

**DEVELOPMENT AND USABILITY TESTING OF A DATA VISUALISATION
PLATFORM FOR AN AFRICAN TRAUMA DATA REGISTRY**

by

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Thank you to the AFEM team for your support near and far. And, of course, thanks to Megan.

ABSTRACT

Introduction

Trauma is a significant contribution to the global burden of mortality and disease, especially in sub-Saharan Africa. The methods for tracking, recording, and analysing the incidence and causes of trauma are underdeveloped. To address this, The African Federation for Emergency Medicine (AFEM) developed a trauma form and Trauma Data Registry to collect trauma data in multiple sites in sub-Saharan Africa. We undertook a study to create, and assess the usability and functionality of, a trauma data visualisation platform for use in conjunction with the Trauma Data Registry.

Methods

We created a web-based trauma data visualisation platform for use with the AFEM Trauma Data Registry. This study involves a usability assessment of the AFEM Trauma Data Visualisation Platform to determine the specific website features and analytical needs of African trauma research facilities. This was done by surveying individuals from healthcare facilities that are currently using the AFEM Trauma Form. Two types of questionnaires were administered: Questionnaire I gathered information on the study population and their expectations for the platform, and Questionnaire II assessed the usability of the platform after it was introduced. Surveys took place in person and online, with the last group of questionnaires being administered on-site at the healthcare facility. Data were captured via Survey Monkey online and paper survey. The results were entered into Excel and analysed using descriptive statistics using Stata Version 14.

Results

A total of 45 healthcare practitioners from eight countries participated in the background survey. The greatest proportion were trained in Tanzania (14, 31.1%) and Ethiopia (14, 31.1%). The mean age of participants was 32.6 (SD=6.6). The mean number of years reported for working at their current facility is 3.7 (SD=3.5). The greatest number of participants in the survey were physicians (22, 48.9%) and specialists (11, 24.4%). Over half (53.3%, n=24) selected that they had moderate experience with data analysis, and the majority reported that they had less than three publications. A total of 34 HCPs participated in the usability study. The mean scores for the usability questionnaire portion were high, with all of the scores being above 6. Major positive themes of the participant comments included easy to use and time

saving, major negative themes included feasibility concerns, and comments specific variable to add were common.

Discussion

There is a lot of heterogeneity in the data analysis and technology experience of participants. The participants were overall satisfied with the Trauma Data Platform. Participants' comments and suggestions on elements to add indicate that there is still work to be done to design a Trauma Data Platform that is suitable for this setting.

Conclusions

Overall satisfaction with the Trauma Data Platform was high, and the user comments and suggestions will be incorporated into future versions of the platform. This research highlights the importance of considering the feasibility of health technology in its introduction.

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ACRONYMS AND ABBREVIATIONS

| | |
|------------|---|
| EM | Emergency Medicine |
| EC | Emergency Care |
| HCP/HCPs | Healthcare practitioner[s] |
| LMIC/LMICs | Low and Middle Income Country[ies] |
| UMIC/UMICs | Upper and Middle Income Country[ies] |
| GNI | Gross National Income |
| PPP | Purchasing Power Parity |
| BG | Bridget Griffith |
| WCDEM | World Congress on Disaster and Emergency Medicine |
| TASH | Tikur Anbessa Hospital |
| PMH | Princess Marina Hospital |
| MNH | Muhimbili National Hospital |
| CSUQ | Computer System Usability Questionnaire |
| SSA | Sub-Saharan Africa |
| GI | Gastrointestinal |
| IGEC | Institute for Global Emergency Care |
| EU[s] | Emergency Unit[ies] |
| GBD | Global Burden of Disease |
| EMR | Electronic medical record |

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1 CHAPTER 1

INTRODUCTION

1.1 Background

The African Federation for Emergency Medicine (AFEM) provides the following definition of acute care: “The provision of initial resuscitation, stabilization, and treatment to acutely ill and injured patients, and delivery of those patients to the best available definitive care, regardless of their ability to pay.” As a subset of acute care, emergency care (EC) is specifically “concerned with providing effective health action in response to extreme risk under intense time pressure to address emergent health conditions that present sudden or unexpected threats to life or limb”(1, 2).

The International Federation for Emergency Medicine (IFEM) emphasizes the same part of the health system, but uses the term emergency medicine(EM), and defines it as “a field of practice based on the knowledge and skills required for the prevention, diagnosis and management of acute and urgent aspects of illness and injury affecting patients of all age groups with a full spectrum of episodic undifferentiated physical and behavioural disorders; it further encompasses an understanding of the development of prehospital and in-hospital emergency medical systems and the skills necessary for this development”(3). In this dissertation, the term “emergency care” or “EC” will be used to refer to facility-based treatment of acute or emergent conditions, and we will use “emergency medicine” to refer to the medical speciality providing emergency care.

1.1.1 Emergency Medicine in Africa

The specialty of emergency medicine is a relatively new discipline in Sub-Saharan Africa(SSA), with the creation of the first EM residency program in 2004 at the University of Cape Town in South Africa(4). Since then, this nascent discipline has expanded to include EM training programs in Botswana, Tanzania, Ethiopia, Ghana, Sudan, Rwanda, and Uganda(4-13).

Even in countries that do not have formal EM training programs, there are efforts to unify healthcare practitioners (HCPs) around the practice and promotion of EM. One such development with this goal in mind is the creation of national professional societies. Currently, there are eight societies in Africa: Emergency Medicine

Association of Tanzania (EMATZ), Emergency Medicine Society of South Africa (EMSSA), Egyptian Society of Emergency Medicine (EgSEM), Libyan Emergency Medicine Association (LEMA), Ethiopian Society of Emergency Medicine Professionals (ESEMP), Sudanese Emergency Medicine Society (SEMS), Society of Emergency Medicine Practitioners of Nigeria (SEMPON), and Rwanda Emergency Care Association (RECA). In addition to these country-recognised EC societies, there are other affiliate organizations with similar goals, including Emergency Care Society of South Africa (ECSSA), the Egyptian Resuscitation Council (EgRC), and Emergency Medicine Uganda (EMU)(1).

The AFEM, which was formed in 2009, works as an umbrella organization for all of the aforementioned societies and affiliate organizations. It also aids in the creation of EM societies for previously unrepresented African countries. Its mission is: “To advocate to all stakeholders for universal access to EC and to ensure scientifically rigorous, quality EC systems by developing clinical and research capacity, provision of technical guidance protocols and frameworks, and building collaborative networks across the continent and beyond.” (14).

In addition to organizing and supporting African EM societies, the AFEM is involved in a range of other projects that align with its mission and overarching goal of promoting African EC. With members from over 40 countries, it works to unify HCPs and researchers with an interest in African EC. The organization uses regional consensus meetings to identify specific priorities and yearly goals. The AFEM provides data to inform policy-making, offers open-access EM training resources and curriculum guides to nurses, midlevel providers, and specialists, and coordinates continuing education programs for HCPs in EM.

As emphasised in AFEM’s mission, the provision of quality EC involves the production and keeping of scientifically rigorous data and publications that are locally-relevant. This includes systems research, feasibility studies, and epidemiological analyses of the specific burden of ailments typically treated within the scope of EC in Africa. One of AFEM’s projects is the AFEM Trauma Form and AFEM Trauma Registry. The purpose of these is to close the gap around the access and provision of data relevant to EC. The AFEM Trauma Form (Appendix 1) is a standardized clinical chart for capturing essential information on trauma patients and is currently in use in several

hospital sites. The information collected on the trauma form is used both as a means of directing clinical care at the bedside and also as a data repository. So far, there has been good success with the trauma data collected using the AFEM Trauma Form.

There are many region-specific obstacles that hinder the generation of quality research on EM and EC, including lack of epidemiologic data on emergency conditions, the underdevelopment of in-hospital EC, confusing prehospital terminology, poorly defined prehospital research priorities, the lack of qualified local prehospital researchers, and a poor understanding of local prehospital care systems(15). These obstacles form notable foundational gaps in the generation of research on EC in Africa.

1.1.2 Documentation of emergency conditions in Africa

The burden of acute disease in SSA is severely under-documented(2). Although the data needed for quantifying the actual incidence of trauma are limited, it is estimated that trauma contributes approximately 10% to global mortality and 12% to global morbidity(16-19). These proportions are disproportionately high, with an estimated 80% of death from injuries occurring in low and middle-income countries(LMICs).

Trauma contributes substantially to the burden of disease and mortality throughout the world, but particularly in LMICs. In addition to injuries from trauma, the burden of acute illness is particularly overwhelming in LMICs, which suffer the highest rates of every category of injury. This includes road-traffic injury and drowning; maternal death from acute complications of pregnancy; and the highest rates of acute complications of communicable diseases, including respiratory infections, malaria, and HIV(20).

Much of this burden is preventable, but prevention efforts are hampered by a lack of published data to demonstrate the need for improvements to health systems that can reduce morbidity and mortality and infrastructure that can reduce the incidence of trauma. Without published data, it is not possible to convince policy makers and other stakeholders of this multifaceted problem and to help prioritize and design effective intervention programs.

1.1.3 The African publication gap

The production of peer-reviewed publications is an essential part of research and practice for multiple reasons. The publication of research results is what informs the greater research community and pushes the discipline forward. These publications connect medical discoveries to medical practice and provide context and explanation to medical practice in different settings. In addition, there are often publication requirements for the completion of education, such as a medical residency program, and promotion, such as earning tenure at an academic institution. Without the necessary resources to produce peer reviewed publications in a specific setting, it hinders both research progress and professional progress.

There is a dearth of injury-related peer-reviewed literature being published by researchers in Africa compared to other regions of the world. The great majority of health publications, even those pertaining to health in LMICs, are published by research groups at institutions in high-income countries, and are most often published in high-profile, Anglophone journals(21). As of 2005, more than 90% of the publications were produced by scientists in 20 countries, with over one-third of the publications coming from the United States alone(22). This “publication gap” is due to multiple factors, including lack of resources, lack of access to data, and unequal collaboration with overseas partners. Often, this results in research focused on broad, regional problems rather than national challenges that are a greater priority for local researchers (23).

There is an enormous research gap on trauma in SSA. This data gap obscures the profound health impact of the lack of access to timely care for injuries, and in many countries, trauma care system development is only slowly becoming a priority. Barriers to publishing trauma data include lack of documentation of trauma and poor reporting, but these barriers also include intrinsic gaps in the research and publishing capabilities of African research institutions. When data do get reported, they are often not analysed and published constructively(21).

1.1.4 AFEM Trauma Form

In order to address the lack of critical documentation of trauma in SSA, the AFEM created a data collection tool to be used in African EUs to capture data on all trauma

cases. The tool, called the AFEM Trauma Form, takes the form of a clinical chart, and it is either used as the primary clinical chart or a supplement to be filled at point of care in the EC setting. It was developed after consulting the literature on trauma data collection, the WHO recommendations on essential trauma care(24), and other trauma forms used in Tanzania. The form was then refined via focus group discussions among administrators, nurses, and physicians working in several African EUs.

The Trauma Form is available every day in each patient room, and on-going training on its use for HCPs is conducted in multiple settings, including at teaching conferences. The forms are cross-referenced with the admissions book to ensure that all trauma cases are identified and properly documented.

The clinical information from the chart informs a multi country database, called the AFEM Trauma Registry. The aggregate data from the registry provide essential information for research on trauma in Africa and, potentially, improves early intervention in injured patients, informs future preventive initiatives, and influences policies related to care delivery. The collection of these data inspired a need for a way to access the data remotely through an online or server-based system to increase the ease of access to the data for HCPs.

The Trauma Form is currently being used to document the burden of injury in multiple countries in SSA, including Tanzania, Ethiopia, Cameroon, and the Democratic Republic of Congo, and it will help to characterise risk factors associated with these injuries. Use of the Trauma Form is pending in Uganda and will begin upon the completion of hospital construction at Mulago National Referral Hospital.

In conjunction with the AFEM Trauma Registry the creation of a platform to access and visualise the data would begin to address barriers to research and publishing observed in research by presenting the data in a more useable form. This data platform would be made available to all institutions participating in the AFEM Trauma Data Project, and it would provide them with a method of uploading, storing, and analysing the trauma data coming from their facility. In this way, as the AFEM Trauma Registry database grows, there is already a platform in place to help the study institutions take ownership of their data.

1.2 Motivation for study

When compared to other regions of the world, the amount of EC-related peer-reviewed literature being published by researchers in Africa is lacking in both quantity and quality. Health research institutions in SSA are not the main worldwide producers of research, and they are not the main producers even among LMICs. Although this is the current state, their research activity is of importance, and the lacuna in Africa-based publishing may cause journals to be missing evidence, analyses, perspectives, and nuance essential to solving health problems peculiar to the region(21, 25).

This publishing gap has also been linked to “brain drain” in both academia and medicine, incentivising African scientists and HCPs to seek positions in other countries to gain more publishing opportunities (26). It can also be a hindrance to international collaborations and funding.

Scientific and statistical tools are noted as a specific cause of the publishing gap in SSA(21). This includes tools for the capture, storage, and analysis of data. These tools are an essential foundation to publishing and furthering scientific discovery There is a need for a way to provide local data and for it to be accessible to HCPs and researchers.

There is a need for a way to provide local clinical data to health science researchers that is in both a raw format and a graphical or descriptive format that is straightforward in interpretation and scope. In addition to being important for research, data accessibility is integral to influence other factors related to building health systems, including motivation for health policy changes, advocacy, and funding.

The data platform seeks to remedy this by providing trauma researchers with a built-in method for analysing the aggregate data coming from their facility and others also participating in the AFEM Trauma Registry. The trauma registry, in conjunction with the data visualisation platform, will serve as a conduit for trauma data that drives the evaluation, prevention, and research of trauma care, and it can be used for quality control and planning. (27).

Other research groups have used data visualisation to increase the usability and understandability of global health data to the general public, such as Gapminder(28, 29). Using a similar vision, we aim to design a data visualisation platform that makes trauma data more accessible to Africa-based HCPs and researchers in EC. This platform will act as a resource for individuals interested in studying retrospective

trauma data for the purposes of publishing, policy making, or using data trends to inform changes in clinical practice healthcare facility design. This data visualisation platform will provide users with retrospective data from their respective healthcare facility and aggregate data from all other healthcare facilities using the AFEM Trauma Form. The aim of the visualisation portion of the website is to increase the accessibility of the data by providing built-in analytical tools to create descriptive visualisations of the data. Therefore, we undertook a study to better understand the components of a data visualisation platform that are important for HCPs working in EC in Africa.

1.3 Aims and objectives

The primary aim of this study is to assess the usability and functionality of a trauma data visualisation platform to be used in conjunction with the AFEM Trauma Registry.

The secondary aim of this study is to gather information and opinions regarding the wants and needs of a data analysis platform specifically designed for African EC practitioners and researchers.

