, each vital sign is assigned a subscore from 0 to 3 according to established parameters (see figure 1). Afterwards, the subscores are added together to yield a total score; a higher total score indicates more physiological derangement and is used as a proxy for more severe illness or injury. The TEWS is very user friendly,¹² can be taught quickly to inexperienced staff¹⁹ and uses simple clinical parameters, making it useful at all levels of emergency service delivery in a developing setting.²¹ Unlike TRISS, TEWS can be much more readily handled in developing countries and is therefore a potential candidate to assist such countries in measuring the success of an emergency care system or intervention.

Although TEWS was originally designed as a triage score, we propose using it as part of a TEWS methodology to assess emergency care in developing countries. In the TEWS

Figure 1 The Triage Early Warning Score. RR, respiratory rate; HR, heart rate; SBP, systolic blood pressure; AVPU = alert, voice, pain, unresponsive. Reprinted with permission. Infant and paediatric versions of the scorecard, along with any updated versions (if developed), can be found at <http://emssa.org.za/sats>.

ADULT TRIAGE SCORE								© South African Triage Group 2008
	3	2	1	0	1	2	3	
Mobility				Walking	With Help	Stretcher/Immobile		Mobility
RR		less than 9		9-14	15-20	21-29	more than 29	RR
HR		less than 41	41-50	51-100	101-110	111-129	more than 129	HR
SBP	less than 71	71-80	81-100	101-199		more than 199		SBP
Temp		Cold OR Under 35		35-38.4		Hot OR Over 38.4		Temp
AVPU		Confused		Alert	Reacts to Voice	Reacts to Pain	Unresponsive	AVPU
Trauma				No	Yes			Trauma
over 12 years / taller than 150cm								

methodology system that we propose, assessing both emergency centre (EC) and prehospital care (PHC) effectiveness focuses on the use of the TEWS taken upon the patient's arrival to the EC, henceforth referred to as intake-TEWS.

USING TEWS TO ASSESS EC EFFECTIVENESS

To assess the effectiveness of an EC, the outcomes of patients (discharged, admitted to ward, deceased) are compared with a parameter of intake-TEWS. For example, the outcome statistics of all patients with an intake-TEWS of 6–7 can be compared with the outcome statistics of patients with the same intake-TEWS at a different EC, or at the same EC but at different points in time (see table 1 for an illustration).

If one EC's outcome statistics for a TEWS parameter is better (eg, higher proportion of patients are discharged and a lower proportion dies), then that EC is more effective. If the outcome statistics for a single EC gets better over time, then the EC is becoming more effective.

USING TEWS TO ASSESS PHC EFFECTIVENESS

To use TEWS to assess the impact of a PHC system or intervention, the intake-TEWS of all patients affected by a system or intervention are averaged and plotted over time. If a PHC system or intervention has a positive effect on a population, the affected patients will be physiologically more stable upon arrival at the hospital, which results in a lower average intake-TEWS. To eliminate confounding factors that could also reduce TEWS, the average TEWS over time for the target population can be compared with a control population (see figure 2 for an illustration).

In addition to the average intake-TEWS, information on prehospital mortality or the outcome statistics (eg, expedited alive to EC, deceased en route) based on a parameter of TEWS at the time of injury (much like the assessment procedure for EC effectiveness) can further justify or validate findings. However, many developing areas in need of the TEWS methodology will not have reliable access to such data.

TEWS SHOULD DECREASE WITH MORE EFFECTIVE PHC

Although the general consensus in the emergency medical community is that effective care stabilises vital signs, or at least alleviates their deterioration, some studies still argue whether PHC has a significant effect on patient physiology.²² However, almost all of these studies were done in high-income nations that can be drastically different from developing ones. In developing countries, which are typically more rural and have much longer prehospital transportation times, the effect of PHC can be significantly different.²³

Previous studies have confirmed that PHC can stabilise patients' vital signs in developing countries. After implementing PHC systems in northern Iraq and Cambodia, two research teams tracked their personnel's effects on patient physiology

using the vital signs based Physiologic Severity Score (PSS).²⁴ Both teams found that as the PHC systems matured and improved, as indicated by reduced prehospital mortality, quicker transportation times and anecdotal evidence, the average improvement from the initial on-scene PSS to the intake-PSS at the hospital became greater, indicating that more effective PHC in developing areas correlates with an increasingly positive effect on vital signs.^{4 5}

This evidence suggests that improvements in PHC will correlate with a reduction in average intake-TEWS, as both TEWS and PSS rely on vital signs.^{19 24} However, confirmation of this result is still needed.

BENEFITS OF THE TEWS METHODOLOGY

The TEWS methodology is a very simple protocol that can be performed using very basic data that are not region specific and can be reasonably collected in a developing country. This allows researchers to easily measure the efficacy of PHC, an EC or emergency system intervention in any developing country. Additionally, the TEWS methodology requires minimal calculation and resources to perform, and generates more mileage out of a single intake-TEWS data set that can be collected in one project. This allows healthcare workers from developing countries to monitor their own emergency care systems, as it requires minimal training and does not require excessive resources or attention, and helps them to keep track of multiple components of the emergency care system simultaneously using just one set of intake-TEWS data.

There is also the benefit in the TEWS being a part of the larger SATS. As SATS is a validated triage scale designed for usability in developing countries,¹⁹ its adoption by developing hospitals and emergency care systems is convenient and may be rapid in the future. SATS is already being implemented in South Africa,¹² Médecins Sans Frontières—Operational Centre Brussels (Sebastian Spencer 2011), Botswana, Malawi, Brazil, Poland and New Zealand, and is in the planning stages for implementation in Sudan, Ghana, Rwanda, Tanzania, Saudi Arabia and for an adapted version with TEWS in Sweden (South African Triage Group 2011). Any region that adopts SATS will already be collecting and calculating the data for the TEWS methodology.

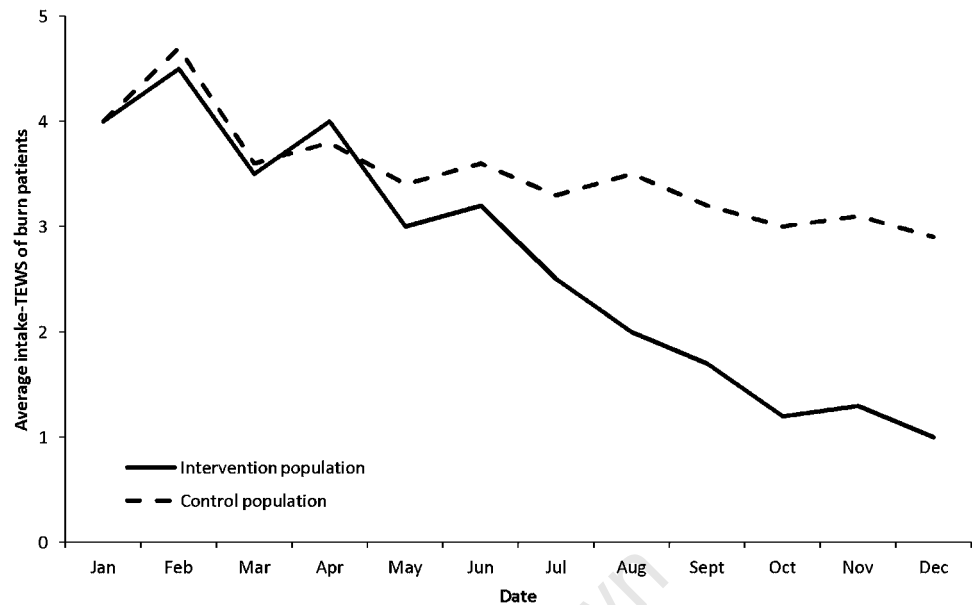
Additionally, the TEWS methodology can be versatile for locations that have not adopted SATS and do not have the infrastructure to collect all of the basic vital signs expected for TEWS. Under these circumstances, researchers and local health workers can still monitor their emergency care systems using a modified TEWS that is the composite of TEWS subscores based on the vital signs that are available. However, this alternative is not optimal, as the ability of the TEWS to predict the severity of an emergency is greater with the inclusion of more vital signs,¹⁷ and because ECs, PHC systems and interventions that are monitored using a modified TEWS can only be compared with other ECs, PHC systems and interventions that

Table 1 Illustrative outcome statistics for patients with blunt injuries at XYZ Emergency Centre

TEWS parameter	2008			2010		
	Discharged	Admitted	Deceased	Discharged	Admitted	Deceased
0–2	90%	8%	2%	90%	9%	1%
3–5	55%	20%	25%	75%	20%	5%
6–7	40%	30%	30%	60%	25%	15%
>7	20%	35%	45%	25%	55%	20%

In this example, XYZ Emergency Centre became more effective at treating patients for blunt injuries between 2008 and 2010.

Figure 2 Illustrative average intake-TEWS between two populations. In this example, the PHC system or intervention has a positive effect on burn patients from the intervention population, compared with those of the control population without the PHC system or intervention. PHC, prehospital care; TEWS, Triage Early Warning Score.



are monitored using the same modified TEWS. Though, it is understandable that these alternative methods may be the only option in certain developing areas.

Finally, although the TEWS methodology is purposefully simple, simplicity does not imply invalidity. The TEWS methodology is simple and non-cumbersome out of necessity, and even complex measurement scores and calculations can have their complications.²⁵

There is a clear research gap in emergency care for developing areas; we propose the TEWS methodology as a potential solution. By building a methodology around TEWS, we sought to find a simple, non-cumbersome measurement that a single hospital's EC in a developing country can easily use to objectively analyse the effectiveness of an emergency care system or intervention. This factor could become essential in the development of new emergency care systems worldwide.

LIMITATIONS OF THE TEWS METHODOLOGY

As with any analytical method, even ones used in high-income nations, the TEWS methodology has some limitations. The TEWS methodology does not take into account patients who never reach the hospital. This is because many developing areas will not have access to this information, but if it is available then such data can be presented along with the results from the TEWS methodology.

Also, the TEWS methodology shows promise and evidence of reliability, but has yet to be fully validated. Obstacles to complete validation involve the lack of robust data in areas where this would be implemented.¹³ However, if these obstacles can be overcome, one way to validate the TEWS methodology for assessing PHC would be to verify that more effective PHC in developing areas does have a more positive effect on TEWS scores. This would involve the observation of patients' TEWS decreasing (or not increasing as much) after being treated by PHC providers, such as first responders or paramedics. Also, fluctuations in average TEWS improvements over time can be compared with concurrent fluctuations in other measurements of PHC, such as transport times and mortality rates. As these effects have already been shown for the similar PSS,^{4,5} finding them for TEWS is more likely. As for assessing EC efficacy,

validation is not needed since TEWS is used in the methodology as an input variable that categorises patients according to emergency severity, and TEWS has already been validated as a triage score.^{17–19}

Finally, as an example we have only included the adult version of TEWS (figure 1); paediatric and infant versions, along with any updated versions (if developed), are available (<http://emssa.org.za/sats>) and should be used to assess the efficacy of PHC or ECs for these populations.