In order to achieve these aims, this study has the following objectives:

- To create a data visualisation platform for the pre-existing AFEM Trauma Registry
- To assess the usability of the platform through surveys and user testing to inform the development of an Africa-specific low-bandwidth website.

1.4 Summary

As EC develops in SSA, there is a clear gap in the amount and detail of research being published in the field. To address this, the AFEM developed and piloted a trauma form for capturing data on the burden of trauma seen in African care facilities. In conjunction with this form, this study aimed to design and test a trauma data platform software that can be used to store and analyse the trauma data. The purpose of this study is to assess the usability and functionality of the software, and to make suggestions on how to further improve it for use in the African EC setting. This will be accomplished by collecting information on the data storage and analysis preferences and needs of African EC workers and by measuring the usability of a pilot version of a trauma data platform. The AFEM Trauma Data Platform is referred to as the “Trauma Data Platform” for the rest of this dissertation.

The aims and objectives of this study will be described in the following chapters:

Chapter 2 is a literature review in which the current state of EC is explored, in addition to current research on the African publication gap and the use of usability science in assessing technologies for healthcare.

Chapter 3 outlines the design and creation of the Trauma Data Platform, including the survey methodology used to collect information on the design of the Trauma Data Platform.

Chapter 4 outlines the methods used to assess the usability of the Trauma Data Platform.

Chapter 5 details the findings of the study, which includes the results of the background survey from both online and the in-person administration and the results of the usability assessment of the Trauma Data Platform. Additionally, the user comments from the surveys are organised and presented by theme.

Chapter 6 is the discussion, which interprets the findings reported in Chapter 5 and outlines the applicability of the Trauma Data Platform in a broader context. It also includes the limitations of the study.

Chapter 7 is the conclusion, which incorporates both the researcher's own conclusions and the conclusions of the participants in the study. It also includes the researcher's recommendations for improvements and changes to the Trauma Data Platform.

2 CHAPTER 2

LITERATURE REVIEW

2.1 Africa-Based Publications

In 2014, the World Bank and Elsevier published an extensive report on the status of the generation of publications coming from SSA: “*A Decade of Development in Sub-Saharan African science, technology, engineering, and mathematics research*”(30). This report outlines much of the progress on African publications in the health field. In this report, Africa is split into three regions: Eastern, Western, and Southern; South Africa is considered separately from the southern region.

The report found that although SSA greatly increased the quantity and quality of its publications between 2003 and 2012, countries with similar baseline levels of output grew at a faster rate over the same period. As illustrated in Figure 1, all three of the SSA regions more than doubled their research output over the decade and increased the subcontinent’s share of global research from 0.44% to 0.72%. Although this is a notable accomplishment, SSA still contributes less than 1% of the globe’s research while being home to 12% of its population.

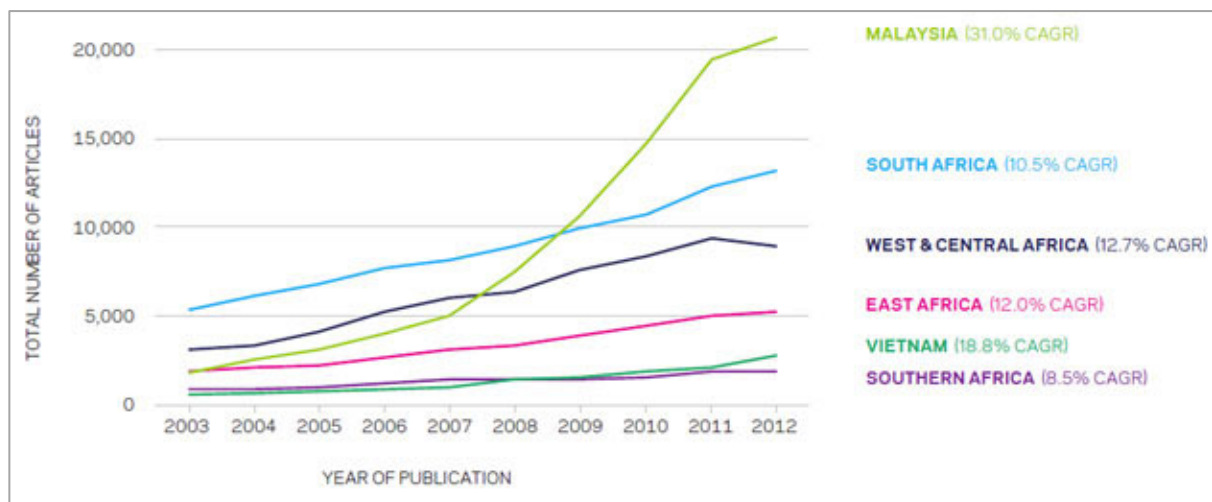


Figure 1: Overall number of articles and Compound Annual Growth Rate (CAGR) for SSA regions and comparator countries from 2003-2012(30).

In addition to its proportionally low research outputs, the Sub-Saharan research output in the fields of science, technology, engineering, and math (STEM) lags in comparison to other subject areas. From 2003 to 2012, STEM research makes up only 29% of all

the research done in SSA. Table 1 compares the three African regions, South Africa, Malaysia, and Vietnam to demonstrate that STEM research is comparatively low in comparison to South Africa, Malaysia, and Vietnam. Conversely, the relative output in the health sciences, social sciences, and humanities increased in all SSA regions over the same time period.

This overall skew of scientific output towards the health sciences and away from physical sciences and STEM is a concern that dates back to the 1990s. *“The continent’s research emphasizes medical and natural resources disciplines to the detriment of disciplines supporting knowledge based economies and societies.”*(31).

| | Southern Africa | East Africa | West & Central Africa | South Africa | Malaysia | Vietnam |
|------------------------------|------------------------|--------------------|----------------------------------|---------------------|-----------------|----------------|
| Physical sciences & STEM | 28.0% | 25.3% | 32.3% | 44.7% | 69.2% | 67.9% |
| Agriculture | 33.4% | 34.4% | 28.2% | 22.9% | 15.3% | 22.0% |
| Health Sciences | 44.8% | 47.8% | 43.1% | 26.5% | 13.1% | 16.5% |
| Social Sciences & Humanities | 17.5% | 15.4% | 14.0% | 21.8% | 19.4% | 8.4% |
| Life Sciences | 15.7% | 15.0% | 15.2% | 8.7% | 5.1% | 8.6% |

Table 1: Total article output by subject groupings for Africa regions and comparator countries, 2012. For each subject area (row), the region with the highest percentage is bold(30).

Even if the health sciences are an over emphasized field of research in SSA, there is still a large difference between the research output of this region and that of high-income, Anglophone countries. Paraje et al. examined the global distribution of health research publications from an earlier period, 1992-2001. This study illustrates the disproportional distribution and high concentration of scientific publications from the highest income countries; the top 20 producers of scientific publications compose more than 90% of the overall generation of publications. Furthermore, although 23 languages were represented by at least one publication, about 96% of publications were in English(22).

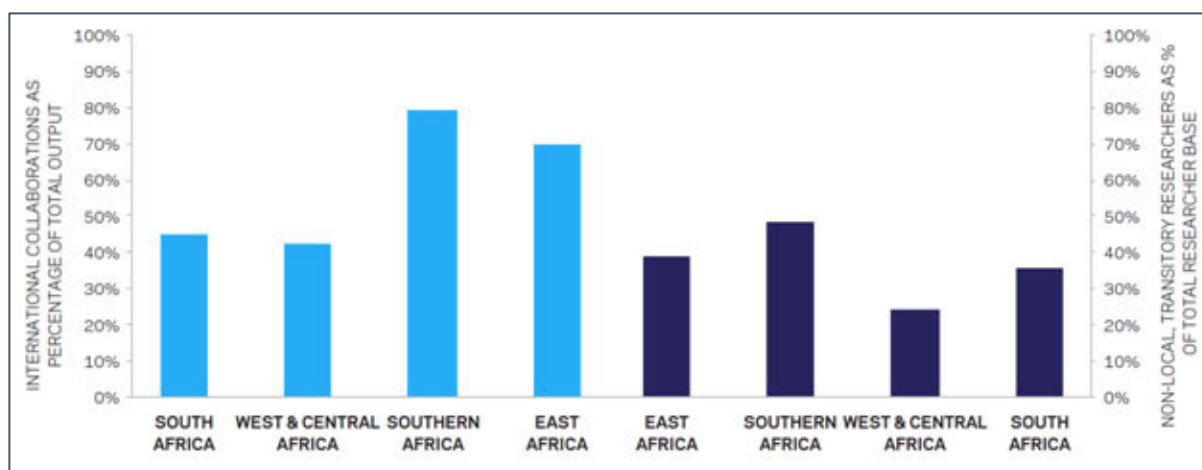


Figure 2: Level of international collaboration for SSA regions (2012) and percentage of non-local, transitory researchers for SSA regions, 1996-2013(30).

A potential reason why there is such a large emphasis on health science research is because of the heavy influence and reliance on international research collaborations and visiting faculty for the generation of research and publications. In 2012, 79% of all research in Southern Africa and 70% of research in East Africa was produced through international collaborations. In contrast, 45% of South Africa’s research output was produced through international collaboration. Similarly, a large percentage of SSA researchers are transitory and/or based at a research institution outside of SSA. A total of 39% of East and 48% of Southern African researchers fit into this category (Figure 2).

2.2 Country profiles

This study was conducted in three countries: Tanzania, Botswana, and Ethiopia. Together, these countries represent three different examples of the development of EC in an African healthcare setting.

2.2.1 Tanzania

Tanzania is classified by the World Bank as a low-income country with a gross national income (GNI) per capita based on purchasing power parity (PPP)¹ of \$2,510 and a

¹ GNI PPP is based on international \$. Data are in current international dollars based on the 2011 ICP round.

population of 51.82 million in 2014, which makes it one of the world's poorest economies in terms of per capita income.

The average life expectancy is 61 years, which is an 11-year increase since 2000. 70% of the population lives in rural areas. The under-5 mortality rate is 48.7 per 1000 and the maternal mortality rate is 398 per 100,000 live births(32-34). The low life expectancy is impacted by high rates of poverty (>28.2% below the poverty line)(32), infectious disease (including HIV, malaria, tuberculosis, plague, typhoid, and schistosomiasis), trauma, and poorly controlled chronic medical conditions(5).

The most DALYs lost are from HIV, TB, and Malaria. Nationally, Tanzania is experiencing an increase in deaths due to chronic disease, such as diabetes and heart disease, in addition to an increase in death due to road traffic injury(34).

2.2.2 Emergency care in Tanzania

Muhimbili National Hospital (MNH), which is a public government hospital located in Dar es Salaam, inaugurated its first full capacity EU in collaboration with Ministry of Health and Abbot Fund Tanzania in 2009. Following that, the first EM residency program was started in 2010, with its first graduates in 2013. The emergency nursing curriculum was introduced in 2011. The Emergency Medical Association of Tanzania (EMATZ) was formed and ratified by the Ministry of Health in 2011(5). Medical education has been available in the region since 1963(33).

2.2.3 Trauma care in Tanzania

Tanzania has one full-capacity trauma care centre located in the Eastern Zone of the country. All patients needing trauma interventions are dependent on being referred to this facility from lower levels of care. Country-wide, Tanzania does not have a formal trauma care system. To address this, specific instruction in trauma management skills is incorporated into the curriculum of registrar training programs at different facility levels(35). According to a cross-sectional, one-day survey of trauma burden of all district and regional public hospitals in mainland Tanzania, 9.7% of patients presented with trauma-related complaints. Road traffic crash was the most common mechanism of injury that resulted in the need for trauma care. In the Eastern Zone, which is where MNH is located, 29.7% of patients presented with trauma-related complaints. This

large proportion can be attributed to the high-population density in this region and the zone's provision of the only hospital with a trauma care centre(36).

2.2.4 Botswana

Botswana is classified by the World Bank as an upper middle-income country (UMIC), with a GNI (PPP) of \$16,030 and a population of 2.220 million in 2014. The average life expectancy is 62 years, which is a 14-year increase between 2000 and 2012 and notably higher than the regional increase of 7 years. Approximately 43% of the population lives in rural areas. The under 5 mortality rate is 43.6 per 1000, and the maternal mortality rate is 129 per 100,000 live births(37-39). As of 2014, the prevalence of HIV was 25.2%(40).

The country has experienced over four decades of uninterrupted civilian leadership, progressive social policies and significant capital investment(41). This has resulted in rapid economic growth, poverty reduction, and improvements in living standards. Although this is the case, Botswana has one of the highest distributions of family income (GINI index) in the region at 60.46 in 2009, indicating a broad gap between the nation's wealthy and poor populations(42). The diamond industry has fuelled much of the country's expansion, accounting for more than one-third of the government's revenues and 70-80% of its export earnings, which leaves the country vulnerable to fluctuations in demand. Tourism and livestock (cattle) are other significant areas of economic earnings(41).

2.2.5 Emergency care in Botswana

Currently, EC is provided by health professionals with a broad variety of non-emergency focused training, and many of the practitioners are expatriates. This is mostly because the University of Botswana did not open their medical school until 2009. Students interested in pursuing medicine were sponsored by the government to seek medical education outside of the country. Furthermore, the government's efforts to increase the number of doctors in the country included incentivising foreign doctor appointments(43). Emergency Medicine was recently recognised as specialty by Botswana Health Professions Council; the first EM specialists were employed by the Ministry of Health in late 2017.

The University of Botswana School of Medicine has a Division of Emergency Medicine that coordinates a 4-year post-graduate Emergency Medicine residency training program. Within that school, the MMed (EM) programme was introduced in January 2011, but logistical problems meant that the first cohort of 2 specialists only graduated in late 2017. At the commencement of the programme, the predicted annual intake of new residents was 4-6 (9). The first international EM conference in Botswana was held in May 2014 (9).

2.2.6 Trauma care in Botswana

In response to World Health Assembly Resolution 60.22, which urged all member states to strengthen their trauma and emergency care services(44), the Ministry of Health Botswana and the Department for International Collaboration of Haukeland University Hospital in Norway created a trauma care improvement program which ran from 2007 to 2009. The main objective of this program, titled “Better and Systematic Team Training” (BEST) was to improve trauma care services in Botswana through education(45). At the time of the training, a national trauma organisation and a national trauma registry did not exist. A much more recent publication by Mwandri et al. indicated that, in an assessment of three major public hospitals, there has been substantial improvement to the resources necessary for the provision of trauma care, but there remains an absence of trauma teams, trauma team training, quality improvement initiatives, trauma-related policies, and presence of a trauma registry in all of the hospitals evaluated(46).

2.2.7 Ethiopia

Ethiopia is classified by the world bank as a low-income country, with a GNI(PPP) of \$1,500 and a population of 96.96 million in 2014. The life expectancy at birth is 64 years, and the under-5 mortality is 59.2 per 1000. Maternal mortality is 353 per 100000 live births(47-49). The country is over 80% rural, and it has a GINI coefficient of 33.6(47).

The country has experienced a host of crises in the last two decades that have led to serious health issues for its citizens. This includes drought, famine, an influx of refugees and IDPs, armed conflicts among its people, and epidemics. In addition, the country is ranked 99 out of 103 on the UNDP Human Poverty Index, making it one of the poorest countries in Africa.

The main health concerns of Ethiopia include high maternal mortality, malaria, tuberculosis, HIV/AIDS, acute malnutrition, and diseases that are a direct result of limited access to clean water. The World Health Organisation estimates that more than half of the population lives more than 10km away from the nearest health facility, usually in regions with poor transportation infrastructure. The predominately rural portion of the population experiences limited access to healthcare and inefficient distribution of medical supplies(48, 49).

2.2.8 Emergency care in Ethiopia

No national or regional guidelines exist for triage, and EUs function like outpatient departments. With the exception of two teaching hospitals, all government hospitals in Addis Ababa do not have designated EUs. In 2008, the University of Wisconsin, United States, and the University of Toronto, Canada, joined the AAUMF to support Ethiopia's first EM post-graduate training programme in EM for physicians and nurses. The AAUMF also has a Master's programme in EM for nurses. In addition, under the AAUMF leadership, the Ethiopian Society of Emergency Medical Professionals was established in 2012(50). In 2012, in order to address the 1:100,000 doctor to patient ratio, the Ethiopian government opened 13 new medical schools(51). The Emergency Medicine Task Force, which is based at the Addis Ababa School of Medicine, has been a pioneer for many of these developments(52).

2.2.9 Trauma care in Ethiopia

There is limited information on the status of the trauma care system in Ethiopia. There have been several studies, including a cross sectional study and a retrospective chart review, to quantify the burden of traumatic injury in Tikur Anbessa Hospital and others in the surrounding area(53, 54). Furthermore, a study of predictors of early mortality among emergency department patients quantified that approximately 30% of patients who died within 72 hours of admission suffered a traumatic injury (including traumatic brain injury or polytrauma/non-head trauma)(55). These types of studies are an important step toward understanding the burden of traumatic injury on the patient population and creating training tools and interventions to specifically address this burden.

2.3 Emergency Care Data in Sub-Saharan Africa

Overall, the number of DALYs lost to injury worldwide is decreasing, but there is a lot of variation of success in this reduction by region(56). Injury accounts for 10% the global burden of disease(57). It is estimated that 45% of deaths and 36% of all disability-adjusted life years worldwide are amenable to secondary prevention via emergency care services(58). In boys under the age of 15 years, DALY rates per 100 000 vary from a low of 468.4 (UI 427.7 to 509.7) in western Europe to a high of 6471.4 (UI 4197.1 to 8680.9) in central SSA. In girls under the age of 15 years DALY rates vary from a low of 307.4 (UI 277.9 to 336.8) in western Europe to a high of 4788.1 (UI 3260.4 to 6354.7) in central SSA(56).

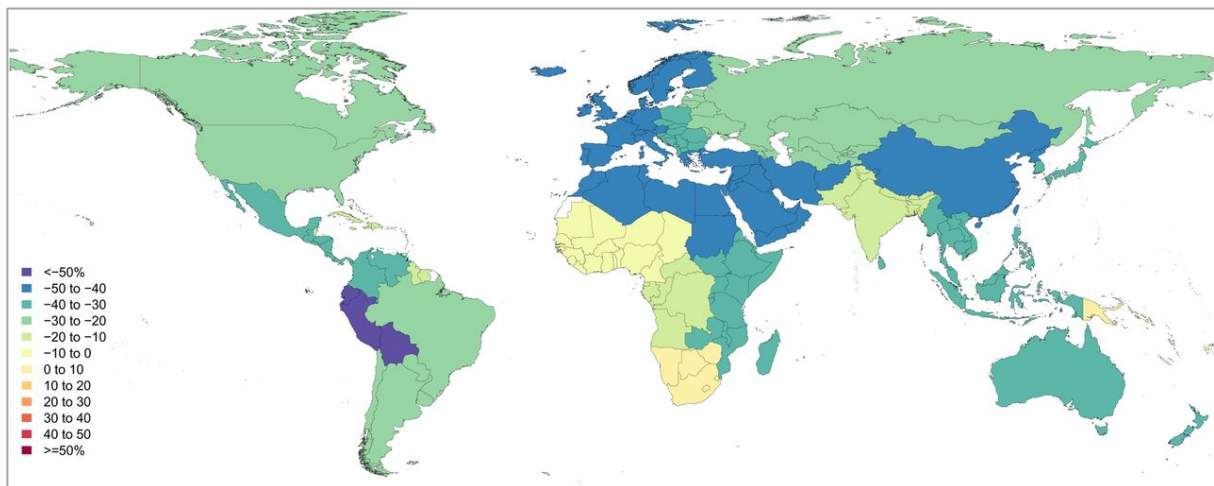


Figure 3:Percent change in age-standardised all-injury disability-adjusted life year (DALY) rates 1990–2013(56).

The Centres for Disease Control and Prevention (CDC) defines trauma as "an injury or wound to a living body caused by the application of external force or violence." EC most often addresses acute trauma, which can occur with the sudden, one-time application of force or violence that causes immediate damage to a living body(59).

The first EM conference in Botswana occurred in May of 2014. This meeting was focused around setting the EC agenda for SSA. The conference generated 11 major assumptions to be made about EC in Africa (Table 2) (60).

| | |
|-----|---|
| 1) | Emergency care needs abound in the southern African region |
| 2) | Health related emergencies promote and may emanate from vulnerability, inequity and poverty. |
| 3) | The State (particularly in constitutional democracies) is the principle custodian of a country's health |
| 4) | A poor emergency care response' can render the health system complicit in the vulnerability that a citizenry endures. |
| 5) | The demand for emergency care exceeds its supply. |
| 6) | There is an ethical obligation to manage emergencies, scarce EM resources and EM related costs. |
| 7) | This presents an opportunity to enhance the value proposition of emergency medicine in the developing world context. |
| 8) | EM design must be sustainable to promote population confidence and public safety. |
| 9) | Micro-economic evaluations at the treatment level are likely to identify cost drivers. |
| 10) | The development of an evidence-informed policy landscape for EM is paramount to guide sustainable and ethical implementation, relevant to country need and resource availability. |
| 11) | Positive feedback mechanisms after EM evaluations are likely to enhance quality |

Table 2: 11 Major assumptions of African emergency care (53)

2.4 Trauma registries

A trauma registry is a database which records the epidemiology, processes, and outcomes of trauma care within a single health facility or a network of facilities. These registries have been essential to measuring the impact of injury and quality of care in many high-resourced settings. In addition, they have driven the improvement of quality of care and the reduction of mortality through the provision of methods for measuring changes in outcomes over time(61, 62). The utility of trauma registries as a platform for the encouragement of research, development of improved responses, and evaluation of quality of care extends to lower resourced settings, such as health facilities providing trauma care in LMICs(63). In this setting, registries have also been used to advocate for the creation of new and better policies for the support of patient care(64).

Although the benefit of creating and maintaining trauma registries is known, a 2015 review by O'Reilly et al. stated that, within developing countries, there are less than 100 trauma registry publications on less than 50 registries in just 21 countries. Within those registries, there is limited standardization in the way that certain key attributes, such as injury severity scores and vital signs, are collected, which limits the use of these registries for comparative analyses. Several trauma registries in this review collected less than 20 variables(63). Although this is the case, the review also acknowledges the importance and functionality of keeping registries in under-resourced environments. This is an improvement from a review done in 2012, which was able to detect even less evidence of publications on registries being maintained in developing countries(62).

In a series of semi-structured interviews of trauma registry custodians in both developed and developing countries, interviewees stated that the success of trauma registries, especially those being introduced in resource-constrained settings, depends on several factors, including adequate funding and trained staff. A local champion and engagement with key stakeholder also play an important role in the success of a trauma registry. It should have a clear purpose and certain protections put in place to ensure it can capture and produce high-quality data(65).

Overall, the utility of trauma registries in both high and low resourced settings is well-recognised. As emergency care systems, and trauma care systems specifically, continue to develop in low-resource settings, it is important to consider the creation of a trauma registry in the early stages of these systems. Practitioners and data specialists alike can learn from the lessons of high-resourced setting that have gone through the process of creating and maintaining viable trauma registries that produce good quality data.

2.5 Data platforms

Other research groups have used data visualisation to increase the usability, understandability, and accessibility of aggregate global health and demographic data to the general public, such as Gapminder and the Institute for Health Metrics and Evaluation Global Burden of Disease Data Visualisation tool (28, 29, 66).

can be used at the global, national, and local levels to understand health trends over time. In addition, the GBD can be an important tool for informed policymaking(68).

2.6 Usability testing

Usability testing is a technique used to evaluate a product by testing it on the users and collecting information on the user impressions and experiences. Usability testing usually involves asking users to complete tasks, typically while being observed by a researcher or evaluator to see how the user reacts to the system.

2.6.1.1 System Development Life Cycle

The usability of technology can be evaluated at different stages of the development of the product(69). This iterative approach is beneficial, because it can create a product that is more specific to user's needs and the context of use(70). The System Development Life Cycle (SDLC) was first linked to levels of evaluation for software for medical use in Stead et al in 1994(71). Freidman and Wyatt further expanded the concept of using SDLC as an evaluation framework for the design of healthcare-related IT systems. These publications both emphasize the importance of the iterative approach to the design and testing of a system to refine it for ultimate usability.

The SDLC framework is broken into 5 stages, each representing a step in the usability testing process, and an advance to the next stage represents the addition of an external component that will enhance the understanding of the functionality of the system.

2.6.1.2 Stage 1: specify needs and setting

Stage 1 of the SDLC framework is to measure in a laboratory or field environment. The goal of this stage is to identify the user population's needs and to inform the design of the system components. The key questions that the developer must ask during this stage are "What are the needs/tasks [of the situation]?" and "How can [a system] be used to support the identified needs/tasks?"

In order to identify the needs of the users in the early [Stage 1] of development, many developers rely on peer-reviewed publications, along with published guidelines and regulations. An example of this is seen in the development of an electronic record system for nurses in two hospitals in Seoul, South Korea. The development was informed by nursing diagnoses classifications and terminology databases(72). Other

studies relied on focus groups, expert panels, observation, and interviews with future or potential users to identify needs(73-75). Workflow and the work environment are important for understanding how multiple tasks and subtasks get accomplished within a certain space and time by multiple people(76). This is readily applicable to clinical practice, which is an environment with many non-linear tasks being accomplished at one time.

2.6.1.3 Stage 2: system component development

Stage 2 of the SDLC framework is to validate the system. The main question that the developer must ask is “Does this system work for the prescribed task?” Validation of the system can be done through measuring user performance, and then examining the specificity and sensitivity of the output.

2.6.1.4 Stage 3: combination of components

Stage 3 of the SDLC framework is centred around determining if the system can minimize human errors and help users accomplish the task. In this stage, the important questions to ask of the system include “Does the system have a well-designed interface?” “Are the users able to correctly interact with the system (accomplish the task)?” “Are the users satisfied with their interaction with the system?” This stage also involves asking questions of user performance, in terms of output quality, speed accuracy, and completeness.

This stage has both objective and subjective outcomes to measure. Objective measures include system validity and system efficiency. Validity is measured by assessing task accuracy and completeness, and efficiency is measured by metrics of speed and learnability. Russ *et al.* demonstrates these objective measures in the assessment of a patent prescription database for pharmacist. The researchers used webcam and microphone data to collect information on the level of user frustration while learning the new software, which translated to information on the learnability and usability errors(77).

Subjective measures of user satisfaction can be accessed via interview, focus group, and questionnaire. In the review of 69 Stage-3 studies on IT usability by Yen et al., 30 (78%) used questionnaires to assess user’s perceptions and attitudes. Among all of these studies, one of the most commonly used questionnaires was the IBM usability questionnaire, the Computer System Usability Questionnaire(76, 78).Other common

questionnaires include the Questionnaire for user satisfaction and the Modified Technology Acceptance Model Questionnaire(79, 80). Although these vetted surveys are popular, it is not uncommon for researchers to use study generated questionnaires, that are not previously validated, if they provide a better fit for the study outcomes(76).

The Computer System Usability Questionnaire is a tool for assessing the usability of a software subjective usability measurement tool that is focused on evaluating the psychometric properties of questionnaires designed for use in scenario-based usability evaluation. The questionnaire addresses evaluation at both a global level and at a scenario-specific level (78). It was developed by IBM to measure computer system usability, it has since been adapted and use by a broad range of researcher to evaluate computer systems, software systems and mobile technologies.

2.6.1.5 Stage 4: integrate health IT into a real environment

Stage 4 of the SDLC framework is classified by the edition of environmental factors into the assessment of usability. The questions asked of the system are similar to that of stage 3, except now the trials of the system are being completed in the expected setting of use. The methods are also similar to Stage 3; a mixture of focus groups, interviews, and questionnaires is an effective way to understand the user's work quality, such as workflow and process efficiency.

Since this stage of assessment is done in the actual working environment, a case control trial can be used to assess the usability of a system. For instance, in the study by Golob *et al.*, a 3-month prospective crossover trial approach was used to determine the efficiency and functionality of a new infection-care registry system. Outputs of the users (in this case, doctors) were measured at baseline for three months, and then the new IT system was introduced, and the same outputs were measured and compared(81). It is also common for researcher to measure other outcomes, such as guideline adherence, patient outcomes, and medication errors as secondary measures of functionality of the system.

2.6.1.6 Stage 5: routine use

The main purpose of Stage 5 of the SDLC is to understand the impact of health IT over time. Researchers must consider factors beyond the system-user-task-environment interaction, and determine how the system impacts healthcare. This is

the most commonly published stage of a usability study. The most common type of evaluation for a stage 5 study is by reviewing medical charts or medical facility log files. Other methods for measuring outcomes include guideline adherence, document quality, medication error, patient outcomes, and cost effectiveness(76).