CONCLUSION

Currently available methods to assess emergency care in high-income nations are not applicable in developing countries. We propose the TEWS methodology as an objective way to quantitatively measure the efficacy of ECs, PHC and emergency interventions in these settings. Using the most basic, universal parameters, simple calculations and a straightforward protocol, it allows for widespread analysis of emergency care in the developing world. It can also adapt to severely low-resource areas that cannot calculate the complete TEWS, and is inherent in the SATS, which is also designed for developing countries and is growing in popularity. Further studies are recommended to demonstrate that PHC does have a beneficial effect on TEWS scores.

Competing interests None.

Contributors JHS and JT came up with the original concept. JHS, LAW and MT developed the analysis. JHS wrote the first draft. All authors contributed to the final article.

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This was the first proposed method to easily measure emergency care effectiveness in under-resourced areas. As we experienced first-hand, the current existing methods were beyond the capability of healthcare systems in developing countries. If we couldn't use the standard methods in Cape Town, South Africa, which was relatively more developed than the rest of the developing world, then using those methods would also be near impossible in less developed areas. This meant that much of emergency care in the under-resourced countries were being based on research that only measured secondary parameters, were qualitative or subjective, or were done in high-income nations or isolated cases. Objective, quantitative global emergency care research was not being done on a large enough, standardized scale. The lack of methodology could have partially even explained the reason for governments of under-resourced countries being so keen to adopt the expensive, centralized ambulance model; the model was working very well in high-income nations, but there was no way to analyse its cost-effectiveness in under-resourced countries.

The TEWS methodology was our attempt to fill that research gap, or at least gain momentum into the right direction. What we developed was a tool that measured pre-hospital care effectiveness by tracking the hospital intake-TEWS as an outcome variable, and which also measured emergency centre effectiveness by using the exact same intake-TEWS data set as an input variable. The TEWS methodology could effectively meet the needs of developing emergency care systems for a number of reasons. For one, the entire methodology was based on vital signs that could be reasonably collected in a developing setting, and even if the all the variables could not be collected a modified TEWS methodology could be used instead. Second, the data used for the methodology was inherent in the data that was already the most reliably collected in any developing setting: the vital signs of emergency patients upon arrival to the hospital. In many under-resourced areas, vital sign collection after triage could be highly variable, and any data collection in the pre-hospital setting could be minimal or non-existent. By relying on the intake vital signs of patients, the TEWS methodology meant it would be extremely easy for developing, overwhelmed emergency care systems to use since it required minimal training and data that was typically being collected already anyway. Finally, the fact that the TEWS methodology was able to use the same data set to measure both pre-hospital care and emergency centre

effectiveness meant saved time and effort for overwhelmed emergency care systems to monitor their entire system. Emergency care systems in developing areas are already typically strapped for time and resources, but with the TEWS methodology they could hypothetically analyse their entire system in a single data collection protocol.

At its completion, the TEWS methodology was already ready for researchers to use in the hospital setting to measure emergency centre effectiveness. Ironically, however, the methodology we developed was not ready to be used to measure pre-hospital care effectiveness, such as that of the Manenberg EFAR system. Despite the methodology not being ready yet for application to the EFAR system, it still showed great promise that in the future it could. We are currently working on validating the methodology, or developing new alternatives in the case that the TEWS methodology cannot be shown to work for measuring pre-hospital care effectiveness. Either way, the search for a quantitative, direct way to measure pre-hospital care effectiveness in the developing world continues, and the TEWS methodology was hopefully a step in the right direction for the research field.

Towards the end of developing the TEWS methodology, despite being unable to confirm the EFAR system's direct effects on morbidity and mortality, others outside of Manenberg and even South Africa began to take notice of the EFAR system. Government officials, academics and healthcare providers from these areas began to see what we saw, that a pre-hospital emergency care model that integrated community-based responders with a centralized EMS was a potential answer to establishing pre-hospital emergency care in the developing world, and that we had already designed a functioning model prototype to do this. We began getting requests for replicating our EFAR system in other locations, and had taken notice that others were already trying to do it on their own. However, people were keen on replicating Manenberg's EFAR system almost identically, which was not what we intended. Our strategy from the very start of the project was to develop a system that worked for a target community first, and then expand into a theoretical model. We knew the Manenberg EFAR system worked in Manenberg, but did not know how it would work elsewhere. So, we believed that others replicating the Manenberg EFAR system in other locations could be inappropriate, a more general and adaptable model was needed. We wanted to confirm the Manenberg EFAR system's effects on morbidity and mortality

before working on a more general model, but the growing demand for expansion of the EFAR system meant we had to start on a general model before the Manenberg EFAR system model was inappropriately implemented in too many places. The following paper is the result of our general model development, which we did out of necessity so that others could implement the EFAR system much more effectively.

University of Cape Town

CHAPTER 6: A STRATEGY TO IMPLEMENT AND SUPPORT PRE-HOSPITAL EMERGENCY MEDICAL SYSTEMS IN DEVELOPING, RESOURCE-CONSTRAINED AREAS OF SOUTH AFRICA.

Declaration by candidate

In the case of Chapter 6, the nature and extent of my contribution to the work was the following:

Nature of contribution	Extent of contribution (%)
The candidate was the primary author and responsible for the literature review, study and methodology design, and analysis. The candidate also wrote all drafts of the manuscript while incorporating input from the co-authors. The candidate accepts overall responsibility for the publication.	70%

The following co-authors contributed to the work. Co-authors who are students at the University of Cape Town must also indicate the extent of their contribution in percentage terms:

Name	Nature of contribution	Extent of contribution (%) for student co-authors only
Rachel Shing	Co-developed the analysis. Helped with implementation and data collection. Contributed to the final article.	15%
Michele Twomey	Co-developed the analysis. Helped with implementation and data collection. Contributed to the final article.	15%
Lee Wallis	Co-developed the analysis. Contributed to the final article.	

Candidate's Signature

<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <p>Signed by candidate</p> </div>
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Declaration by co-authors

The undersigned hereby certify that:

- (1) the above declaration correctly reflects the nature and extent of the candidate's contribution to this work, and the nature of the contribution of each of the co-authors.
- (2) they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;
- (3) they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
- (4) there are no other author of the publication according these criteria;
- (5) potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and
- (6) the original data are stored at the following location(s) and will be held for at least five years from date indicated below:

Location(s):Date

University of Cape Town Division of Emergency Medicine : August 2012

[Please note that the location(s) must be institutional in nature, and should be indicated here as a department or division.]

Rachel Shing	<table border="1"><tr><td>Signed by candidate</td></tr></table>	Signed by candidate
Signed by candidate		
Michele Twomey	<table border="1"><tr><td>Signed by candidate</td></tr></table>	Signed by candidate
Signed by candidate		
Lee Wallis	u	

Before we had even completed our research on the EFAR system, we were already receiving requests from others in South Africa and beyond to replicate the EFAR system in their respective areas. Though we did not have a complete set of data to conclusively confirm the EFAR system's impact on a region's morbidity and mortality, the amount of evidence we did have was already enough to convince others that the EFAR system was worth implementing in under-resourced areas. We then began discovering that others were keen on replicating the system on their own, and that in certain cases some had already begun.

The attention given to the concept of the EFAR system did not concern us, neither did the specific action of others attempting to replicate the system without our direct input. Our intentions from the start of the project was to create a model concept that others could take and perpetuate on their own, as opposed to continuously relying on our oversight and consultation which was not sustainable for truly expanding pre-hospital emergency care throughout the developing world. However, as the Manenberg EFAR system was specifically designed in and for Manenberg, we believed that a more general, adaptable and strategic model was needed before the EFAR system could be appropriately expanded to other regions.

The problem with the EFAR system prototype was inherent within the study design and premise of the project from the very beginning: the EFAR system we had developed thus far was designed specifically for one community, and the hurdle to establishing adequate pre-hospital emergency care in under-resourced areas was that previously designed models were created for other locations with different contexts. We originally designed the EFAR system model for the single community of Manenberg because we wanted to start with something that we knew worked in at least one location, and then we would expand upon it into a theoretical model that others could use. However, before we could create that theoretical model others wanted to start replicating the Manenberg EFAR system prototype almost identically, and because the prototype was not designed for other locations we surmised that the prototype could be inappropriately implemented. Additionally, from the questions we were receiving from others, such as whether their community-based organisation was similar enough to the Manenberg Health Committee, or if they could use our exact EFAR training materials, it was apparent that many viewed our Manenberg EFAR system as a recipe and not as a theoretical model.

For the sake of those who could be affected by the implementation of the EFAR system, and because we understood that expansion of the EFAR system could soon be out of our control, we knew we had to begin developing a more general and adaptable EFAR system model that others could more effectively implement in a range of under-resourced areas. We hoped that this new EFAR system model would allow others to establish a more site-appropriate EFAR system in their areas. However, the work is continuous, and we wanted to first create a model that would work for under-resourced areas throughout South Africa before we went on to adapting it for use throughout Africa and beyond.

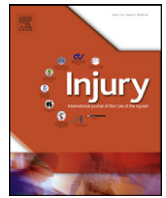
The following study explains the more general, adaptable and strategic EFAR system model that we developed for EFAR system expansion in other under-resourced areas. It describes the establishment of EFAR systems in multiple developing areas, and an experience based and consensus building approach to draw similarities and differences between the sites and develop a universal strategy for implementing pre-hospital emergency care in developing areas. The model we developed was designed primarily for the greater South African region, but we believe that the model could be of use elsewhere as well.



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A strategy to implement and support pre-hospital emergency medical systems in developing, resource-constrained areas of South Africa

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ABSTRACT

Resource-constrained countries are in extreme need of pre-hospital emergency care systems. However, current popular strategies to provide pre-hospital emergency care are inappropriate for and beyond the means of a resource-constrained country, and so new ones are needed—ones that can both function in an under-developed area's particular context and be done with the area's limited resources. In this study, we used a two-location pilot and consensus approach to develop a strategy to implement and support pre-hospital emergency care in one such developing, resource-constrained area: the Western Cape province of South Africa. Local community members are trained to be emergency first aid responders who can provide immediate, on-scene care until a Transporter can take the patient to the hospital. Management of the system is done through local Community Based Organizations, which can adapt the model to their communities as needed to ensure local appropriateness and feasibility. Within a community, the system is implemented in a graduated manner based on available resources, and is designed to not rely on the whole system being implemented first to provide partial function. The University of Cape Town's Division of Emergency Medicine and the Western Cape's provincial METRO EMS intend to follow this model, along with sharing it with other South African provinces.

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Introduction

Over 90% of traumatic deaths worldwide occur in resource-constrained countries,¹ with mortality rates expected to increase as these nations further develop, urbanize, and industrialize.^{2–9} In addition, an overwhelming proportion of these deaths occur before patients even reach the hospital.¹⁰ As a result, governments in resource-constrained countries have been attempting to establish and strengthen pre-hospital emergency medical systems that can provide patients with pre-hospital basic life support and transportation to higher care.^{7,11–16}

Thus far, a popular strategy to establish pre-hospital emergency medical systems has been to implement an adapted version of a Western country's model, particularly the United States'.¹⁷ However, the Western world's top-down and centralized pre-hospital care models often greatly exceed a resource-constrained country's limited resources, and were not designed to function in a resource-constrained country's context anyway.¹⁷ Consequently, this strategy

could delay the establishment of an adequate pre-hospital emergency medical system by distracting valuable, scarce resources towards a pre-hospital care system that may be inappropriate. Resource-constrained countries require new strategies of establishing and supporting new pre-hospital emergency medical systems—ones that are within their means.