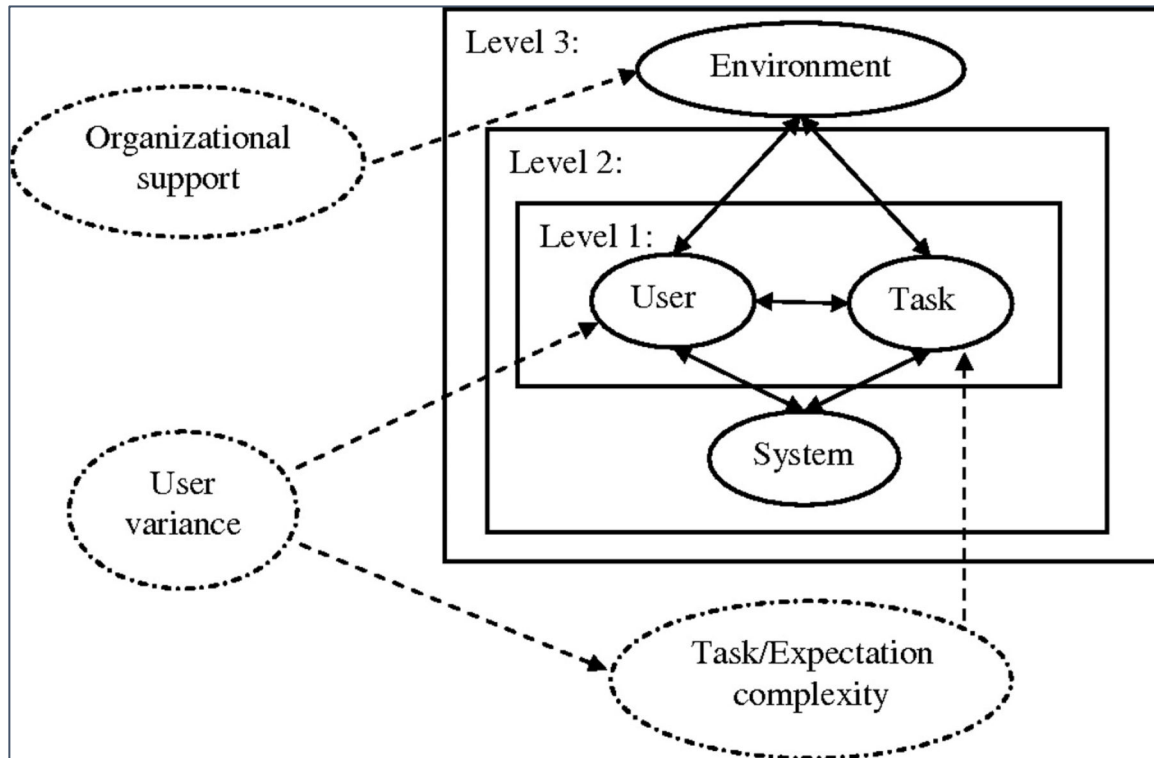


Figure 5: A stratified view of health information technology evaluation(78)

Figure 5 outlines a stratified view of health information technology, including the different levels at which the system can be evaluated. The evaluation at Level 1 targets system specification to understand user-task interaction for system development. Evaluation at Level 2 examines task performance to assess system validation and human-computer interaction. Level 3 aims to incorporate environmental factors to identify work processes and system impacts in real settings. Task/expectation complexity, user variances, and organizational support are factors that influence the use of the system, but are not problems of the system itself, and need to be differentiated from system-related issues when considering the evaluation of the system.

2.7 Design and development of analysis software

The development and design considerations were made with the intention of optimising the data entry process for the specific target population, African health professionals working in the EC setting of a hospital. The most important considerations for the design of the platform include:

1. **The availability and connectivity of internet and the need for low-bandwidth applications and software.** Due to the variability of internet availability in this setting, there was an emphasis on finding a method of delivering the functions of the software in which internet availability would be as little of a concern as possible. This included considerations of launching the program as a website, data backup and server restrictions, and internet need for providing software updates.
2. **The provision of basic data analysis tools for conducting research on the data being collected.** One of the main goals of the platform is to provide an accessible method of analysing the data in real time. This is especially important for conducting research and generating reports for measuring outputs in the unit and generating figures for policymaking.

3 CHAPTER 3

TRAUMA DATA PLATFORM DEVELOPMENT METHODOLOGY

3.1 Introduction

This chapter includes a description of the considerations and processes that went into the design of the Trauma Data Platform. The methodology outlined in this chapter describes how we achieved the objective: *To create a data visualisation platform for the pre-existing AFEM Trauma Registry.*

3.2 Considerations in the design and development of analysis software and data platform

The development and design considerations were made with the intention of optimising the data entry process for the target population, African health professionals working in the EC setting of a hospital. The considerations for the design of the platform are outlined in Chapter 2. Other considerations that were incorporated into the development and design of the platform include:

1. **The provision of two years of sample data from the AFEM Trauma Registry database at Muhimbili National Hospital.** In order to test the usability of the platform, the participants completed a series of tasks using the prototype of the platform. This was done using two years of data from MNH in Dar es Salaam, Tanzania, that has been pre-loaded onto the platform. This is important for measuring the usability of the platform with data that are similar in structure and content to that of the data that users will be entering and analysing using the platform.
2. **The incorporation of trends and suggestions from the background survey.** The background survey (Appendix 2), which is described in detail later in this chapter, collected information on the characteristics of the population that would someday be using the platform, including their data analysis experience and publishing history. These factors were considered in designing the platform, in terms of what the specific needs and expectations of the platform would be for the target user.

3.3 Software construction and development

The platform was created in collaboration with Health Solutions Africa (HSA), a South African health-related consulting and software company (82). The system was created based on a previously existing, company-owned health information database, and the interface was customised for the data capturing and analysis requirements of this project. All software development and programming was done by HSA employees at the specification of B. Griffith.

3.4 Design components

The design of the interface was based on the layout of the AFEM Trauma Form (Appendix 1) with adjustments made for an electronic format data collection tool, such as dropdown menus and automatic date/time detection. The software was designed to include the content of the most current trauma data form at the time of the data collection. In addition, the development and design suggestions of Dr Teri Reynolds, AFEM Trauma Data Project lead, were considered.

3.5 Program architecture and operation

The current version (V1.1) is only compatible with Windows operating systems. The development of Windows-compatible software was prioritised due to its widespread preference over Macintosh or Linux in Africa. Installation of the program was done on a single laptop, and all usability testing was done on that machine.

The original conception of the data analysis tool was for the data entry, storage, and analysis to be website-based. After discussing this with the web developers, a software-based platform seemed like a better option. This decision was mostly based on concerns about internet availability and connectivity in the health facilities that the Trauma Data Platform would be used in. Furthermore, the details and requirements of web-based security for identifiable health data were outside the scope of this study. The design of the software is such that it has the capabilities to transition into a web-based version, and these considerations have been incorporated into the recommendations in Chapter 8.

3.5.1 Data security

All functions of the platform are protected with a username and 4-digit password, which provides a way of tracking the users of the system while also providing a customised selection of tasks that can be accomplished in the platform, which is controlled by an

administrator at each healthcare facility using the Trauma Data Platform. Each healthcare facility that is using the platform will have an assigned administrator who will control the user permissions of each function of the platform. For instance, a person whose primary task is to enter data into the system will not have access to viewing other patient records. This adds security and customizability to the system, and it simplifies the user experience.

The de-identified data was used with permission from MNH. The control over user permissions will limit the access that users have to identifiable data. In addition, the software is designed so all data will be stored on a secure, institution-based server.

3.5.2 Platform design

The platform is opened by double clicking on the Institute for Global Emergency Care (IGEC) icon, located in the applications folder of the computer. The system screens are labelled with the IGEC logo because the Trauma Data Platform was created in partnership with IGEC and AFEM. On the opening screen (Figure 6), the user is prompted to enter a username and password and click the login button.

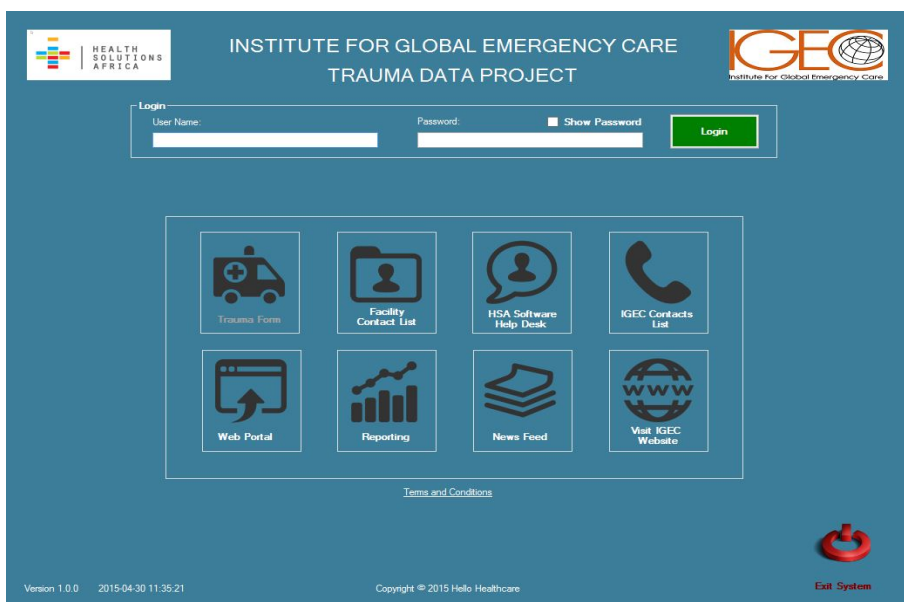


Figure 6: Opening screen with login prompt

After logging in, the user is prompted to select a hospital or clinic name from a dropdown menu. Administrators will have control over whether a user has access to the de-identified, aggregate data from other facilities. Most users will only have access

to the data from their home facility, and only users from their respective facility can enter data from that facility.

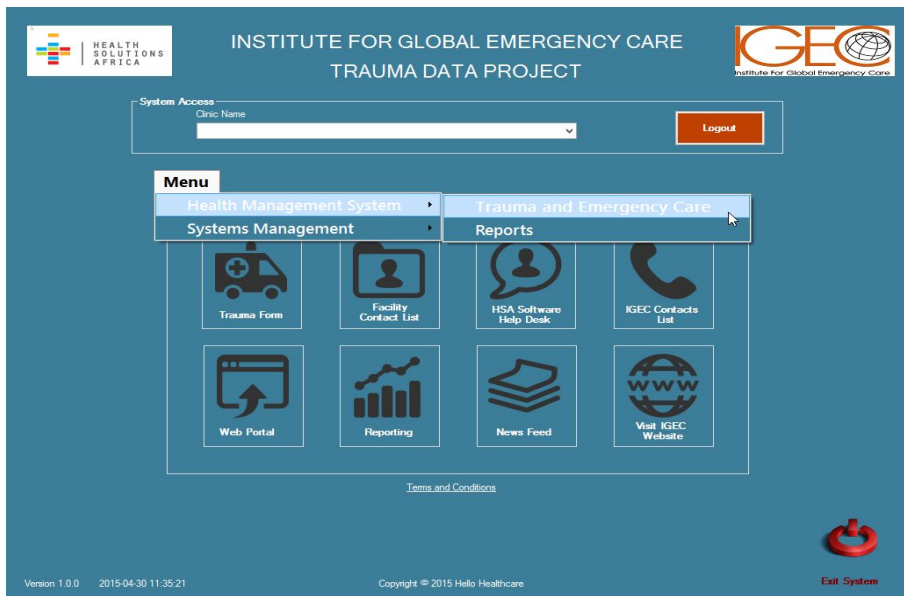


Figure 7: Screen displayed after login with directions to navigate to the data entry module

After specifying the facility, users have two ways of navigating the platform. This includes a series of responsive dropdown menus and button icons on the main page. For the purposes of the usability assessment, the only capabilities that were active were the data entry option and the reporting options. Other options that will be available in future versions of the platform include: a facility contact list, a link to contact the HMS software desk, an IGEC/AFEM contacts list, a link to the web portal, a news feed, and a link to the IGEC website.

Figure 8: The first screen of the data entry module where patient demographic information is entered and a unique identifier for each database entry is created

When the user selects the “Trauma and Emergency Care” option of the dropdown menu, the initial screen for entering patient data will appear. This screen includes fill in the blank and dropdown menus to fill demographic information about the patient. At the bottom of the form, there is a textbox for filling in information on the patient’s chief complaint.

In order to move to the next screen and to move throughout the data entry process, the user can use the labelled tabs at the top of the page. Before the user can move to the next tab, a message will appear asking the user if they want to save the record. Selecting yes will generate and store the record with a unique ID code, which is composed of the initials of the patient and the date and time that he/she arrived.

The following screens ask for patient information in a format that closely follows the AFEM Trauma Form. Before advancing to the next page, the user must save the newly entered information by pressing the “save” icon at the bottom right of the page to save. If they do not do that, the program will prompt the user about whether they want to save their data.

The order of the tabs closely follows the arrangement of the paper version of the trauma data form. This order is based on the order and flow of clinical care that is followed when assessing and treating a trauma case in this setting(12, 83).

The interface of the platform includes several different methods of data entry. There are fill in the blank sections, radio buttons, check boxes, and date/time specific fields. These are designed with the data type for each field in mind and optimised to reduce the incidence of typos in the data entry process.

Previously generated patient records can be retrieved by year, month, or day of discharge date. The information will only be accessible if the user has the permissions to do so.

Figure 9: The screen of the data entry module to enter the primary survey information, including vitals, airway information, and breathing information

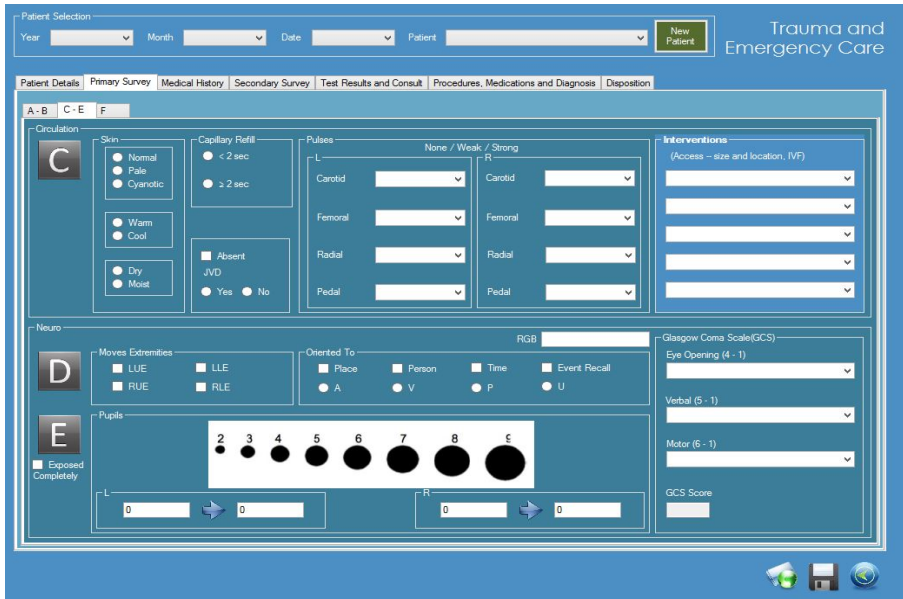


Figure 10: The screen of the data entry module to enter the primary survey information, including circulation and neuro

Screens 5-16 (Figures 11-21) are the continuation of the screens for capturing clinical information for each patient.

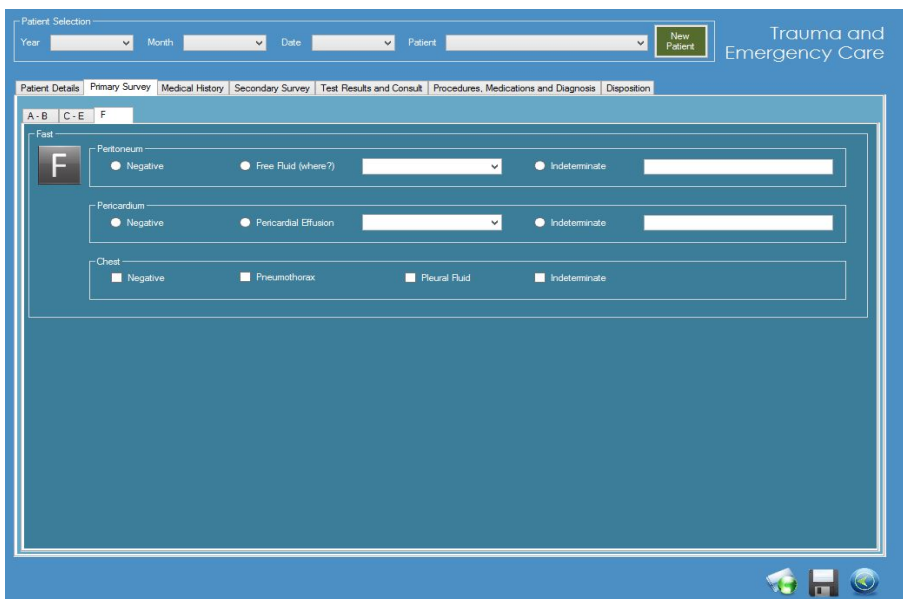


Figure 11: The screen of the data entry module to enter the primary survey information, including the FAST examination

The screenshot shows the 'Past Medical History' tab within the 'Medical History' section of the data entry module. At the top, there is a 'Patient Selection' area with dropdowns for Year, Month, Date, and Patient, along with a 'New Patient' button. The main content area is divided into several sections:

- Allergies:** A large empty text box for entering allergy information.
- Medications:** A large empty text box for entering medication information.
- Significant Past Medical History:** A grid of checkboxes for conditions such as Diabetes, Hypertension, TB, HIV/AIDS, Cancer, Seizures, Sickle Cell Disease, Asthma, Heart disease, COPD, Stroke, Hepatitis B / C, and Other. There are also text input fields for Cancer and Other.
- Surgical History (Type and Date):** A dropdown menu.
- Prior Trauma Surgery?** A dropdown menu.
- Last Menstrual Period Report as number of days:** A text input field.

 The bottom right corner features standard system icons for help, save, and refresh.

Figure 12: The screen of the data entry module to enter the past medical history, which is located under the Medical History tab

The screenshot shows the 'Present Illness' tab within the 'Medical History' section of the data entry module. It features a 'Patient Selection' area at the top. The main form includes:

- Date of Injury:** A date picker set to 2015-04-30.
- Time:** A time picker set to 17:17:07 (hrs).
- Place of injury (if 'place' not listed, enter manually):** A dropdown menu.
- Activity at Time of Injury (if 'activity' not listed, enter manually):** A dropdown menu.
- Mechanism of Injury:** A complex section with multiple checkboxes and radio buttons for categories like MTA/RTA (Driver, Passenger, Pedestrian), Seatbelt, Ejected, Extricated, Patient Vehicle, Other Vehicle 1, and Other Vehicle 2. It also includes checkboxes for Loss of Consciousness, Assault, Burn Caused By, Gunshot, Drowning, Unknown, Other Blunt Trauma, not assault, Other Penetrating Trauma, not assault, Head Trauma, Neck Trauma, Stab / Cut, Sexual Assault, Fall From, Hanging, Poisoning, Drugs / Toxins Used, and Hit by falling object.
- Intent:** Radio buttons for Unintentional, Intentional, Self Harm, and Unknown.
- Hours Since Last Meal:** A text input field labeled 'HRS'.
- Alcohol Use within 6 Hours of Injury:** Radio buttons for Confirmed, Suspected, No Information, and None.

 The bottom right corner features standard system icons for help, save, and refresh.

Figure 13: The screen of the data entry module to enter the present illness information, which is located under the Medical History tab

Patient Selection
 Year Month Date Patient

Trauma and Emergency Care

Patient Details | Primary Survey | Medical History | Secondary Survey | Test Results and Consult | Procedures, Medications and Diagnosis | Disposition

Physical Exam - Part 1 | Physical Exam - Part 2 | Physical Exam - Part 3 | Physical Exam - Part 4 | Physical Exam - Part 5

HEENT
 (Trauma, PERLL, EOM) = extra - ocular movement
 Check if HEENT is Normal

- Unequal Pupils
- Eye Injury
- Scalp / Face Laceration
- Skull Fracture - Open
- ENT Injury
- Signs of Basilar Skull Fracture
- Skull Fracture - Closed
- Bleeding from Ears
- Penetrating Head / Face Injury
- Oral / Jaw / Dental Injury
- Scalp Haematoma
- Other Superficial Head / Face Injury

Neck and C - Spine
 (Supple, Tender, Full ROM)
 Check if Neck - Spine Normal

- C - Spine Tenderness
- Limited ROM
- Superficial Neck Injury
- Active Bleeding
- Haematoma
- Neck Creptation
- Palpable C - Spine Deformity / Step Off
- Penetrating Neck Injury (through platysma)

Neurological
 (CN, Reflexes, Strength, Sensation)
 Check if Neuro is Normal

- Cranial Nerve Abnormal
- Weak RUE
- Sensation Loss RUE
- Rectal Tone Decrease
- Level:
- Hypo - reflexia
- Weak LUE
- Sensation Loss LUE
- Incontinence of Urine
- Hyper - reflexia
- Weak RLE
- Sensation Loss RLE
- Incontinence of Stool
- Normal Reflexes
- Weak LLE
- Sensation Loss LLE
- Saddle Anesthesia

Figure 14: The screen of the data entry module to enter the Physical Exam - Part 1, including HEENT, neck and c-spine, and neurological, which is located under the Secondary Survey tab

Patient Selection
 Year Month Date Patient

Trauma and Emergency Care

Patient Details | Primary Survey | Medical History | Secondary Survey | Test Results and Consult | Procedures, Medications and Diagnosis | Disposition

Physical Exam - Part 1 | Physical Exam - Part 2 | Physical Exam - Part 3 | Physical Exam - Part 4 | Physical Exam - Part 5

Pulmonary
 Check if Pulmonary Normal

Respiratory Rate

- Increased Respiratory Rate
- Decreased Respiratory Rate
- Normal Respiratory Rate

Transmitted Upper Airway Sounds

LEFT BREATH SOUNDS:

RIGHT BREATH SOUNDS:

Chest
 (Expansion, Paradoxical, Movement, Creptus)
 Check if Chest Normal

- Paradoxical Chest Wall Movement
- Sucking Chest Wounds
- Subcutaneous Emphysema / Creptus
- Penetrating Chest Wall Injury
- Palpable Rib Fracture
- Superficial Chest Wall Injury

Cardiovascular
 (Rate, Rhythm, Pulses)
 Check if Cardio Normal

- JVD
- Irregular Heart Rate
- Diminished Sounds
- Asymmetric Pulses - Upper Ext
- Tachycardia
- Murrur Present
- Asymmetric Pulses - Lower Ext
- Bradycardia

Figure 15: The screen of the data entry module to enter the Physical Exam - Part 2, including information on pulmonary, chest, and cardiovascular, which is located under the Secondary Survey tab

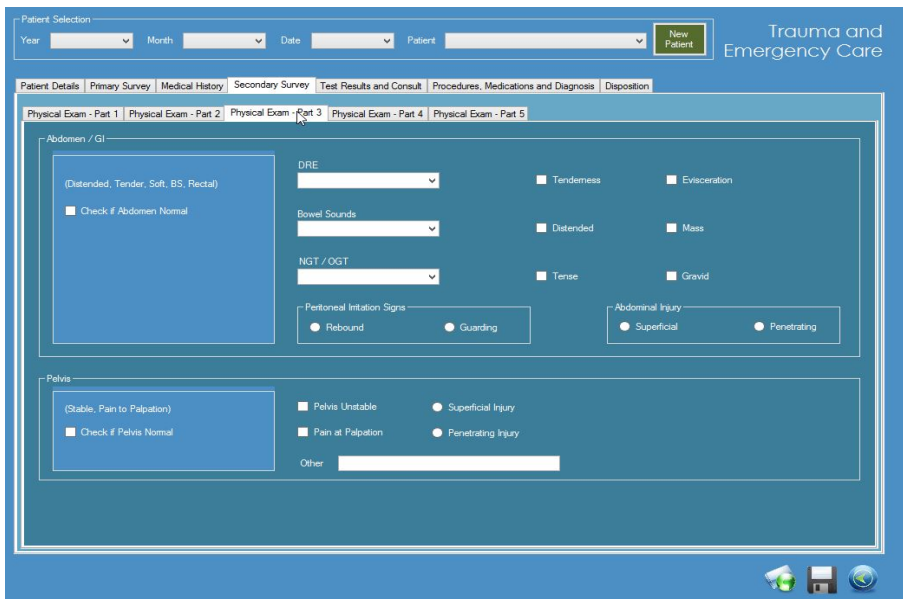


Figure 16: The screen of the data entry module to enter the Physical Exam - Part 3, including abdomen/GI and pelvis, which is located under the Secondary Survey tab

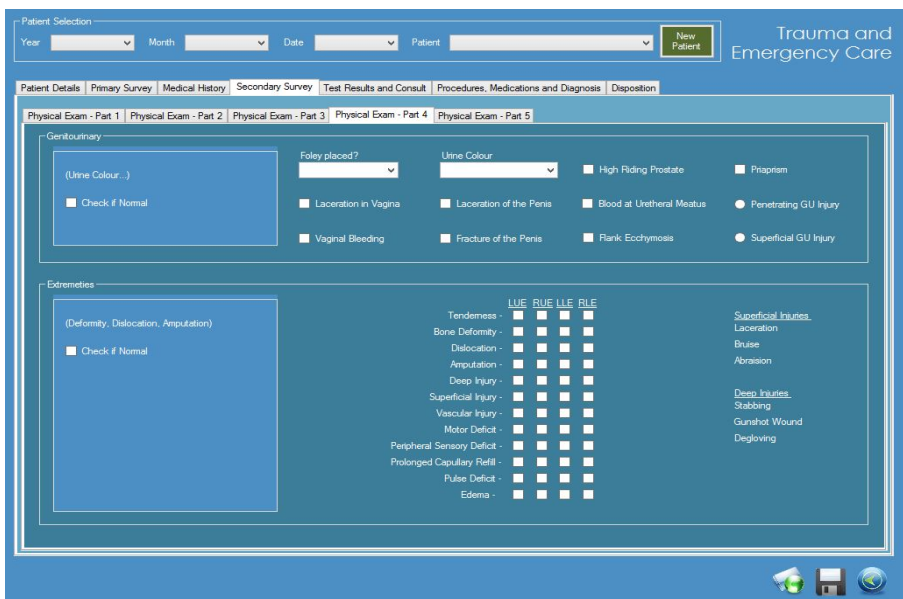


Figure 17: The screen of the data entry module to enter the Physical Exam - Part 4, including genitourinary and extremities, which is located under the Secondary Survey tab

Patient Selection
 Year Month Date Patient

Trauma and Emergency Care

Patient Details | Primary Survey | Medical History | Secondary Survey | Test Results and Consult | Procedures, Medications and Diagnosis | Disposition

Physical Exam - Part 1 | Physical Exam - Part 2 | Physical Exam - Part 3 | Physical Exam - Part 4 | Physical Exam - Part 5

Back

(Log Roll)
 Check if Normal

Spine Tenderness Tenderness Level
 Spine Deformity Deformity Level
 Penetrating Back Injury
 Superficial Back Injury

Skin

(Colour, Perfusion, Diaphoretic, Lacerations/Abrasions)
 ** If BURN, give % of surface area.
 Check if Normal

Total Skin Area Burned

| | Superficial | Partial | Full |
|---------------|----------------------|----------------------|----------------------|
| Face / Head - | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Neck - | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Torso - | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Back - | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Genitals - | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Extremities - | <input type="text"/> | <input type="text"/> | <input type="text"/> |

Circum Extremity Burn Restrictive Chest Burn

Figure 18: The screen of the data entry module to enter the Physical Exam - Part 5, including back and skin, which is located under the Secondary Survey tab

Patient Selection
 Year Month Date Patient

Trauma and Emergency Care

Patient Details | Primary Survey | Medical History | Secondary Survey | Test Results and Consult | Procedures, Medications and Diagnosis | Disposition

Imaging Studies

Chest X - Ray CT Head
 Pelvis X - Ray CT Abdomen
 C - Spine X - Ray CT C - Spine
 Extremity X - Ray

Labs

UPT
 Positive Negative Not Done

HGB
 Normal Low Done, No Results

Blood Grouping
 Done Not Done

Consult

Called Saw Patient in EMD

Service(s) Time Called 17:19:32

Physician(s) Time arrived in EMD 17:19:32

Consultant Recommendations

Figure 19: The screen of the data entry module to enter the imaging and consult information, which is located under the Test Results and Consult tab

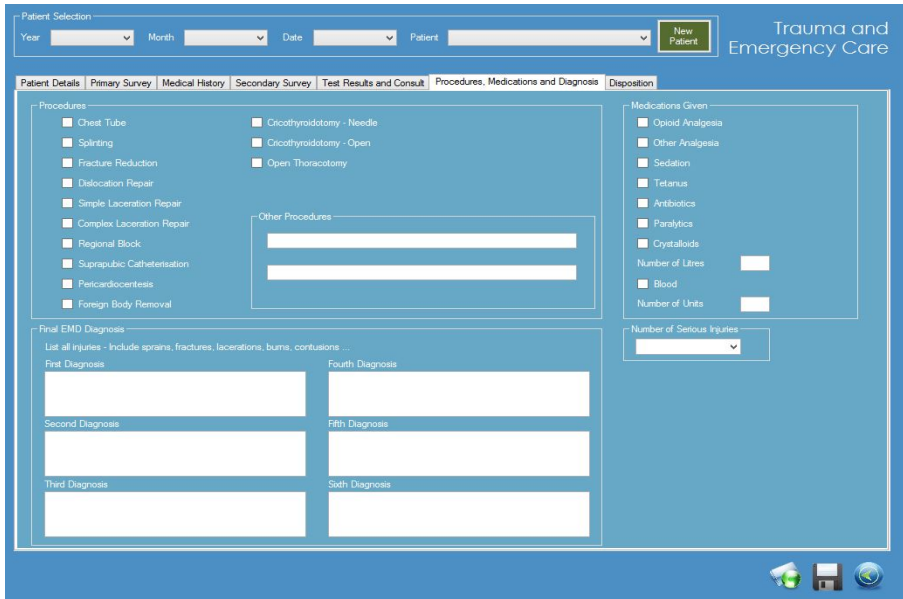


Figure 20: The screen of the data entry module to enter the procedures, medications, and final diagnosis information, which is located under the Procedures, Medications, and Diagnosis tab