South Africa, which currently has the highest proportional annual death rate in the world,¹⁸ is no exception to this problem. Within its population of 50 million people, South Africa is experiencing some of the highest rates of injury worldwide.¹⁹ Additionally, prevalent developing world diseases, such as HIV and tuberculosis, and increasing urbanization and adoption of Western lifestyles, which result in chronic conditions such as heart disease and cancer, are increasing medical emergency rates.²⁰ Many parts of the country still have inadequate or non-existent pre-hospital care,²¹ and are faced with emergency patient overloads, financially constrained public-sectors, and poor infrastructure such as a lack of communication technology, poor road networks, and qualified personnel.²¹

To begin to address this problem, in 2010 we designed and implemented an emergency first aid responder (EFAR) system prototype in Manenberg, one of South Africa's most crime violent

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townships.²² Community members were trained to become EFARs that provided first-responder care for emergency patients until (if necessary) an ambulance or other transportation method was available. We observed that the system was low-cost and able to deliver pre-hospital emergency care and transport for patients,²² and that EFARs were able to learn and retain their training.²³ Following the success of the EFAR system in Manenberg, the University of Cape Town's Division of Emergency Medicine (UCT EM) and the Western Cape's provincial emergency medical services (METRO EMS) are now attempting to expand the EFAR system throughout the Western Cape province, and there is growing interest for the EFAR system in other provinces of South Africa as well. However, because Manenberg's EFAR system was designed specifically for Manenberg, and because other resource-constrained areas of South Africa can range in terms of infrastructure, financial resources, and population needs, a more general and locally adaptable EFAR system model and implementation strategy was needed.

In this study, we aimed to use a two-location pilot and consensus approach to develop a pre-hospital care system and implementation strategy that was more appropriate for a range of conditions in South Africa. This model utilizes a core EFAR system model that can be locally adapted, along with an implementation strategy that could be done in a graduated fashion within an area's means. The UCT EM and METRO EMS intend to follow this model, and we present it, along with how we developed it, to help better establish more effective pre-hospital emergency care in underdeveloped parts of the world.

Methods: developing the model and strategy

To develop a generic model and implementation strategy, we first tested and compared versions of the EFAR system and implementation process at the original site, Manenberg, and at a new location, Lavender Hill, in order to first assess which parts of the Manenberg model were specific to that community and which could be universal. After developing a model scheme that was universal to both Manenberg and Lavender Hill, we then used a consensus approach to make the model more universal to other areas, followed by a consensus approach to develop a strategy to implement the model.

Piloting the model

Manenberg is a township of approximately 55,000 residents just outside of Cape Town, and is particularly notorious for its high rates of crime violence, especially related to gang activity. The Cape Town METRO EMS officially report that throughout Cape Town only 65% of life-threatening emergencies are responded to within 15 min, with about 250 life-threatening calls per day. In addition, the Manenberg residents heavily report that ambulances are typically delayed and can take hours, even for critical patients. We first implemented the EFAR system in Manenberg at the start of 2010, and it has been running ever since. Lavender Hill is a more distant, coastal township near Muizenberg in the Western Cape and has approximately 60,000 residents. Lavender Hill is known for its poverty and high accident rates. Ambulances are less available to the Lavender Hill area, and residents describe them as almost non-existent or arriving hours after patients die.

In Lavender Hill, we asked local community leaders to select community members that we could consult regarding the state of emergencies, the typical response to emergencies, and the infrastructure of Lavender Hill. Based on the information gathered from these individuals, we adapted the original Manenberg EFAR system model into a form tentatively better suited for Lavender

Hill's environment, particularly in regards to the different stakeholders available there and the area's more restricted access to ambulances. We then asked relevant experts (UCT EM and METRO EMS doctors and government officials) and the Lavender Hill community members to comment on the newly revised model's feasibility, and we then made modifications based on their input. At the start of 2011 the experts and community members then cooperated to implement a pilot of the model in Lavender Hill, and afterwards everyone evaluated the model for local feasibility and cultural appropriateness based on implementation experiences. The model then underwent further cycles of modification, implementation and evaluation by everyone until all parties achieved consensus that the emergent EFAR system model was specifically appropriate for Lavender Hill, and community members reported that EFARs were providing care. Lavender Hill's EFAR system has been running ever since.

In both areas, we periodically re-tested EFARs and reviewed their Patient Care Reports to ensure that they were properly rendering the skills they were trained to do. Additionally, community members, professional EMS personnel, and hospital staff reported during interviews and discussions that they were impressed with the EFARs' work, and that they believed the EFAR systems were needed. Professional EMS personnel also commented that EFARs were reducing patients' pre-hospital times since the EFARs would identify emergencies earlier and also call for and be able to direct transportation much quicker than bystanders would.

Developing the more general EFAR system model

We then compared Lavender Hill's EFAR system model with Manenberg's model for similarities and differences to generate a generic EFAR system model that could describe both. We then presented this general model to experts and community members from various Western Cape province townships, and asked them to comment on the feasibility of the model in their own areas. Experts were identified as UCT EM and METRO EMS doctors and government officials along with emergency doctors that served the areas, and we used local community councils to select the community members to be consulted. The community members consulted ranged in level of education, original nationality, race, primary language, and level of their community's local infrastructural development. We modified the generic EFAR model based on the experts' and community members' input, and then presented the model back to them for further evaluation. We repeated these cycles of evaluation and modification until all parties achieved consensus that the model, once established, would work in their areas.

Developing the implementation strategy

After the general model was developed, the same experts and community members were then asked for strategies to implement the developed EFAR system given any range of an area's development from severely impoverished, rural townships to middle-income, semi-developed areas. We drafted their input into an implementation strategy that we then subjected to rounds of evaluation and modification by the experts and community members until consensus was achieved that the strategy provided a way for any resource-constrained area to establish the system.

Through this process, and by observation of the methods used to adapt the model, a general yet customizable framework for developing and implementing the EFAR system emerged. Ethics approval was granted by Yale University and the University of Cape Town.

Results

The adaptable, core EFAR system model

Though they assumed various names and forms at each site, archetypical roles existed across the EFAR systems (see Fig. 1). There are two categories of roles: care delivery roles and management roles.

Care delivery roles: Local EFARs, Head EFARs, Transporters

Overview. All care delivery roles function to provide patient care and, if necessary, expedited transport to a hospital (see Fig. 1 and Table 1). When an emergency occurs, bystanders activate a Local EFAR nearby in the community by either personal retrieval or a direct call, and the Local EFAR arrives on scene to provide immediate basic life support. While the Local EFAR tends to the patient, bystanders can simultaneously call a communications emergency number that will dispatch a Head EFAR and Transporter to the scene, and once a Head EFAR is activated he or she can further dispatch Local EFARs near the emergency scene as needed (communications issues are discussed later). Head EFARs, who are also community members, are fewer in number and may take longer to arrive on-scene, but can provide additional support or be a replacement if Local EFARs cannot be activated. On scene, the EFARs continue to provide patient care until either the Transporter or an affordable form of transportation (taxi, bus, etc.) can rush the patient to a hospital. The scope of training for the EFARs depends on the needs of the community (see implementation strategy

below). (See Fig. 2 for examples of EFARs using their skills during the piloting.)

Transportation issues. Transporters can assume one of two forms, or be a combination of the two. One form would be the employment of already existing methods community members use to get to the hospital (i.e.: minibus drivers, taxi drivers, police officers, etc., and their vehicles). This method is more instantly accessible to community members and is quicker to establish.

However, this form can be unreliable since public and personal transportation vehicles and those who drive them will be beyond the EFAR system's full control. The alternative form is to station EFAR system controlled Transporters throughout a region. These Transporters can transport patients using any locally available vehicle from push-bikes to formal ambulance trucks. An EFAR system can start with one Transporter, and strategically station more as resources become available. The disadvantage to this method is that although EFAR system controlled Transporters would be more reliable, resources may limit their number. If this is the case, Transporters may take longer to arrive on scene than public transportation taxis and minibuses, which are typically well established even in developing areas. Because of this, we recommend combining the employment of public transportation vehicle drivers (along with their vehicles) and EFAR system controlled Transporters, and instructing EFARs to transport the patient by whatever means becomes available first.

Communication issues. Bystanders and Local EFARs can activate Head EFARs and Transporters by personal retrieval, direct call or

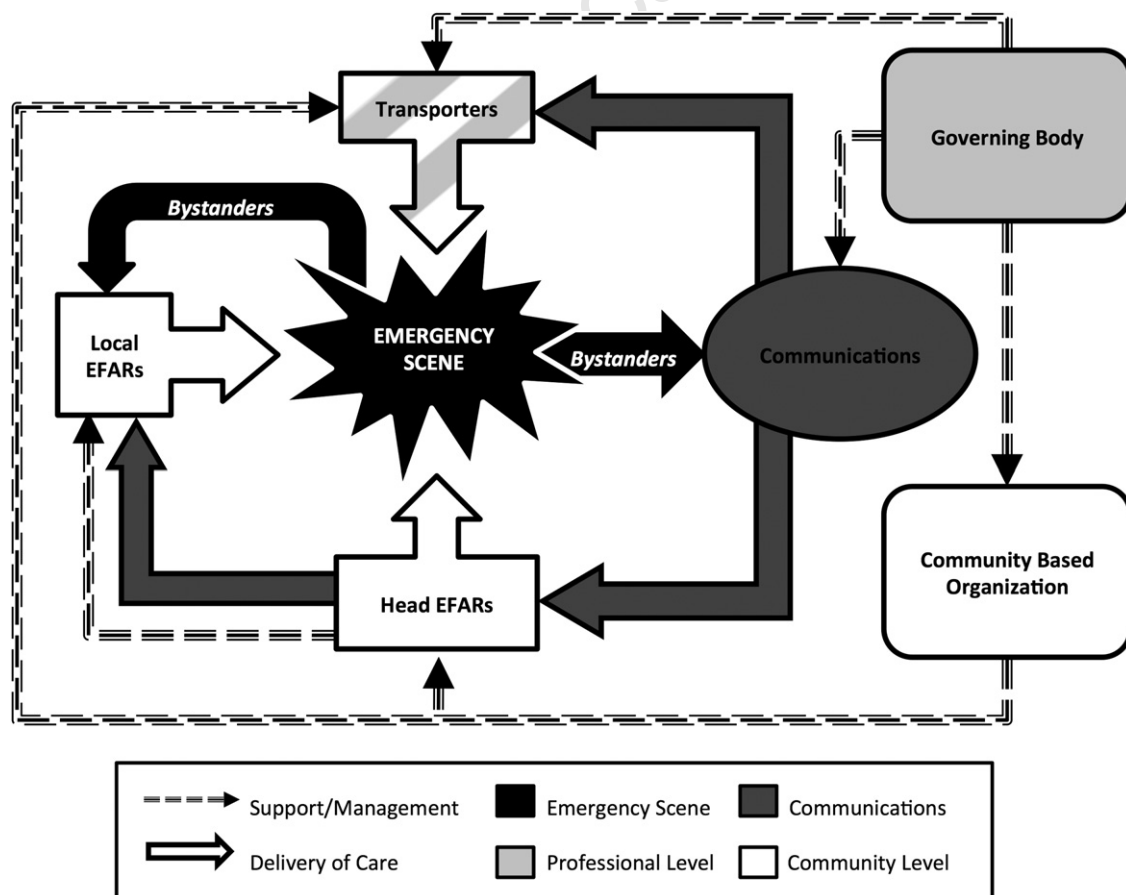


Fig. 1. The general EFAR system model. EFARs can respond quickly to emergencies and care for patients until transportation is available. Local EFARs are spread throughout a community and can be activated by personal contact or dispatch by a Head EFAR. The manner in which Head EFARs and Transporters are activated depends on the available resources of the area (see Fig. 4). If an ambulance system is already available, the ambulance units can serve as Transporters.