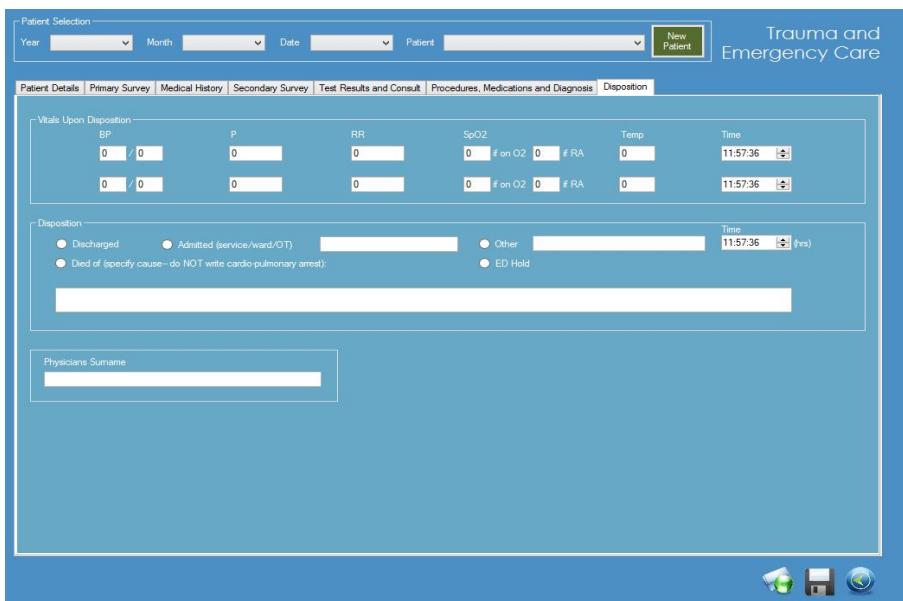


Figure 21: The screen of the data entry module to enter the vitals upon discharge, description of discharge, and physician's signature, which is located under the Description tab

3.6 Data report module

After entering in the data, users with the appropriate permissions are prompted with options for data reports that can be created. Users can navigate to the Reports module from the dropdown menu depicted in Figure 7. The users select the data report type

and the variables to be included. Figure 22 shows example figures that can be made using the Trauma Data Platform.

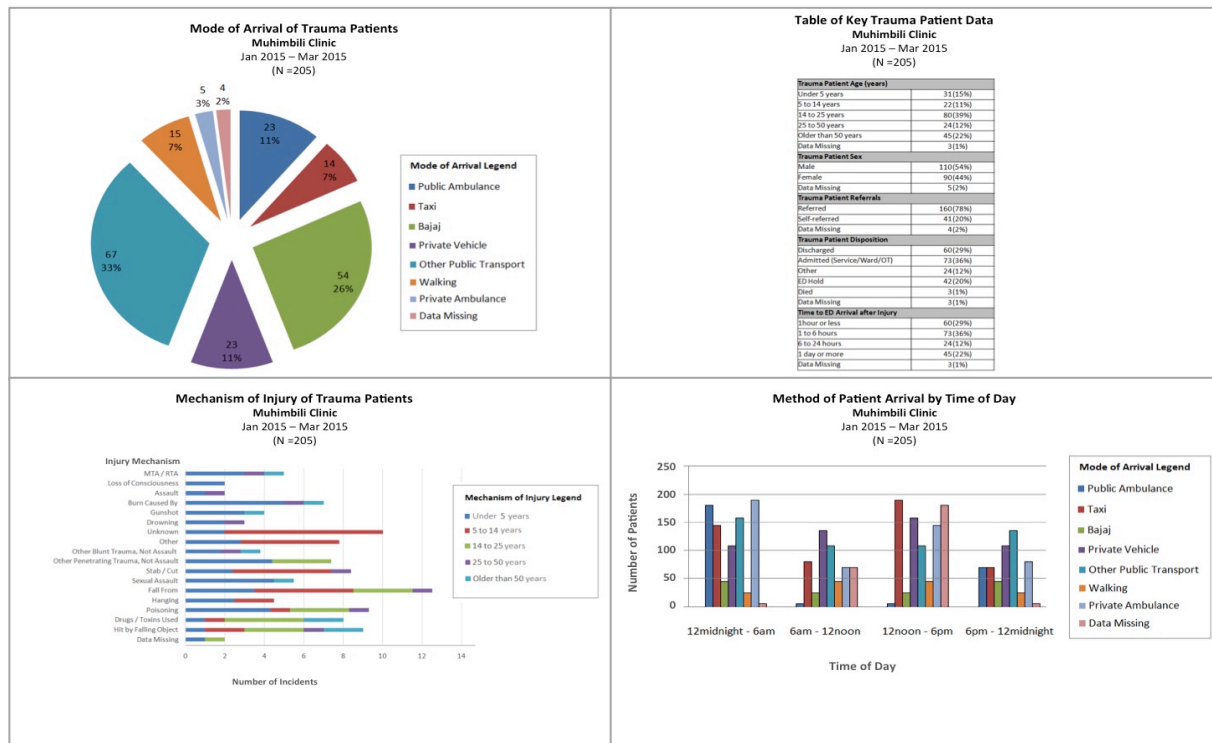


Figure 22: Examples of data visualisations generated by the Trauma Data Platform

The data reports are descriptive in nature, and include histograms, bar charts, pie charts, and frequency tables. In addition to controlling which variables are included in the data reports, users can also customise titles, data labels, and legends. The aim of the reporting tool is to produce figures that are ready to be included in publications or formal reports without needing to customise or edit in another program.

3.7 Background questionnaire (Questionnaire I, Appendix 2):

3.7.1 Study type

In order to increase the specificity of the software for African HCPs, study participants were asked to participate in a short questionnaire prior to receiving any exposure or introduction to the software. The purpose of this survey was twofold. First, it was to collect background information on the individuals' experience with data analysis and use of technology in medical practice. Secondly, it was to give the participants an opportunity to make suggestions about what they want or need in a data analysis platform. The survey also helped to determine the experience level and professional

age of the participants by ascertaining how many years the individual has been working in the medical profession, how many peer-reviewed articles each participant has published, and what their baseline internet availability was.

This study was a multisite, observational assessment to gather quantitative information on the data analysis experiences and preferences of African HCPs.

3.7.2 Population

The participants were a convenience sample composed of African HCPs from facilities currently using the AFEM Trauma Form. These individuals have a leadership role in their respective healthcare facility, along with a history or desire to publish peer-reviewed research on the data collected by the registry. Additionally, individuals at the facilities that will be responsible for data collection and entry were included. Due to the nature of the data collection for the usability questionnaire (Questionnaire II, Appendix 3), not all of the survey participants that completed the background survey also completed the usability questionnaire. This is further explained in Chapter 4.

3.7.3 Recruitment and enrolment

The first round of testing took place in Cape Town, South Africa during the 19th World Congress on Disaster and Emergency Medicine (WCDEM) in April of 2015. Individuals from all hospitals participating in the AFEM Trauma Data Project were contacted prior to the conference and asked to participate in the study online or at a mutually convenient time during the conference. After receiving a confirmation of interest in participating via email, they were prompted to complete Questionnaire I via online survey(84).

3.7.4 Data collection and management

Depending on location, participants either completed the survey in-person, or they completed the survey online via the Survey Monkey platform(84). Consent for participation was granted before the start of the survey. The survey was written and administered primarily in English, but a French version was available upon request. All survey content was translated into French by Dr Muller Mundenga Mutendi, MD.

Data from the online version of the survey was imported from Survey Monkey in a .csv file and combined with the data that was entered by hand from the paper version of

the survey. The data was then imported into Stata Version 14(85), where all data cleaning, including spelling corrections and relabelling of variables was completed.

3.7.5 Data analysis

The information from the survey was analysed using descriptive statistics, including quantifying responses by study site (Tanzania, Botswana, Ethiopia, online survey) and calculation of the means and standard deviations of responses with numerical answers (age, number of years at facility). All analyses were done using Stata version 14(85).

3.7.6 Human Ethics Committee approvals

Ethics approval was sought and granted from the Human Research Ethics Committee (HREC) at the University of Cape Town. The approval letter can be found in Appendix 4.

4 CHAPTER 4

USABILITY METHODOLOGY

4.1 Introduction

This chapter is a description of the methods used to assess the usability of the Trauma Data Platform, which includes both qualitative and quantitative measures of user experiences, responses, and suggestions.

4.2 Usability Study Methodology

Usability is a multidimensional characteristic within the context of users performing tasks with a certain product in a specific environment(86). In the case of this study, the product being tested is the Trauma Data Platform software being used by African HCPs in the context of African EC facilities.

Measuring usability is particularly difficult, because it is not a unidimensional product, user characteristic or quantity(86). A common approach to usability assessment is to ask a set of participants to complete a task or set of tasks (usability assessment scenarios) using the system of interest. Each usability assessment scenario involves solving a realistic problem. From there, investigators can measure the usability in the context of a scenario-based evaluation with both objective and subjective variables. For example, an objective task could be the time it takes a participant to complete a task using the system, and a subjective variable could be how the participant felt about the interface of the system.

As the amount of technology increases in health practice, health IT usability studies are now more relevant than ever to maintaining current and effective medical practice. A wide range of health IT usability studies have been conducted to explore usability requirements, discover usability problems, and design solutions within the context of medicine(76). Usability testing in this context is typically complex, due to the many sociological, organizational, technical, and clinical research questions that influence the desired outcomes of this type of usability study.

Usability testing is used in website and mobile application development to measure dimensions including: effectiveness, errors, efficiency, satisfaction, attitude, flexibility, learnability, memorability, operability, accessibility, and acceptability(87). It is also used to improve the functionality of websites and mobile applications delivering health

data. Testing in this study will improve the functionality of the program, to ascertain the continuous use of the data visualisation platform.

4.3 Study design/type

This study is a multisite, observational assessment to gather qualitative information on the usability of the Trauma Data Platform software.

4.4 Study Setting

4.4.1 Tanzania

The data collection was conducted at Muhimbili National Hospital in Dar es Salaam, Tanzania. MNH is a national referral hospital and university teaching hospital with 1500 beds. It attends approximately 1000-1200 outpatients per week and admits 1000-1200 inpatients per day. The hospital has 2700 employees, of which 300 and doctors, 900 registered nurses, and supporting staff(88).

4.4.2 Botswana

The data collection was conducted at Princess Marina Hospital in Gaborone, Botswana. PMH is a Ministry of Health-operated referral hospital. It is the largest referral hospital in the country with over 500 beds(89).

4.4.3 Ethiopia

The data collection was conducted in the Tikur Anbessa (Black Lion) Hospital, 600 bed hospital (90). The hospital has 200 doctors and 379 nurses and 115 other health professionals. It is affiliated with the Addis Ababa College of Health Sciences.

4.5 Study population

The study population is composed of HCPs from health facilities that are currently using the AFEM Trauma Form. Some of these individuals have a leadership role in their respective healthcare facility, along with a history or desire to publish peer-reviewed research on the data collected by the registry. Additionally, individuals at the facilities that will be responsible for data collection and entry were included in the surveys because of their unique perspective on the data entry and management processes at these facilities.

4.6 Recruitment and enrolment

During the on-site study, recruitment was communicated with the help of supervisors at the healthcare facility through email announcements and verbal reminders. Official enrolment in the study did not occur until the participant signed the consent form at the time of the training and usability assessment.

Recruitment in all settings was done through convenience sampling. Due to the availability of participants and nature of the study, the target number of participants was not based on a power or sample size calculation.

4.7 Data Collection

4.7.1 Tanzania

Data collection was conducted over the course of three weeks. All interviews were done in the EU of MNH during working hours. 17 participants were recruited and interviewed. The largest sample came from this facility.

4.7.2 Botswana

Data collection was conducted over the course of two weeks. Two participants were recruited and interviewed for the complete training and usability assessment. The smallest sample came from this facility.

4.7.3 Ethiopia

Data collection was conducted over the course of two weeks. A total of 14 participants were recruited and interviewed.

4.8 Software introduction and training

Each participant in the usability study was trained on how to use the software before the beginning of the study. BG conducted all trainings. Every training involved an explanation of the purpose and reason for the creation of the software. The participants were specifically told that the completion of this training would not in any way affect their relationship with AFEM or the overarching AFEM Trauma Data Project. After answering any preliminary questions, BG walked the participant through the data entry process screen-by-screen. She made sure to demonstrate the notable features, including time auto fill boxes and dropdown menus containing hospital-specific information.

After the software was explained and BG answered any questions, the participant was asked to enter an AFEM Trauma Form containing mock data. The participants were advised to not ask questions on completing a task during the data entry. Rather, they were expected to figure it out on their own, as would be the case in real-life use of the software.

After all the mock data were entered, the software training was considered complete. At that point, the usability questionnaire was administered. All training sessions were audio recorded for consistency between sites, but were not transcribed for analysis.

4.8.1 Website usability testing (Questionnaire II, Appendix 3):

The Usability Questionnaire (Questionnaire II, Appendix 3) was administered after the completion of the software training and trial. This questionnaire was modelled after the Computer System Usability Questionnaire (CSUQ)(78) with a 7-point Likert scale. In addition to the CSUQ questions, there were also questions addressing the satisfaction of the user on the software training instruction given by BG. The end of the questionnaire had two free answer questions, where participants can include any comments on ways to improve the software. Participants were encouraged to write any comments they had on the software, both positive and negative.

The purpose of this survey is to use both quantitative and qualitative measures to assess the usability of the software. The CSUQ provides a quantitative and vetted scale for measuring usability. The free text questions at the end of the survey provide an opportunity for participants to share information for the design of the next phase of the software that can be analysed using qualitative methods.

4.9 Data management and analysis

The information from the survey was analysed by calculating the mean, standard deviation, and range of the CSUQ scores by category. The CSUQ categories of usability include: System Quality, Information Quality, Interface Quality, and Overall Usability. The additional category of Training Quality was analysed in the same way.

The information that came from the interview was reviewed for common themes, which were coded and organised by theme and frequency. All quantitative analyses were completed using Stata 14(85). After the completion of all data collection, audio recordings of the trainings were deleted.

4.10 Timeline

The software training and usability testing took place at healthcare facilities that are currently participating in the AFEM Trauma Data project. This included Muhimbili Hospital in Dar es Salaam, Tanzania, Princess Marina Hospital in Gaborone, Botswana, and Tikur Anbessa (Black Lion) Hospital in Addis Ababa. The tutorial and questionnaires were administered in the same style at each facility by BG.

The data collection at three sites allowed more individuals to become familiarised with the platform. and it will facilitate the introduction of the platform or of similar technology into the facility. It is expected that, in future versions of the software, each facility will require a tailored plan for use of the platform depending on internet availability, security, computer availability, and general hospital workflow.