Table 1
Comparison of the EFAR system care delivery roles.

Bystanders	
Expected function:	Identify emergencies, activate EFARs and Communications
Important relationships:	Activate EFAR system
Local EFARs	
Expected function:	Provide immediate on-scene care, call for additional help if necessary
Candidates:	Community members selected by Community Based Organization
How activated:	Personal retrieval or call by neighbours, dispatch via mobile phone by Head EFARs
Dispersal:	At least one quickly accessible by all community members by foot
Training:	First responder, specific training depends on identified community needs
Equipment:	Household materials
Important relationships:	Care for patients, managed and dispatched by Head EFARs
Funding/incentives:	Are volunteers, can be promoted to Head EFAR
Head EFARs	
Expected function:	Provide on-scene care in addition to Local EFARs, call for additional help if necessary, manage and dispatch Local EFARs
Candidates:	Community members selected by Community Based Organization
How activated:	Personal retrieval or call by neighbours, dispatch via Communications
Dispersal:	At least one per community or sub-region to manage Local EFARs and to be able to access emergencies they are dispatched to
Training:	Basic life-support, specific training depends on identified community needs
Equipment:	Communication equipment, possibly professional medical supplies
Important relationships:	Care for patients, manages and dispatches Local EFARs, reports to Community Based Organization
Funding/incentives:	Are volunteers or are paid by Governing Body, scholarships available for more advanced medical training
Transporters	
Expected function:	Transport patients to hospital if necessary
Candidates:	Community members selected by Community Based Organization, Head EFARs, taxis, police units, ambulance units
How activated:	Personal retrieval or call by neighbours, dispatch via Communications
Dispersal:	Based on existing public transportation methods and local resources
Training:	Transportation of patients
Equipment:	Transportation supplies and vehicle, possibly professional medical supplies
Important relationships:	Transport patients, managed by both Community Based Organization and Governing Body
Funding/incentives:	Paid or reimbursed by Governing Body

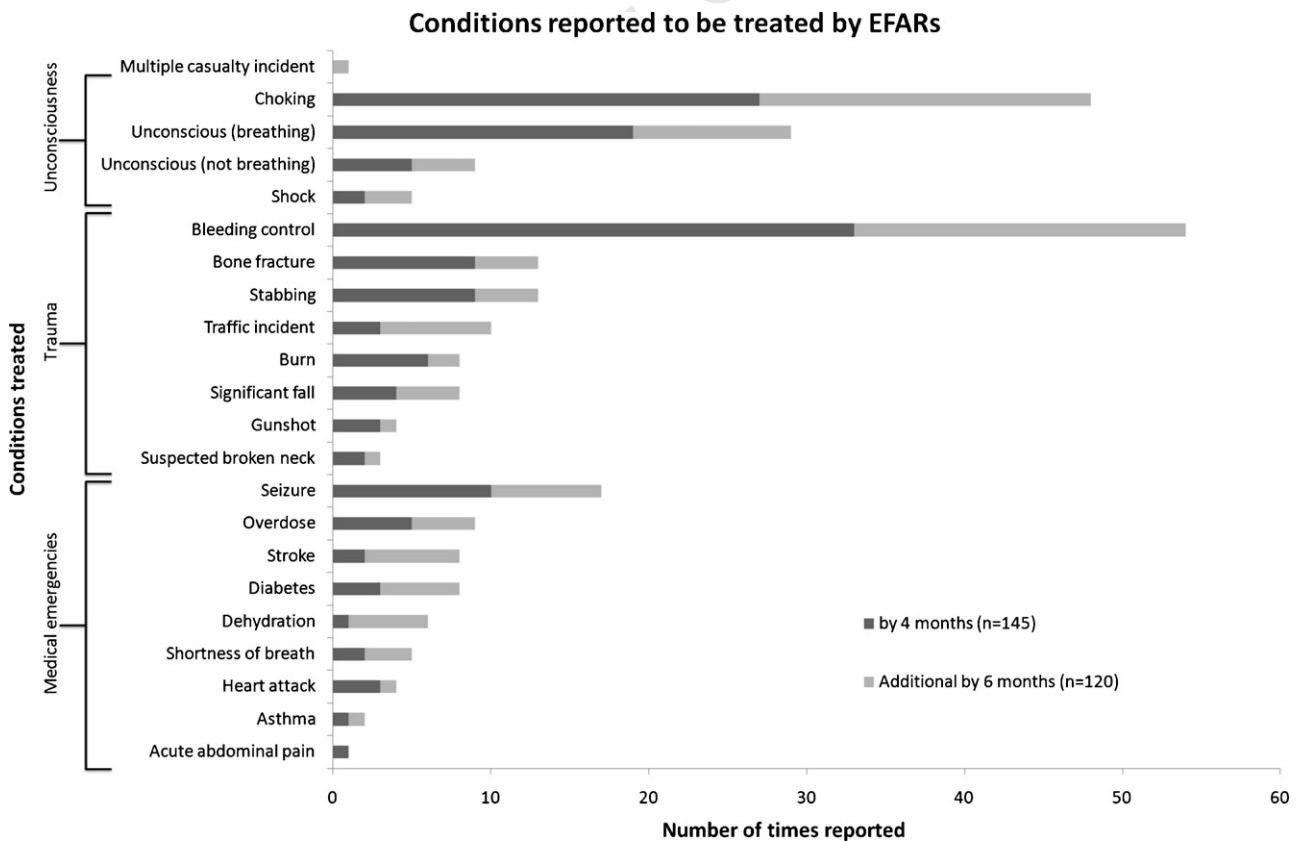


Fig. 2. Reported usage of skills by Manenberg EFARs. Reports are from 274 EFARs surveyed over a six-month period immediately after their training. We asked the EFARs to complete for each encountered emergency a patient care report that documented the incident, the care provided, and the patient outcome. Review of reports revealed that EFARs were properly providing the skills they were trained to do. The specific curriculum is described elsewhere.²² Re-printed with permission from Sun and Wallis.²²

text messaging on standard mobile phones, or if possible by calling a central communications phone number to dispatch them. Once a Head EFAR is dispatched, he or she can use local knowledge and a mobile phone to further dispatch Local EFARs that are near the emergency scene. Utilizing a central communications number for dispatch would require mobile phone technology in the area and knowledge of the emergency number by at least the Local EFARs. In low-resource settings, communication can be entirely coordinated using free mobile phone and text message based technology developed by the growing field of telemedicine. Such technology could auto-forward calls and text messages to the Head EFAR and Transporter closest to the emergency scene, or from the Head EFAR to pre-selected Local EFARs near the scene (personal communication, Medic Mobile). However, should insufficient communication technology be available, EFARs must rely on local transportation methods available. Issues concerning insufficient communications technology are further discussed in the implementation strategy section.

Management roles

Overview. All Local EFARs in a defined area are managed by Head EFARs, who in turn are managed by a Community Based Organization that oversees all EFARs for an entire sub-region (see Fig. 3). Community Based Organizations are separate, independent entities that are guided, supported and financed by the Governing Body regarding all EFAR related matters. The Governing Body additionally manages issues that transcend single sub-regions, such as communications technology, research, training, and the Transporters. However, training and management responsibilities of the EFARs and Transporters are also shared with Community Based Organizations as much as possible, as they are more familiar with their sub-regions and best methods of recruitment, training, dispatch, and the local geography (i.e.: where to station Transporters).

Governing Body. The Governing Body is any professional, institutionalized body willing to oversee, fund, and take responsibility for

the entire system. This encompasses professional, organizational, academic and financial support for the system (see Table 2 for example). The Governing Body must also be able to obtain accreditation for the EFAR training. If a country or region has an existing ambulance system, it will be the most intuitive candidate for the position. Other potential candidates include universities, hospitals, or public health departments.

Community Based Organization. Because professional institutions can be removed from local communities, the EFAR system uses independent Community Based Organizations to manage the “on the ground” operations associated with the EFAR system. Their primary purpose is to ensure the EFAR system is suitably adapted to an area’s specific needs and context, to represent the EFARs to the Governing Body, and to increase community buy-in. These Community Based Organizations should be stable organizations of any kind that are made up of local community members who are well acquainted with their community, respected by the locals, and willing to oversee the EFARs of their area on behalf of the Governing Body. The organizations can be schools, religious centres, NGOs, community councils, or any other group that is close to the community. The Governing Body should consult local community members and leaders as to which organization should fill this role. As the EFAR system is expanded into new sub-regions, the Governing Body must recruit additional Community Based Organizations to oversee the new sub-regions.

Implementation strategy

The EFAR system is implemented in a stepwise manner, as resource-constrained areas are typically unable to establish an entire pre-hospital emergency medical system at once. Each step in the system is self-functioning and can provide partial function without the presence of later components. Further components are added on as more resources become available to the region (see Fig. 4).

The EFAR system’s implementation strategy is also designed to first integrate into select sub-regions before expanding to others.

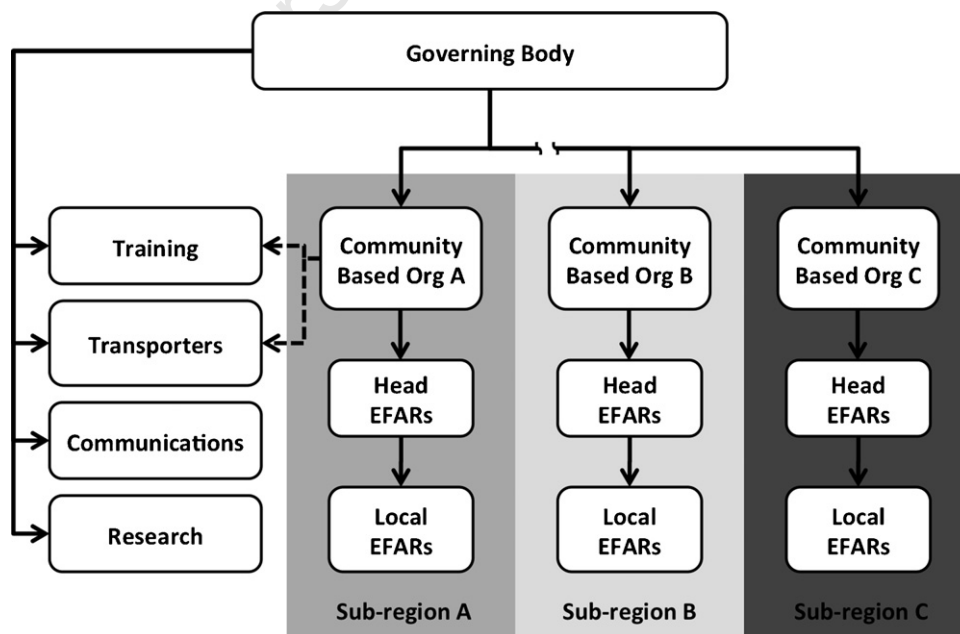


Fig. 3. Management structure of the EFAR system. Community Based Organizations and Head EFARs oversee all EFARs in their respective regions, with the Community Based Organization having the ability to modify and run the system in their areas as needed to ensure local and cultural appropriateness. The Governing Body oversees the Community Based Organizations for EFAR related matters, ensures the quality of the training and system, and handles matters that transcend single sub-regions such as communications and research. An already existing ambulance system can serve as the Governing Body, with its ambulance units serving as Transporters.

Table 2
Example of the total potential costs of the Basic EFAR training in Manenberg. Costs for Head EFARs, Transporters and stations depend on what medical equipment or vehicles are used and the norm for local wages and rent.

Basic EFAR training		Items	Cost	Recurrence	Expected total
Start-up costs		Netbook laptop	US\$300	Once	US\$700 total
		LED projector	US\$400	Once	
		Splints/bandages	US\$000	Once	
On-going costs	Instructor's wages	Per course taught	US\$60.00	4 per month	US\$3120 per year
		Per additional day	US\$20.00	1 per month	
	Course costs	Per handout	US\$00.25	100 trainees per mo.	US\$3450 per year
		Per final exam	US\$00.25	100 trainees per mo.	
		Per certificate + ID	US\$00.50	75 trainees per mo.	
		Per first aid kit	US\$02.00	75 trainees per mo.	
		Extra costs	US\$50.00	1 per month	

Re-printed with permission from Sun and Wallis.²²

This is done to avoid straining scarce resources from the outset. This also leaves room for the model to be adapted before rolling out to an entire region.

First steps: preparing for the EFAR system

Once a Governing Body is identified, the next step is to recruit Community Based Organizations in the first sub-regions where the EFAR system is to be implemented. Within a sub-region, this can be done by asking community leaders and members for suitable organizations, and selecting a willing organization. The recruited Community Based Organization can then help the Governing Body to perform a needs assessment to identify the target sub region's most prevalent emergencies, available resources, and community members' typical response to and management of medical

emergencies. This can be performed by consulting hospital staff and medical records (if available) for the most frequently occurring emergencies, and by surveying community members of their perceived experiences. This information should be used to develop the sub-region's EFAR training course and to modify the core EFAR system model as needed, which should both then be presented to the Community Based Organization to be evaluated and modified until both the Community Based Organization and Governing Body agree that the training and model would be locally supported and are feasible, culturally appropriate, and within the ability of the local people to learn and perform.

Once the training is designed, the Community Based Organization should identify who would be the most effective trainers, after which the Governing Body will train the individuals as the

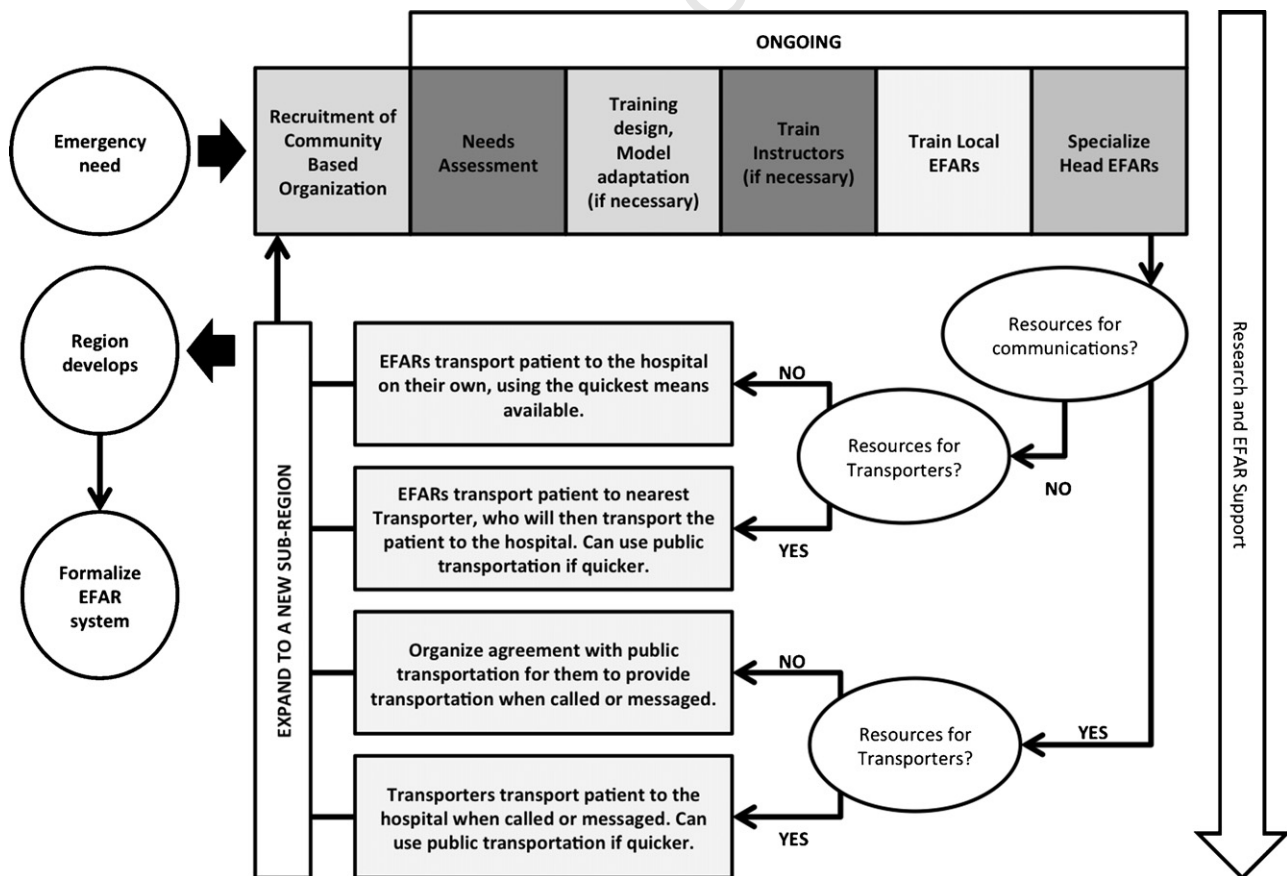


Fig. 4. Strategy to implement the EFAR system. The needs assessment, training design, model adaptation, and training for instructors, EFARs, and Transporters are ongoing for each sub-region even after the EFAR system is established there. Additionally, organization of communications and patient transport should be based on the available resources of the area, with sub-regions modifying their models as resources for communication and transportation become available.

sub-region's trainers. After the trainers are prepared, the needs assessment, curriculum design, and trainer training should be routinely updated to assure that the EFAR training course remains appropriate for the sub-region.

Establishing the EFARs, Communications and Transporters

Because a Community Based Organization will be the most familiar with how to best recruit, attract, and retain effective community members in their region, it should be up to the Community Based Organization to decide how to recruit Local EFARs, Head EFARs, and Transporters. The sub-region's trainers can then train the recruited individuals for their positions. If resources are limited for a sub-region, the Community Based Organization should focus on training Local EFARs first so that they can immediately start providing in-community emergency care. When enough resources are available, Head EFARs should be specialized so that they can start managing the Local EFARs and start dispatching them if the communications technology is available. When Head EFARs become available, the Community Based Organization should decide where are the best places to station them.

Throughout this process, transportation must be organized either through relying on pre-existing forms of transportation to the hospital or through EFAR system Transporters, depending on the available resources. If a region already has an existing ambulance system, the ambulances can serve as Transporters. When EFAR system Transporters become available, the Governing Body and Community Based Organizations should decide together where to station them. When the communications technology becomes available, a central dispatch system should be integrated into the EFAR system so that bystanders and EFARs can call an emergency number that will dispatch the appropriate Head EFAR and Transporter. If such communications technology is not available, EFARs and Transporters must coordinate matters, such as patient transfers, through personal contact. (For more explanation on how to proceed should communications or Transporters be unavailable, see Fig. 4.)

Expanding to new sub-regions

Once the EFAR system has been suitably piloted and fully adapted to one local area, it can be expanded to other sub-regions by recruiting new Community Based Organizations and repeating the model adaptation and implementation.

Research and EFAR support

The Governing Body should continuously conduct research on the system's efficacy so that improvements can be tracked and made. Unfortunately, record-keeping infrastructure is typically weak in areas requiring the EFAR system,^{24–26} and thus very few tools are available. The most accessible methods would be to track the EFARs' and Transporters' skill retention and use over time in order to see if the intended care is being delivered to the community, or to survey community members and hospital staff for their observations. However, there is currently no accepted method for measuring an emergency medical intervention's effects on morbidity and mortality in an under-resourced country. One potential method is the TEWS methodology that is based on vital signs that can be reasonably collected at an emergency centre,²⁷ though the methodology has yet to be validated. Other possible methods include comparing pre and post-intervention pre-hospital time, or correlating patient length of stay and outcome at the hospital with being cared for by EFARs versus un-trained bystanders only. However, all of these methods are dependent on the record-keeping infrastructure of the area.

The Governing Body and Community Based Organizations should continuously strive towards providing EFARs with additional

support. This includes being sensitive to EFARs' needs, providing additional training and refresher courses at their request, and organizing counselling sessions and quarterly or monthly social gatherings for EFARs (during which research protocols can also be performed).

The final steps: formalizing the EFAR system

Over time, as resources and infrastructure allow, Transporters and some EFARs can be upgraded to staff formalized ambulances. Once an ambulance system is in place, the EFARs can continue to serve as first responders, providing organized patient care in the extended period between the emergency incident and ambulance arrival. As the region further develops, the ambulances will ideally be capable of managing all pre-hospital emergency needs, leaving the region with a fully developed, formalized pre-hospital emergency medical system. Throughout this progression, the Community Based Organizations should be consulted on how to best educate their communities about the emerging system.

Discussion

Pre-hospital emergency care in a resource-constrained country such as South Africa faces three major obstacles: (1) limited access to acute care, (2) limited transportation to hospitals, and (3) inappropriateness of Western pre-hospital care models for resource-constrained areas. The EFAR system model addresses these issues in South Africa by utilizing and building upon the resources available in a resource-constrained area. Immediate emergency care is initiated and provided by community members themselves in an organized way. Hospital transport is achieved using the area's existing methods of transportation or, resource permitting, through EFAR system controlled Transporters. Finally, the integration of Community Based Organizations into the EFAR system provides a way for the model to be locally adapted, provides a method for EFARs to voice their input and needs, and ensures local support and that the model remains appropriate for the targeted communities and regions. Also, we have previously found that many community members in South African townships desire to help during emergency situations.²⁸ The EFAR system model provides a way for community members to care for themselves and to avert potential harm caused by untrained volunteers treating patients, both of which would also help alleviate the rest of the emergency medical system.