After the visit, the health facility was offered a copy of the survey for their review and permanent records. However, the study coordinator made it clear that the survey does not measure the healthcare facility's performance in any way.

| | | |
|-----------|-----------------------------|-------------------------|
| May 2015 | Muhimbili National Hospital | Dar es Salaam, Tanzania |
| June 2015 | Princess Marina Hospital | Gaborone, Botswana |
| July 2015 | Tikur Anbessa Hospital | Addis Ababa, Ethiopia |

Table 3: Study timeline and participating hospitals

4.11 Ethical considerations

Ethical and legal considerations included confidentiality and anonymity of the survey information and the security of country data. All efforts were taken to minimise the risk of participants in this study for both individuals and institutions.

4.11.1 Description of risks and benefits

There were minimal anticipated risks to participants in this study. There was a risk of a breach in confidentiality of survey data, but each survey was de-identified at the time of collection and did not contain any protected health information.

The participation in this study included taking time away from the work day to complete the training and survey, which could cause minor disruptions to the activities in the

EU. This was minimised by providing a wide range of participant times that included tea breaks, lunches, etc.

Benefits included the optimization of a data visualisation tool to specifically fit the needs of EC HCPs and researchers working in SSA and instruction in the use of a medical data entry software.

4.11.2 Informed consent process

Participation in the questionnaire was voluntary, and all participants were given the option to decline. The participants were asked to sign a formal consent form which contained information about the study along with their individual rights with regards to the study methods. Participants were asked to sign this form, stating that they read and understand their rights. The consent form can be found in Appendix 5.

4.11.3 Confidentiality of survey data

Any information that was obtained in connection with this study and that can be identified with an individual remains confidential and would be disclosed only with the participant's permission or as required by law. The only item that retained the participant's name is this consent form. The actual questionnaire used for research purposes does not contain participants' name or any identifying information. The consent forms are kept separately from the questionnaires, so there is no indication as to which participant completed which questionnaire. All collected documents are kept in the Investigator's office at University of Cape Town, in a locked cabinet. Only the investigator and the researchers involved in the study have access to the key. The data were transcribed into an Excel database and then imported into Stata Version 14, and they are password protected and stored in a computer in the possession of the investigator.

4.11.4 Data security

Collected data were compiled and handled by the researchers only. Only study investigators have access to the completed toolkits and results. The data analysis platform was protected by username and password. Only the investigators listed in this study have certain high-level admin privileges, including having access to all country data. The results do not contain any identifying information about the

participants. The information was not sold or used for any commercial purpose. Recordings were deleted upon completion of the data collection.

4.11.5 Data safety and monitoring

All surveys were collected and kept by BG, who acted as both the survey administrator and analyst. Collected data were compiled and handled by researchers only. Only study investigators had access to the completed surveys and aggregate data. The specific results of the Background and Usability Questionnaire[s] (Appendix 2 and 3) that pertain to website design were made available to the bespoke website designers in aggregate. The results do not contain any identifying information of the participants.

4.11.6 Reimbursement for participation

There was no reimbursement for participation in this study.

5 CHAPTER 5

RESULTS

5.1 Introduction

An assessment of the usability of the Trauma Data Platform software was conducted at three hospitals in three different countries: Tanzania, Botswana, and Ethiopia with the aim of measuring the functionality of the Trauma Data Platform and to collect information and suggestions on how the software could be improved for use in this setting.

At Muhimbili National Hospital in Dar es Salaam, Tanzania, a total of 17 participants completed the entire data collection process, which included the background survey, Trauma Data Platform introduction, and usability questionnaire. The interviews were all done within the hospital to current employees of the EU.

At Princess Marina Hospital in Gaborone, Botswana, a total of two participants completed the entire software training and usability survey process. One additional individual was able to complete just the Background Survey. The participants were all current employees of PMH hospital, and data collection were completed at mutually convenient times outside of the EU, in an office setting.

At Tikur Anbessa Hospital in Addis Ababa, Ethiopia, a total of 14 participants completed the data collection process. All participants were currently working in the EU and were recruited via email after BG arrived on site.

The findings from the mixed-methods usability assessment are split into three categories and summarized in this chapter. First, a comprehensive report of the background characteristics for each of the interviewees is provided, these data were acquired via written survey. Next, the quantitative results of the Computer System Usability Survey are reported by aggregate category means, and the results are interpreted based on the official CSUQ documentation. Lastly, comments from the free-response questions at the end of the Usability Questionnaire (Appendix 3) are included as tabulated data based on their coded theme.

All surveys and trainings were done one-on-one and in-person by BG. The small sample size at PMH was due to low availability of workers in the EU and scheduling

constraints during BG's visit. Although this is the case, thematic saturation was reached with the obtained number of participants at both MNH and TASH.

5.2 Results from the background questionnaire

The Background Questionnaire was administered to participants in Tanzania, Botswana, and Ethiopia before the introduction of the Trauma Data Platform. The context of the survey and some basic information on the Trauma Data Platform was provided before the participants filled out the background survey. BG was present during the administration of all surveys.

The online version of the survey, which was offered to participants via Survey Monkey(84) was written in English with line-by-line French translations by a trained EC physician. The context of the survey and some basic information on the AFEM Trauma Data Project and Trauma Data Platform was provided before the participants filled out the online background survey.

5.2.1 Background characteristics of the study participants

| | | Tanzania (n=17) | Botswana (n=3) | Ethiopia (n=14) | Online Survey (n=11) | Total (n=45) |
|--|-------------|----------------------------|---------------------------|----------------------------|-------------------------------------|-------------------------|
| | | Mean(SD) | Mean(SD) | Mean(SD) | Mean(SD) | Mean(SD) |
| Age | | 33.6(4.8) | 40.3(7.4) | 26.8(2.8) | 36.3(7.1) | 32.6(6.6) |
| Years working at current facility | | 3.4(2.1) | 8.3(8.4) | 1.9(1.5) | 4.9(4.0) | 3.7(3.5) |
| | | N (%) | N (%) | N (%) | N (%) | N (%) |
| Country of training* | Ethiopia | 0(0) | 0(0) | 14(100) | 0(0) | 14(31.1) |
| | Tanzania | 13(76.5) | 0(0) | 0(0) | 1(9.1) | 14(31.1) |
| | Australia | 0(0) | 2(66.7) | 0(0) | 0(0) | 2(4.4) |
| | DRC | 1(5.9) | 0(0) | 0(0) | 3(27.3) | 4(8.9) |
| | Uganda | 1(5.9) | 0(0) | 0(0) | 1(9.1) | 2(4.4) |
| | Rwanda | 0(0) | 0(0) | 0(0) | 4(36.4) | 4(8.9) |
| | Other* | 2(11.8) | 1(33.3) | 0(0) | 0(0) | 3(6.7) |
| | | | | | | |
| Occupation | Physician | 9(52.9) | 1(33.3) | 4(28.6) | 8(72.7) | 22(48.9) |
| | Specialist | 5(29.4) | 2(66.7) | 3(21.4) | 1(9.1) | 11(24.4) |
| | EM Resident | 3(17.7) | 0(0) | 3(21.4) | 0(0) | 6(13.3) |
| | Nurse | 0(0) | 0(0) | 4(28.6) | 1(9.1) | 5(11.1) |
| | Paramedic | 0(0) | 0(0) | 0(0) | 1(9.1) | 1(2.2) |

Table 4: Summary of background information on participants

* Other countries include Cuba, DRC, South Africa, Uganda, and Ukraine

Background characteristics were collected on all participants by survey, and select characteristics are displayed in Table 4. The surveys were administered in two formats (paper and online) in two languages (English and French) with identical content.

A total of 45 people participated in the survey, with the greatest number (17) coming from MNH in Tanzania. The mean age of participants was 32.6 (SD=6.6). The mean number of years reported for working at their current facility is 3.7 (SD=3.5). Within the cohort of Tanzanian participants, the majority (13, 76.5%) were trained domestically. This is also true of Ethiopia, where all participants (n=14) were trained in Ethiopia.

All of the Ethiopian and Rwandan participants were trained in their country of practice. None of the Batswana participants were trained domestically, and they reported training in Australia and Cuba. University of Botswana, which offers the only domestic medical education, only graduated its first class of doctors in 2014(43). The most common country of training for the online participants was Rwanda (4, 36.4%) and DRC (3, 27.3%).

The greatest number of participants in the survey were physicians (22, 48.9%) and specialists (11, 24.4%). EM residents were interviewed in Ethiopia(n=3) and Tanzania (n=3), and only one paramedic responded to the online version of the survey.

5.2.2 Data management and publication experience

| | | Tanzania (n=17) | Botswana (n=3) | Ethiopia (n=14) | Online Survey (n=11) | Total (n=45) |
|--|-----------|----------------------------|---------------------------|----------------------------|-------------------------------------|-------------------------|
| | | N (%) | N (%) | N (%) | N (%) | N (%) |
| Previous data analysis experience | Extensive | 2(11.8) | 0(0) | 0(0) | 0(0) | 2(4.4) |
| | Moderate | 7(41.2) | 1(33.3) | 10(71.4) | 6(54.6) | 24(53.3) |
| | Minimal | 7(41.2) | 2(66.7) | 3(21.4) | 4(36.4) | 16(35.6) |
| | None | 1(5.9) | 0(0) | 1(7.1) | 1(9.1) | 3(6.7) |
| | | | | | | |
| Personal computer ownership | Yes | 17(100) | 3(100) | 14(100) | 10(90.9) | 44(97.8) |
| | No | 0(0) | 0(0) | 0(0) | 1(9.1) | 1(2.2) |
| | | | | | | |
| Smartphone ownership | Yes | 17(100) | 3(100) | 14(100) | 8(72.7) | 42(93.3) |
| | No | 0(0) | 0(0) | 0(0) | 3(27.3) | 3(6.7) |
| | | | | | | |
| Consistent internet access | Yes | 13(76.5) | 3(100) | 6(42.9) | 10(90.9) | 32(71.1) |
| | No | 4(23.5) | 0(0) | 8(57.1) | 1(9.1) | 13(28.9) |
| | | | | | | |
| Formal data management/ analysis training[†] | Yes | 13(76.5) | 3(100) | 6(42.9) | 3(27.3) | 25(55.6) |
| | No | 4(23.5) | 0(0) | 8(57.1) | 8(72.7) | 20(44.4) |
| | | | | | | |
| Number of publications[†] | 3 or less | 13(76.5) | 2(66.7) | 11(78.6) | 9(81.8) | 35(77.8) |
| | 4-10 | 3(17.7) | 1(33.3) | 0(0) | 1(9.1) | 5(11.1) |
| | 10-20 | 1(5.9) | 0(0) | 0(0) | 0(0) | 1(2.2) |

Table 5: Summary of information on data management, publication, and technology experience

[†] Totals do not include all participants due to missing data.

In addition to providing background information on their employment, participants were asked to answer questions about their experience with data analysis and technology.

The participants were asked to rate the amount of data analysis experience they've had from the list of: extensive, moderate, minimal, and none. Over half (53.3%, n=24) selected that they had moderate experience with data analysis. Three of the participants (6.7%), from Tanzania, Botswana, and the online survey, reported having no data analysis experience. Two of the participants (4.4%) reported having extensive data analysis experience, and they were both from Tanzania.

Only one of the participants (2.2%) reported not having a personal computer. Three (6.7%) of the online survey respondents reported not having a smartphone. The majority (71.1, n=32) of the participants reported having consistent access to the internet. Botswana was the only country of practice that did not have any participants that reported inconsistent access to the internet.

The group of participants was almost split in half between people that had had some formal data analysis experience than those that did not. Overall, the majority (55.6%, n=25) reported data analysis experience.

Only one participant reported having 10-20 publications, and he/she was from Tanzania. The majority of the group (77.8%, n=35) reported having 3 or less publications. This could be reflective of the overall young age and early career of the participants.

5.2.3 Familiarity with data analysis software

| | Tanzania (n=17) | | Botswana (n=3) | | Ethiopia (n=14) | | Online Survey | | Total | | |
|----------------------------------|--------------------|---|-------------------|---|--------------------|---|------------------|---|-------|----|------|
| | n | % | n | % | n | % | n | % | n | % | |
| Number of software systems | 0 | 9 | 52.9 | 2 | 66.7 | 4 | 28.6 | 7 | 63.6 | 22 | 48.9 |
| | 1 | 6 | 35.3 | 0 | 0 | 5 | 35.7 | 2 | 18.2 | 13 | 28.9 |
| | 2 | 1 | 5.8 | 1 | 33.3 | 5 | 35.7 | 2 | 0 | 9 | 20.0 |
| | 3 | 1 | 5.8 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2.2 |

Table 6: Number of software systems participants reported knowing how to use

As displayed in Table 6, the greatest number of participants reported not knowing how to use data analysis software (22, 48.9%). Of those that reported knowledge of a software system, most reported knowing how to use one type of data analysis software (13, 28.9%).

5.2.3.1 Software types

Participants were asked to list the data management and analysis software systems that they had knowledge of using. Most participant reported being familiar with more than one type of analysis software. Of the participants that reported knowledge of a data analysis software, the most commonly reported software was SPSS (mentioned by 16 participants). The next most common was Epi Info (mentioned by 7). Four participants mentioned being familiar with excel, and two people reported familiarity with Stata. In addition to these software types, five participants mentioned other data analysis software types, such as hospital-specific databases.

5.3 Computer System Usability Questionnaire Results

The summary scores of the CSUQ survey are arranged to provide the most information to the external reviewer as to the usability of the software. The CSUQ scores are split into four categories as outlined in Lewis et al(78): Overall, System Usability, Information Quality, and Interface Quality. In addition to the standardised CSUQ scores, a fifth measure of Training Quality was added to assess the satisfaction of the user with the introduction process to the platform. This information will be useful for informing changes to Trauma Data Platform user trainings in the future.

Participants were presented with a series of statements related to the training and usability of the platform, and asked if they completely agree, completely disagree, or one of a spectrum of 5 options in between. The arrangement and style of the statements is available in Appendix 3. Each response corresponded to a 7-point Likert-style number, and scores were tabulated and averaged over the entire group of respondents.

The mean scores for the usability questionnaire portion were high, with all of the scores being above 6. This indicates that the participants who completed the training on the introduction of the Trauma Data Platform were overall satisfied with the software.

| Variable section | Observations | Mean | Std. Dev. | Range |
|---------------------|--------------|------|-----------|---------|
| Training Quality | 34 | 6.56 | 0.53 | (4.9-7) |
| System Usability | 32 | 6.45 | 0.69 | (5-7) |
| Information Quality | 34 | 6.49 | 0.51 | (5.3-7) |
| Interface Quality | 34 | 6.27 | 0.78 | (4.3-7) |
| Overall Usability | 34 | 6.46 | 0.54 | (5-7) |

Table 7: Summary of the Computer System Usability Questionnaire scores

This was calculated by averaging the relevant Likert-scale scores from the usability questionnaire by section.