In addition, the EFAR system's graduated implementation method allows it to be implemented in different areas with varying degrees of development, and does not rely on the entire system being implemented first to provide partial function. Additional parts of the EFAR system can then be implemented as the region grows and increases in infrastructure, population, and available resources.

Because we have seen that the EFAR system is functional in at least two locations, and because individuals familiar with South Africa's different conditions designed the model and strategy, we believe that the system can provide care and be successfully implemented in the resource-constrained areas of South Africa. In addition, because of the model's adaptability we hypothesize that versions of the EFAR model can be used in other resource-constrained countries as well—though this has yet to be shown.

Limitations and future research

Because individuals in South Africa designed the model, there are potential biases towards conditions in South Africa. We are unsure of how the model would work elsewhere. Additionally, though individuals familiar with a wide range of South African township conditions designed the model, the model has not been

tested yet on all of these conditions. Finally, there are limited resources to quantify pre-hospital interventions' affects on morbidity and mortality in any resource-constrained community (though we are currently working on validating a method that can do this within a resource-constrained area's means).²⁷ As of now, we have only been able to observe that the EFAR system model and implementation strategy is logistically functional and that care is delivered. However, measuring the impact of such a system on morbidity and mortality is of utmost importance, and should be done as soon as a usable method becomes validated. Such data should also be compared to the financial resources consumed, so that cost-effectiveness can be analyzed.

Conclusion

The emergency first aid responder system and implementation strategy is designed to be a versatile pre-hospital emergency care model for South Africa's resource-constrained areas with emergency need, and shows great promise in making pre-hospital emergency care more accessible in under-developed areas of South Africa. It is also designed to be implemented in a graduated fashion based on resource availability. The University of Cape Town's Division of Emergency Medicine and the Western Cape's provincial METRO EMS intend to follow this model, along with sharing it with other South African provinces. We also hypothesize that the EFAR system model can be implemented in other countries—though this has yet to be shown.

Competing interests

The authors report no competing interests.

Acknowledgements

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This final study can be used as an accessible guide on how to establish an emergency first aid responder system in a developing area, and how to foster it into a professional pre-hospital emergency medical system. This is the first paper of its kind to offer a concrete strategy for establishing pre-hospital emergency care in any developing area.

Whereas the first paper we present (chapter two) looks at and describes our first emergency first aid responder system in-depth, this translational research study takes expert and community input, and the lessons learned from multiple sites, and boils them down to a more widely applicable and accessible universal strategy. Instead of describing the specific members and organizations that work together to provide pre-hospital emergency care to a community, this paper describes their roles and relationships in a greater theoretical model, along with describing a way to construct the system.

This study builds upon all of our previous research and goes directly after the primary goal of the thesis: to develop a general model to establish pre-hospital emergency care in an under-resourced area. In this model, transporters (possibly in the form of centralized ambulances) and community members coordinate with one another to provide care to the community. It retains the benefits of both the bottom-up community-based approach and the centralized ambulance approach in that on-hand community responders can still care for a patient if they happen to be on-scene, and community members can call for a more professional and centrally controlled emergency response unit.

However, the model has some key aspects that differentiate it from being just a bottom-up community-based approach and centralized ambulance approach running in parallel. For one, the community responders and centralized responders are fully integrated with one another, more than just working separately and meeting in the middle. During an emergency, if community responders are activated first they can further call upon a head community responder or the central dispatch for further guidance and assistance in getting the patient alive to the hospital. On the other hand, if bystanders call the central dispatch first then the central dispatch can send transportation in addition to notifying a well-informed head community responder who will then coordinate other community responders to respond to the scene, as

opposed to the central dispatch only sending an ambulance after which the bystanders have to independently search for a community responder to help the patient in the long interim until the ambulance arrives.

Additionally, the EFAR system model addresses issues of local-inappropriateness, a recurring pitfall in previous pre-hospital emergency care models for under-resourced areas, by utilizing community based personnel. A governing body does provide oversight and structural support for the EFAR system, but in almost every other aspect the community members' local expertise is capitalized on as much as possible. Local input goes into the EFAR training design, and into the adaptation of the EFAR system model for an area. After design, a community-based organisation oversees the local implementation and maintenance of an EFAR system in an area, and Head EFARs coordinate how EFARs in an area respond to an emergency.

Previous centralized ambulance models sought to control emergency responses from a top and central point (and previous bottom-up community-based models barely had any control at all). However, there is a tremendous gap of knowledge between officials at the top of a centralized ambulance system and what happens in the homes of community members. The new EFAR system uses Head EFARs from the community to dispatch Local EFARs as he or she knows best, and the structure they work in is managed by a community based organisation that is familiar with how things work best within its specific community. It is then, after these two levels of management, that the greater EFAR system is overseen by a central Governing Body that can provide the sub-regional EFAR systems with guidance, organisation, and support, and also coordinate them with each other and the rest of the emergency medical system.

Finally, the EFAR system model is designed to be implemented in a graduated manner within a developing areas means. A lack of resources is typically the primary barrier to establishing effective pre-hospital emergency care. By addressing this issue, along with issues of coordination and adaptability as described before, the EFAR system model described in this study has promise for implementation in under-resourced areas and hits the primary goal of the thesis.

However, though we were able to develop a universal strategy and implementation model that others can use to establish an EFAR system in an under-resourced area, the task is not complete and a lot more can be learned about the EFAR system and utilizing first responders in developing emergency medical systems in general. Researching the impact of the EFAR system as it progresses into the future is of particular interest to us. Such information can not only elucidate the efficacy of the EFAR system, it could also help in modification and improvement of the model. However, as stated in chapter five, there are many hurdles that researchers will have to overcome to measure the efficacy of the EFAR system. Up until now, measurement of responder learning, retention, and skill usage has been the accepted standard, and indeed we can continue to confirm these attributes in every new community that the EFAR system is established in. However, given the number of times that our studies and others have confirmed that community members in under-resourced areas can retain and use emergency training in all sorts of settings, and in addition to these measurements being secondary measurements to an EMS's efficacy, we believe that it is time for the research in this field to further develop.

In order to perform future research on EFAR systems, new ways to evaluate and compare their efficacy are needed. Such methodologies should ideally measure the system's impact on morbidity and mortality, the ultimate outcomes of the systems. However, as also stated in chapter five, endemic in areas that would need EFAR systems is a lack of data infrastructure. If pre-hospital emergency care in developing areas is to continue on a large scale, sheer effort to overcome the data hurdles will not be enough—creative and innovative methods that draw more information from the little data that is available will be needed as well. The TEWS methodology that we presented in the previous chapter is just one possible method we could someday use to evaluate and improve future EFAR system models. Whether by that method, or another that is validated first, we hope to see an effective method that could be used to take research on the EFAR system much further.

CHAPTER 7: DISCUSSION OF THESIS

The primary aim of this thesis was to develop a model of pre-hospital emergency care that uses community members and can be established within a developing area's means. In order to help achieve this aim, we wanted to meet the following goals:

- 1) Understand the context of a developing area in need of pre-hospital emergency care (such as how community members perceive emergencies and emergency response in a developing area).
- 2) Determine whether or not the pre-hospital emergency care model we develop functions (in that community responders are delivering the care we intended and in an organized way).
- 3) Measure the effects of the model (ideally on communities' morbidity and mortality).

These objectives were ambitious, and we faced a monumental hurdle of performing research in a low-resource area with poor infrastructure, which we could not control for due to the necessity for us to perform the research in such an area. However, despite such obstacles we were quite successful in completing almost all of our objectives.

The key findings of each of the five papers included in the thesis were:

1. A pre-hospital care model for a specific community, and evidence that personnel were rendering their skills to their community.

2. That community members in our target violent area have a distressed view of the emergencies in their area, that they have wavering faith in the existing emergency personnel, that they desire to help during emergencies but are primarily discouraged by a lack of ability, and that emergency care training in the community can lead to improved confidence and desire to help during emergencies.
3. That a low-resource area's community members, even with limited education, can effectively learn and retain basic emergency skills, and that skill decay is not continuous over time.
4. A method to measure emergency centre efficacy in a low-resource area, and a potential method to measure pre-hospital care efficacy in a low-resource area.
5. A more generalized pre-hospital emergency care model that can be used in different low-resource areas of South Africa (and possibly beyond), along with a strategy to establish it in a step-wise manner using the currently available means of the area.

We were able to successfully gain insight into the context of emergencies in a developing area, at least through the perspectives of those who understood it best, the community members. They have high distress to the emergencies in their area, and do not believe that the current emergency response is even close to adequate. From the extreme language used in the community members' descriptions, it also seemed that the distress was having an on-going negative impact on their psychology, and was rendering them with a sense of helplessness and a number of them with hopelessness. These reports from community members become even more daunting when one takes into account that these community members were living in South Africa, which has a relatively higher infrastructure than other under-resourced nations. Previous research has already shown that violence, accidents and other emergencies will increase as low-resource nations develop. With this incoming increase in emergencies, and the fact that other

low-resourced nations have even less resources for emergency responses than South Africa, one could predict an even higher level of distress across the developing world.

Interestingly enough though, a recurrent observation we had across the community members was that most of them wanted to be able to do something about their situation. The most prominent request from community members were that they be trained so that they could help manage emergencies themselves, and that a lack of ability was all that was holding them back from helping during emergencies. Though we did not confirm this feeling until after we had begun implementing the EFAR system in Manenberg, it provided us encouragement that we were on the right track to providing more effective pre-hospital emergency care in developing areas, or at least implementing a system that would be well-received by the community members. It was also clear that enough community members were motivated to help during emergencies, and that this motivation could be capitalized on to provide care to emergency patients—those who received emergency training felt more empowered and said they would be more confident and willing to help during emergencies. From an alternative point of view, the community members' motivation could also translate into inappropriate, vigilante care for patients. For either perspective, proper emergency care training, as requested by community members anyway, would address both views.

Additionally, we were quite successful in achieving our primary aim of developing a model of pre-hospital emergency care that could be used in a developing setting, and seeing that the system could function. For moral obligations to the people of a single community, we sought to first develop an EFAR system that worked for that specific community before finding a more general one, rather than subject that single community to allegedly sub-optimal experimental conditions. That first system was the Manenberg EFAR system, and had involved community member input every step of the way, always considering what they believed would work best in their own community. We originally used this community-based methodology just for model development, but we later realized how critical community-member input was for every aspect of the system. Simply put, we realized that across the varying conditions of different developing areas, only the community members themselves truly understood the context of their own community and how things best worked for them. Because of this, we incorporated using a

community-based organization into the actual EFAR system model, and we believe is a critical part of the model.

After incorporating the Manenberg Health Committee (Manenberg's community-based organization) into the Manenberg EFAR system, we saw good evidence of the system functioning. Manenberg EFARs were learning and retaining their training, and providing care to the rest of the community. This came as no surprise to us; the Manenberg Health Committee was well familiarized with Manenberg, its people, and how things worked there. As we followed the advice of the Manenberg Health Committee throughout the entire implementation process of the EFAR system, what to us seemed as tentative, uncharted territory was to them intuitive. After our success with the Manenberg Health Committee we retained the role of the community-based organization as we expanded into other townships, and observed the same success even though different community-based organizations had tailored their EFAR systems in their own ways. By the time we reached the consensus approach of developing a more general EFAR system model and implementation strategy, the absolute need of including a community-based organization into the EFAR system model and its implementation was obvious to almost everybody involved.

Following the success of the Manenberg EFAR system, we were approached by various officials from South Africa and beyond to replicate the system in their locations. We wanted to emphasize that the EFAR system we promoted was not the Manenberg EFAR system specifically, but EFAR as a concept—one that at its core holds that in an area where resources are constrained that emergency care needs to include a bottom-up scalable approach that relies on available resources and coordinates the efforts of community members, community based organizations and official authorities. The traditional top-down, centralized approach to pre-hospital emergency care is not working in developing areas, and when governments are not able to fully provide for the pre-hospital emergency needs of a community the community members themselves can help care for themselves and contribute to the greater emergency care system in an organized, systematic way. This was the justification for developing the more generalized EFAR system model along with a scalable implementation strategy.

However, the task is not yet done, and the EFAR system model and implementation strategy can continuously be improved upon. The end goal is to provide effective pre-hospital emergency care to developing areas, and the current EFAR system model and implementation strategy is simply what we have so far for an answer. For one, we can only confirm that the EFAR system can work in South African conditions. We have seen plans drawn to adapt and implement the EFAR system in other countries, and specifically Ghana, though these have yet to be fully done.

As for the aim of measuring the effects of the EFAR system, we were successful according to the currently accepted standards and practices of doing this type of research in this field. However, we are not satisfied with what we have yet uncovered, and there is a lot more that needs to be done. Because of developing areas' poor data infrastructure, and poor infrastructure in general, just determining that responders learn, retain and use their training is difficult enough, and this is typically all that previous researchers were able to do to determine the efficacy of using first responders in developing areas. In this regard, we too have determined that the EFARs are learning, retaining and using their training. However, these factors are only secondary measurements that can triangulate the effects of the first responders. The actual needed measurement would be quantifiably determining the EFARs' effects on morbidity and mortality in their regions.

In order to do this, we tried using standard methods to quantifiably measure emergency care efficacy, but found that all available methods were beyond the means of South Africa's infrastructure or would require an unjustifiable amount of resources for us to use. We then realized that if such research methods were not usable in South Africa's relatively more well-developed infrastructure, then if research into global emergency care were to continue that an easily usable and new methodology was needed to measure emergency care efficacy in developing conditions. Our product was the TEWS methodology, which was developed mostly by observing what was available to most developing conditions.

However, the TEWS methodology is just one of many possible steps in the right direction—there is more work to do. Though the TEWS methodology has been validated for use

in measuring emergency centre efficacy, its use for measuring pre-hospital care efficacy has yet to be confirmed. Only when this method is fully validated, or another method is developed and validated, can researchers more readily quantitatively measure first responder systems' effects on local morbidity and mortality, including those of the EFAR system's. Additionally, with an available method, individual developing areas can rapidly improve their emergency healthcare, instead of relying on a few mega-studies done in areas with access to an isolated case of available resources, and could possibly possess extremely different conditions. In either case, even though we have not yet been able to measure the EFAR system's effects in a quantifiable manner, all other measurements are suggestive of a positive impact, and so the EFAR system remains promising.

LIMITATIONS OF THESIS AND FUTURE RESEARCH

Despite showing that the EFAR system can logistically function, we were unable to confirm the EFAR system's effects on a local area's morbidity or mortality. This is due to the lack of data infrastructure in a developing area, and the lack of a usable method to measure pre-hospital care efficacy with a developing area's limited resources. Because developed areas will likely not need the EFAR system as much, developing a usable measurement would be more useful. We developed the TEWS methodology as a potential measurement, but as of now it too has its limitations. Though it is developed, the TEWS methodology still needs to be validated for measuring pre-hospital emergency care effectiveness, as was described in chapter five. Until then, we can only use qualitative, anecdotal or indirect measurements as evidence of the EFAR system's effectiveness.

Additionally, the development of the EFAR system model and implementation strategy is an on-going process, and so will always be open. As of now we can only confirm that the EFAR system can be implemented and function within South African conditions. The next steps would be to adapt and expand the EFAR system to other regions, and to use what is learned to further refine the EFAR system model.

CONCLUSION

The emergency first aid responder (EFAR) system is a promising model to bring more effective pre-hospital emergency care in developing areas. With South African conditions, and possibly beyond, the system can logistically function and EFARs render pre-hospital care, as they are trained to do, to patients in an organized way. The system is also scalable and can be implemented in a step-wise manner within a developing area's means. This system capitalizes on local community members' desire to help during emergencies, for which they typically are deeply troubled by and feel helpless because they lack the ability to help. Additionally, a quantifiable measurement is needed to directly measure the efficacy of pre-hospital emergency care in a developing area, which can be used to measure the EFAR system's effects on an area's morbidity and mortality. We present the TEWS methodology as a potential way to do this, though it has yet to be validated.

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APPENDICES

- 1) Basic EFAR training handout
- 2) Basic EFAR training certification exam
- 3) EFAR Patient Care Report

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Lesson 1: Being an EFAR

Emergencies and Being an Emergency First Aid Responder

During an emergency, a dying patient is only part of the problem. There are also the possibilities of further danger and mass panic. As an Emergency First Aid Responder you will have the power to...

- Keep the dying patient(s) alive until further help arrives
- Remove further danger to the patient, yourself and others
- Control the situation and keep people calm

First Steps to Treating a Patient: Scene Management is all about SAF-T

The **MOST IMPORTANT** job of the EFAR is to prevent further harm to anyone, including yourself.

When an emergency happens, the first steps are to... **SAF-T**

1. **(S) Check for Scene Safety.** If it is not safe for you to get involved (like if there is a fire or the shooter is still around) then DO NOT treat the patient until it is safe. Your safety comes first.
2. **(A) Call for the Ambulance and help.** Call immediately to give the ambulance time to arrive.
3. **(F) Fix Problems.** Calm the crowd, clear the area, and secure the environment. This moves people out of harm's way and rids distractions/dangers BEFORE you treat the patient.
4. **(T) Treat the patient.** Is the patient unconscious? Violently injured? Medically ill? ABC's!!!

SPECIAL CASE FOR FIXING PROBLEMS: If there are many patients, ask the patients who can get up and walk away to do so. This separates the low priority patients from the more serious ones.

REMEMBER: YOUR SAFETY COMES FIRST!!! IF YOU GET HURT, THEN YOU ARE NOT HELPING THE PROBLEM AND YOU ARE MAKING IT WORSE!!!

Calling the Ambulance: Shout for help, you should also call:

For any emergency, cell phone only: 112 (**W**hat **W**ould you **D**o?)

For the ambulance: 10177 (101 seven-seven for heaven)

For the police: 10111 (101 one-one for protection or gun)

AIRWAY, BREATHING and CIRCULATION (ABC)

The three **most important** bodily functions that keep humans alive are the **ABC's**:

Airway, Breathing and Circulation!!!

EVERYTHING YOU WILL LEARN TODAY CIRCLES AROUND THESE THREE THINGS!!!

YOUR #1 PRIORITY IS TO HELP A PERSON'S AIRWAY, BREATHING AND CIRCULATION!!!!

	Good 😊	Bad ☹️
Airway	Throat + mouth/nose are open and clear	Throat or mouth/nose are blocked or kinked
Breathing	Regular, deep breaths. Not struggling	Too slow/fast or not at all, coughing or wheezing
Circulation	Not bleeding, heart pumping normally	Bleeding, heart beating too fast/slow or not at all

When a patient has more than one problem, treat airway first, then breathing, then circulation

Lesson 2: Unconscious Patients

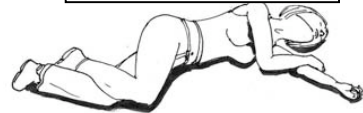


Patients in Shock: Very serious!

The symptoms of shock include confusion and nervousness; pale, sweaty and cool skin; and nail beds that stay white for a while when pressed. Shock can be caused by either heavy blood loss or extreme emotional stress, and can lead to unconsciousness and organ death due to the lack of blood.

When you see a patient in shock, place him or her in the Recovery Position (lying on side with head to the side):

Recovery Position



Choking

- **Conscious and can breathe:** encourage coughing
- **Conscious and cannot breathe (silent):** abdominal thrusts (adults), back thrusts (baby)
- **Unconscious:** CPR OR Recovery Position

Abdominal Thrusts

Back Thrusts



Unconscious Patients: CPR and the Recovery Position

Always make sure if the patient really is unconscious. If the patient doesn't respond and IS unconscious, there is a medical emergency. In this case, the first steps are always **SAF-T**

After **SAF-T**, follow these steps:

1. Check the patient's breathing.
 - a. Look for chest movement
 - b. Listen at the patient's mouth for breath sounds
 - c. Feel for air on your cheek



Decide if the patient's breathing is NORMAL or NOT NORMAL

Breathing is **NOT NORMAL** or **ABSENT**

START CHEST COMPRESSIONS

PUSH HARD AND FAST IN THE CENTRE OF THE CHEST.

- **Men:** at the nipples
- **Women:** between breasts above bra line

TRY TO MAINTAIN A CHEST COMPRESSION RATE OF 100 PER MINUTE AND CONTINUE TILL THE AMBULANCE ARRIVES.



If your patient is breathing normally, put the patient in the **Recovery Position** (on his or her side with the head facing sideways). This prevents the patient from choking on his or her own vomit. Keep checking the patient's breathing.

Lesson 3: Violent Injuries



Spinal Management

When a patient suffers a major general injury or a specific injury to the head or neck, it is important to keep the neck from moving. Major general injuries include a fall from a tree or building, car accidents, or general head and neck pain. Splint the neck to keep it from moving; you can use your hands to hold the head still or even use the patient's arms.



KEEP THE NECK SPLINTED AT ALL TIMES UNTIL THE AMBULANCE ARRIVES. NEVER LET IT MOVE!!!!

Bleeding Control: **DEEP** Wounds!

1) **D**irect Pressure, 2) **E**levation, 3) **P**ressure Point

KEEP DIRECT PRESSURE UNTIL BLEEDING STOPS!!!!



Bandaging

Burn Wounds:

White and Red burns: Run under cold water. Bandage with cool, moist bandages. **DO NOT APPLY OINTMENT, BUTTER OR TOOTHPASTE.**

Black burns: Use **DRY** bandages or clingwrap. **DO NOT APPLY OINTMENT, BUTTER OR TOOTHPASTE.**

Bloody Wounds:

Arms, Legs and Head: Bandage normally with cloth or gauze. For an injured eye, bandage **both** eyes.

Chest: bandage wound with an **AIRTIGHT** seal to protect the lungs. You can seal the wound with clingwrap, a plastic bag, a gloved hand, a cloth smeared with Vaseline, etc.

Abdomen: If organs are still inside the body, treat as normal bleeding and bandage normally. If the organs are outside the body, cover organs with a **MOIST** bandage. **DO NOT TRY TO PUSH THE ORGANS BACK INTO THE BODY!!!**

Impaled Objects: Do not remove impaled objects. Use a doughnut bandage to stabilize the object.

Amputations: Apply a tourniquet. Tighten tourniquet with a pen or stick. Keep severed body part.

Splinting

Do not pull or straighten the bone, splint the body part as you find it. Splinting is done to prevent further movement and damage to the broken area. Splinting can be done with any firm material (wood, newspapers, wires, pillows, other body parts, etc.). Put the splint on the limb and tie it with bandages. **If the patient is bleeding, stop the bleeding and bandage the wound BEFORE splinting** (Bleeding is part of Circulation, ABC's!). If you can, splint the joints above and below the bone.



Lesson 4: Medical Illnesses



Fits, Drug and Alcohol Overdose, and Psychosis



Drunk or drugged patients can be dangerous! Your safety comes first! If you do not feel safe or if the patient is holding a weapon then do not get involved! Call the police if the patient is violent.

If a patient is safe and conscious, it is best to not anger the patient and to keep them calm. If they want to vomit, let them vomit. **If they are having a fit/seizure, DO NOT physically restrain them and DO NOT open or put anything in the mouth (NO SPOONS)—just wait for the fit/seizure to stop.**

Once the patient becomes unconscious, if they are breathing **put them in the Recovery Position** so they don't choke on their own vomit. If they are not breathing then begin CPR.



Diabetes

If a patient is a known diabetic and is acting strange or confused, place something sugary to eat or drink in front of the patient and ask him or her to eat/drink it. Never feed it to the patient yourself because they may choke. Smearing jam under the tongue also works.



Dehydration

Patients, especially infants, who have been vomiting or have diarrhea are at high risk of dehydration. Treat them by giving them a drink made by mixing 1 liter of water with 8 teaspoons of sugar and 1 teaspoon of salt. **(1-8-1 and it's done!)**

Heart Attacks and Chest Pain

If a patient has chest pain, you can give aspirin/Disprin or their own angina medicine. The patient may also have left arm pain, nausea or short breath. **Call an ambulance or get the patient to a hospital AS SOON AS POSSIBLE!**



Stroke

Patients often slur their speech, act strange, or have half their face/body go limp. **Call an ambulance or get the patient to a hospital AS SOON AS POSSIBLE!**



Wheezing, and Abdominal Pain

Call an ambulance or get the patient to a hospital AS SOON AS POSSIBLE! In all cases, transport the patient in their most comfortable position. If the patient is asthmatic they can use their own inhaler.



Thank you for being such wonderful learners! We appreciate your involvement, and we thank you for helping us help the people of Cape Town and South Africa!

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The Emergency First Aid Responder Program is sustained by the University of Cape Town

Emergency First Aid Responder Certification Course

Final Exam

Name: _____

Please write clearly. Reprints for certificates will be charged.

ID Number: _____

(Birthday if you don't know your ID number).
Please write clearly. Reprints for IDs will be charged.

Mailing Address: _____

Contact No: _____

First Language(s): _____

Occupation: _____

Have you had any medical training before this course?

[None]

[First Aid]

[Other, not First Aid]

Explain:

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Final Exam: Emergency First Aid Responder Certification Course

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1. During an emergency, whose safety is the most important?

- a. The patient's
- b. Yours
- c. Other bystanders'
- d. The youngest children around

2. What are the emergency phone numbers in Cape Town?

- Police: _____ Ambulance: _____
- Any emergency, from cell phone only (toll free): _____

3-8. (worth 6 questions) The three most important body functions that keep people alive are the:

3-4: A _____

5-6: B _____

7-8: C _____

9. You witness a lady who was walking and then hit by a car. Which of the following do you do 1st? 2nd? 3rd? 4th? (Mark 1st, 2nd, 3rd and 4th)

- _____ call an Ambulance
- _____ check for Scene Safety
- _____ Fix problems (ex: calm the crowd and control the area)
- _____ Treat the patient

10. When dealing with MANY patients, how do you separate low priority patients from the more serious ones?

- a. Ask for the patients who can get up and walk away to do so. Treat the walking patients last
- b. Treat the unconscious patients first, then treat the ones in the most pain next
- c. Treat the unconscious patients first, patients with traumatic injuries second, and ill patients third
- d. Do not separate the patients into categories. This wastes valuable time

11. What do you do if someone is choking, still conscious, and silent (silent coughs / can't speak or breathe)?

- a. Stand back and encourage the patient to cough
- b. Begin CPR
- c. Insert your hand or long object into the throat to get the object out
- d. Begin abdominal or back thrusts

12. What do you do if someone is choking, still conscious, loudly coughing, and saying, "I can't breathe!"?

- a. Stand back and encourage the patient to cough
- b. Begin CPR
- c. Insert your hand or long object into the throat to get the object out
- d. Begin abdominal or back thrusts

13. Draw or describe how to treat shock (WHEN PATIENTS ARE PALE, SWEATY AND NERVOUS).

14. Number the steps of CPR in the correct order (Mark 1st, 2nd, 3rd, and 4th)

- _____ Check the patient's Breathing
- _____ Recovery Position
- _____ Scene Safety and Calling the Ambulance
- _____ Chest compressions

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15. When do you perform chest compressions?

- a. Patient is breathing and unconscious
- b. Patient is breathing and conscious
- c. Patient is not breathing and unconscious
- d. Patient is not breathing and conscious

16-18. What are the three steps to check the patient's breathing?

16. _____

17. _____

18. _____

19-20. CPR: Match the patient's condition with the proper treatment. EACH ANSWER IS USED ONLY ONCE:

- 19. ___ Patient is unconscious and not breathing
- 20. ___ Patient wakes up during CPR
- A. Recovery position and Monitor
- B. Continuous chest compressions

21-23. What are the three steps to stop bleeding? (In the order that they should be done).

21. 1st Step: _____

22. 2nd Step: _____

23. 3rd Step: _____

24. For which one of these conditions MUST you splint the neck? (Immobilize/Hold the head in place)?

- a. Patient with a heart attack
- b. Patient who fell from a second story window
- c. Patient with a stroke
- d. Patient with a violent fit/seizure

25. How should you bandage a burn?

- a. Bandage with a moist bandage if the burn is red or white, a dry bandage if the burn is black
- b. Apply ointment, butter or toothpaste before bandaging
- c. Remove the charred skin and pop any major blisters before bandaging
- d. Let the burn air-out and do not bandage at all

26. If possible, a chest wound should be bandaged with a(n) _____ bandage.

- a. Moist
- b. See-through
- c. Breathable
- d. Airtight

27. If a person's organs are hanging outside the body, you should:

- a. Cover the organs with a dry cloth
- b. Push the organs back into the body for protection
- c. Cover the organs with a moist cloth
- d. Give the patient something to drink as they will be thirsty

28. True or False (Question 28 only): Impaled objects should be removed before bandaging. (T) (F)

29. When splinting a broken bone, you should:

- a. Splint the bone in the position you find it
- b. Straighten the bone before splinting if you can
- c. Pull on the bone to give the broken ends more room
- d. Move the broken bone as much as possible to force circulation

30. A patient chokes on a roll, passes out and falls down a flight of stairs. You find him bleeding heavily with a severely broken leg and the roll still in his mouth. Which do you treat 1st? 2nd? 3rd? (Mark 1st, 2nd and 3rd)

___ The broken bone ___ The bleeding ___ Choking on a roll

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31. Draw or describe how to position a patient that is UNCONSCIOUS BUT BREATHING.

32. Why are unconscious patients put in the recovery position?

33. When someone is having a fit/seizure:

- a. Hold the patient's head to protect it
- b. Open their mouth or place something inside it, to assure an open airway
- c. Clear the area and then do nothing until the fit/seizure stops
- d. If you must, physically restrain the patient to prevent them from harming themselves

34. You see a friend drunk/drugged on an unknown substance. He passes out on the floor. You rush to him and find that he is unconscious but still breathing. What do you do after calling an ambulance?

- a. Pour water into his mouth to flush out the drugs
- b. Use smoke to help wake him up
- c. Lie the patient on his side
- d. Lie the patient on his back

35. A small child who is a known diabetic misses a meal and starts acting "drunk". What do you do?

- a. Lie her on her back and monitor for pulse and breath
- b. Call the police to report her for drinking at school
- c. Sit the child down and force feed her something sugary
- d. Place a sugary drink or food in front of the child and ask her to drink/eat it

36. Dehydrated patients can be treated by drinking a solution made from:

- a. 1 litre water, 8 tspns salt, 1 tspn sugar
- b. 1 litre water, 2 tspns salt, 4 tspns sugar
- c. 1 litre water, 2 tspns sugar, 4 tspns salt
- d. 1 litre water, 8 tspns sugar, 1 tspn salt

37. If a patient has slurred speech, unequal pupils, trouble walking, and half his or her face limp, what are they most likely suffering from?

- a. Stroke
- b. Heart Attack
- c. Drunk/Drugged
- d. Dehydration

38. Which of the following is NOT a warning sign of a heart attack?

- a. Chest Pain
- b. Weakness on one side of the body
- c. Pain shooting down the left arm
- d. Nausea / shortness of breath

39. Heart attacks may be partially relieved by:

- a. Caffeine (Coffee/Tea)
- b. Aspirin/Disprin
- c. Warm water (possibly with sugar)
- d. Antibiotics

40. How do you treat a patient with a painful medical emergency? (heart attack, stroke, wheezing, ab pain)

- a. Give the patient something to eat or drink, to relieve the pain. Rush to hospital
- b. Put the patient in their most comfortable position. Rush to hospital
- c. Massage the area of pain to relieve tension. Rush to hospital
- d. There is nothing you can do

Box 1: EFAR details	Box 2: Patient details
Name: _____ EFAR ID# / DoB: _____ Address: _____ _____	Age: <i>(circle one or write)</i> _____ years old Baby - Child - Teenager - Adult - Old Person <hr/> Gender <i>(circle one)</i> : Male - Female

Box 3: Incident details	
Date: Day: _____ Month: _____ Year: _____ Time of Incident: _____ Time you arrive on scene: _____ Time of arrival of EMS OR arrival to hospital: _____	Location <i>(street name)</i> : _____ _____ Community <i>(circle one or write)</i> : Lavender Hill 7945 - Other: _____

Box 4: Injury details			
What kind of emergency was it? <i>(circle any one or write)</i>			
Assault No weapon Gun Knife Other: _____	Motor Vehicle Accident Passenger Pedestrian	Other Bleeding Fracture Burn Other: _____	

Please circle injured areas

Front

Back

Box 5: Treatment details	
What care did you provide? <i>(circle all actions taken or write)</i> CPR Apply dressing Recovery Position Splinted fracture Stopped bleeding Other: _____ _____ _____	What equipment did you use? <i>(circle all items that you used)</i> Gloves Airtight chest seal Other: _____ First Aid Dressings <hr/> Was patient taken to hospital? <i>(circle one)</i> Yes No To which hospital did patient go? <i>(circle one or write)</i> Victoria Other: _____