5.3.1.1 Training Quality

The following subjects were satisfactorily explained:

- a. Introduction of the Trauma Data Platform
 - b. Why I would use the Trauma Data Platform
 - c. How to use the Trauma Data Platform
- 2) The trainer was able to support my learning during the training
 - 3) I have the knowledge to use the Trauma Data Platform after this training session
 - 4) I have the resources necessary to use the Trauma Data Platform
 - 5) The length of the workshop was appropriate
 - 6) I have the relevant practical and professional skills to use the Trauma Data Platform

Table 8: Training quality questions

The quality of the training on how to use the Trauma Data Platform was assessed with a series of nine statements related to the instruction provided by BG before the usability survey was administered. The results of each users' reactions of the statements were summed and averaged to create the Training quality measure. Of all the usability measure, training quality was ranked the highest with a score of 6.56. This indicates that the participants were overall satisfied with the quality of the training provided for the Trauma Data Platform software.

5.3.1.2 System usability

- | |
|---|
| <ol style="list-style-type: none">1) Overall, I am satisfied with how easy it is to use the Trauma Data Platform2) It was simple to use the Trauma Data Platform3) I can effectively complete my work using the Trauma Data Platform4) I am able to complete my work quickly using the Trauma Data Platform5) I am able to efficiently complete my work using the Trauma Data Platform6) I feel comfortable using the Trauma Data Platform7) It was easy to learn to use the Trauma Data Platform8) I believe I became productive quickly using the Trauma Data Platform |
|---|

Table 9: System usability questions

The measure of system usability was conducted by summing and averaging the user response to eight statements on the survey related to the ease of use of the Trauma Data Platform, which focused on the potential efficiency and productivity of the outlined task with this software. With a score of 6.45, it appears as though the users were satisfied with the system usability.

5.3.1.3 Information Quality

- | |
|--|
| <ol style="list-style-type: none">9) The Trauma Data Platform gives error messages that clearly tell me how to fix problems10) Whenever I make a mistake using the Trauma Data Platform, I recover easily and quickly11) The information (such as online help, on-screen messages, and other documentation) provided with the Trauma Data Platform is clear12) It is easy to find the information I needed13) The information provided for the Trauma Data Platform is easy to understand14) The information is effective in helping me complete the tasks and scenarios15) The organization of information on the Trauma Data Platform screens is clear |
|--|

Table 10: Information quality questions

The measure of information quality provided by the Trauma Data Platform was conducted by summing and averaging the user response to statements concerning

the functionality and understandability of the information being generated by the system in response to a user completing a task. For instance, the participants were asked to respond to statements on the clarity of error messages generated by the system when a page was not saved before navigating away from it. With a score of 6.49, it appears as though the users were satisfied with the quality of information generated by the platform.

5.3.1.4 Interface Quality

- | |
|--|
| 16) The interface of the Trauma Data Platform is pleasant 17) I like using the interface of the Trauma Data Platform 18) The Trauma Data Platform has all the functions and capabilities I expect it to have |
|--|

Table 11: Interface quality questions

The measure of the quality of the Trauma Data Platform interface was conducted by summing and averaging the user response to three (3) statements related to the clarity and functionality of the platform's interface. This usability measure received the lowest score (6.27), indicating that although the participants were overall satisfied with the interface, there is room for improvement in the look and feel of the Trauma Data Platform. This is further evident in the following section where a summary of themes in user comments is provided.

5.3.1.5 Overall usability

- | |
|---|
| 18) The Trauma Data Platform has all the functions and capabilities I expect it to have 19) Overall, I am satisfied with the Trauma Data Platform 20) Overall, I am satisfied with how easy it is to use the Trauma Data Platform |
|---|

Table 12: Overall usability questions

The measure of overall usability was conducted by summing and averaging the user responses to all of the questions on the survey in addition the summary questions listed in Table 12. The purpose of this is to provide a global illustration of the Trauma Data Platform's performance. With a score of 6.46/7, it appears as though the users were very satisfied with the Trauma Data Platform.

5.4 Summary of user comment themes

In addition to the Likert-scale usability questions on the questionnaire, there was also a section of free-response questions, which allowed participants to include any additional comments or concerns they had about the Trauma Data Platform. These questions are listed in Table 13.

- | |
|--|
| <ol style="list-style-type: none">1) What is missing from the trauma data platform that should be included?2) What are the most negative aspects about the platform?3) What are the most positive aspects of the platform? |
|--|

Table 13: Free text usability questions

The responses to these questions were analysed along with the numeric results of the usability survey to further illustrate the user experiences and comments. Major themes were identified in response to each of the three questions. Then, the number of times the theme appeared was tabulated. Many participants provided more than one comment, which is reflected in the Table 14.

| Comment type | Comment | N (%) |
|-------------------|-----------------------------|----------|
| Positive aspects: | Easy to use | 22(64.7) |
| | Time saving | 9(26.5) |
| | User-friendly | 8(23.5) |
| | Simple | 4(11.8) |
| Negative aspects: | Double work | 2(5.9) |
| | Data security concerns | 1(2.9) |
| | Personnel availability | 3(8.8) |
| | Training | 2(5.9) |
| | Interface needs improvement | 5(14.7) |
| | Feasibility concerns | 7(20.6) |
| Elements to add: | Pre-hospital info | 5(14.7) |
| | French language | 1(2.9) |
| | Free write space | 2(5.9) |
| | Printable forms | 1(2.9) |
| | Advanced analysis | 1(2.9) |
| | More security measures | 1(2.9) |
| | Design specifics | 2(5.9) |
| | Add specific variables | 8(23.5) |

Table 14: Summary of user comments, amassed from the free write portion of the usability questionnaire

5.4.1 Major themes from participant responses with examples

Example comments from the free-write portion of the usability survey are provided in this section to illustrate the major themes observed in the reactions of these participants.

5.4.1.1 Positive themes

Of the 34 participants, 22 (66.7%) wrote about the ease of use of the Trauma Data Platform. There were two major themes in the positive comments.

“[it is] well arranged, easy to use platform; the fact that it looks exactly like the trauma form makes it easy to incorporate in our department writing.”

Other positive comment themes that emerged include that it is time-saving, user-friendly, and simple to use. This information was also found in the results of the CSUQ assessment.

There were also several comments that specifically mentioned using the Trauma Data Platform to advance research in the EU.

“Helps for future research of the ED; to show the effectiveness and also to expand ED all over Ethiopia.”

“It is good that it can generate the results in graphs and tables. It makes data analysis too simple for research purposes.”

These comments contributed to the overall sense that this software would be a welcomed addition to both their medical practice and research needs. The positive comments made by the participants were overall homogeneous in their content and reflect a consensus on the usability of the software.

5.4.1.2 Negative themes

There was less of a group consensus on what the negative comment themes were, but most of the negative comments were observations on the feasibility of the Trauma Data Platform in the participants' unique work settings, which is derived from a mixture of time, personnel, and equipment shortage concerns. There were seven types of comments that directly addressed the feasibility of the Trauma Data Platform in the EU.

“It's a bit bulky and is difficult to fill out in a hectic department like the ED”

“I believe it might be time consuming sometimes because we are busy in the ED.”

Participants expressed specific concern about the timeliness and efficiency of filling out a computer-based data collection.

“[I am concerned about] avoiding double work filling software and at the same time writing hard copy.”

Other negative themes that emerged include needing improvements to the interface, that the platform will require additional training, and that the Trauma Data Platform could result in double work for the HCPs at all levels.

“We might not have the [personnel] resources to enter and maintain the data.”

There were specific comments that addressed concerns about how the Trauma Data Platform would require additional personnel in order to complete the software and paper copies of the patient records. Data security was also mentioned as a concern, in the context of protecting patient data and protecting the EU’s aggregate data for research purposes.

There were also comments about the shortcomings of the current data collection being done at the facility. Participants were concerned about introducing a new data analysis tool into a system with already imperfect data collection methods and practices.

“None [about the Trauma Data Platform]; but data inconsistencies in our setup.”

5.4.1.3 Suggested components to add or change

In response to the question asking what is missing in the Trauma Data Platform that should be included, users included many directions on specific pieces of information related to patient care that HCPs should be prompted to provide. While this is relevant to the usability of the Trauma Data Platform, this indicates a potential need to analyse the current structure and content of the AFEM Trauma Form, which the Trauma Data Platform is based on.

Suggestions on additional content include more information on patient medications, more details on where the patient was referred from and their pre-hospital care, prompts for the different types and length of seizures, more categories for mechanism of injury, prompts for listing child abuse and gender-based violence, more prominent outcomes investigation notes, and more categories for mode of arrival.

“In the secondary survey portion, it would have been better if there are boxes reserved for other data which are not listed in the form. Since patients may have findings other than those listed options.”

It is clear that some of these suggestions are peculiar to the Trauma Data Platform, but many of the additions must be made to the content of the AFEM Trauma Form itself. For example, the Ethiopian participants noted a need for a change in the

date/time reporting format of the AFEM Trauma Form, because the Ethiopian calendar and time format are commonly used in medical documentation, rather than the Gregorian calendar.

“Checkbox [is needed] for time (day, night) as the 24-hour format is not widely practiced in this setting [in Ethiopia].”

The data reporting functions were a prominent theme in the “additional comments” question. There were specific comments about how to improve the data reporting functions of the Trauma Data Platform. This included providing a greater breadth of report types along with a greater number of options within reports.

There were also a lot of requests for a function to be able to select certain variables or all variables within the dataset and then download the aggregate data in excel or .csv format. This could be particularly useful for EM residents who are looking to use the data for a specific research project, and therefore do not need to have access to all variables within the dataset.

“A way of presenting the data in different format but being able to export to excel can be a work-around for this.”

Several of the participants wrote comments on ways to make the Trauma Data Platform connect to other parts of the hospital and/or connect to other medical facilities that may refer to the hospital using the Trauma Data Platform. The motivation behind these comments is to streamline the patient referral process at multiple stages of clinical practice. This also connects to the concerns expressed about the Trauma Data Platform creating double work when a referral needs to take place.

“[the Trauma Data Platform is] Local to the Emergency Department. If possible it would be good to make it reach other hospitals.”

“[it is] not possible to refer the patient to other institutions with this software.”

There was a specific request to create a version of the Trauma Data Platform in French. Currently, all of the countries using the AFEM Trauma Form are Anglophone, but this will quickly become a necessity once the AFEM Trauma Form use is expanded to francophone Africa.

6 CHAPTER 6

DISCUSSION

6.1 Introduction

Trauma is a significant contribution to the global burden of mortality and disease, especially in sub-Saharan Africa. The methods for tracking, recording, and analysing the incidence and causes of trauma are underdeveloped. To address this, the AFEM developed a trauma form and Trauma Registry to collect trauma data in multiple sites in sub-Saharan Africa.

The primary aim of this study was to create, and assess the usability and functionality of, a trauma data visualisation platform for use in conjunction with the AFEM Trauma Registry. The secondary aim of this study was to gather information and opinions regarding the wants and needs of a data analysis platform specifically designed for African HCPs and researchers.

In order to achieve these aims, we created a web-based trauma data visualisation platform for use with the AFEM Trauma Registry Data. This was informed by a background survey administered to African HCPs to collect information on knowledge of data analysis, publication, and technology. Next, we undertook a usability assessment of the Trauma Data Platform to determine the positive and negative aspects of the first version of the Trauma Data Platform. This was done by asking participants to complete tasks on the Trauma Data Platform, and then asking them to rate and describe their experience.

Two types of questionnaires were administered; Questionnaire I was to gather information on the study population and their expectations for the platform, and Questionnaire II is to assess the usability of the platform after it is introduced

We used a mixed methods approach to analyse the information from the background survey, the usability survey, and the interview questions. In this way, we produced a qualitative and quantitative assessment of the usability of the platform. In this chapter, we will discuss the results from both the survey and the usability study.

6.2 Background survey

Using Questionnaire 1 (Appendix 2), we collected information on the participants' experiences with data analysis and technology. The surveys were administered both

in person and online. A total of 45 people participated. The results of this survey increased the amount of information we know about the technology and publication experiences of African emergency care practitioners.

We found that about half of the participants that were surveyed reported moderate amount of experience with data analysis, and about 45% reported minimal or no experience. We also found that the majority (77.8%) of the participants reported that they have produced less than three publications in their career thus far. This is consistent with the region-level statistics on publication production that are outlined by the World Bank report for SSA, which states that SSA contributes a proportionally low amount of research publications for its population size, which an even greater lag in STEM research(30).

Since approximately 87% of the participants are either a resident, physician, or specialist, this is a population that has needed to produce and/or consume research as part of their job. Technology barriers do not appear to be high in this population, with personal computer, smartphone ownership, and consistent internet access all being reported as more than 80%, but familiarity with a data analysis software was reported as less than half. This galvanises the importance of the Trauma Data Platform and other similar tools to address the gap in data analysis and publication production by African HCPs by providing new technologies to make the data analysis process more accessible.

That being said, access to internet and technology varied greatly from country to county, which some countries, such as Ethiopia and Tanzania, reporting unanimous computer and phone ownership, while other, such as Botswana, reporting unanimous internet access (Table 5). This heterogeneity highlights the importance of understanding the specific technology needs and capabilities in the implementation of technology-based health projects such as the Trauma Data Platform.

6.3 Usability study

6.3.1 CSUQ usability assessment

In order to quantitatively assess the usability of the platform, participants were presented with a series of statements related to the training and usability of it and asked to rate their level of agreement based on a 7-point Likert scale. Overall, the

mean CSUQ scores reported by the participants were high, with the mean score being higher than 6 for all categories. This indicates a high level of satisfaction with the Trauma Data Platform. Although this is an efficient way to quantify the user's reaction to the platform, the CSUQ score is limited in its ability to measure all elements of the user experience. Certain features, such as the user's opinions on what should be added or changed about the platform, are better captured through other means, such as interviews and free-answer questions(86, 87). That being said, this measure of usability should not be considered alone. It is also possible that the results could have a bias towards more positive answers, since the desire to increase technology in the workplace is high in this setting, and quality user experience might not be prioritised. This is a relevant concern in similar studies of health technology in a low-resource setting(91). In response, a mixture of methods, such as focus groups, usability surveys, interviews, and mock patient encounters are used to measure a more holistic assessment of usability(74, 91, 92).

The questions about the quality of training were added to the pre-vetted CSUQ usability assessment as a way to measure user's satisfaction about the training and to also maintain consistently high-quality training at each site. Of all the sections of the usability questionnaire, the training was the highest rated. This suggests that the participants reflections on usability are an accurate reflection of their understanding of how to use the software.

6.3.2 User comments

The free-response portion of the questionnaire produced a more holistic picture of the overall thoughts and impressions the participants had of the platform, which included positive comments, negative comments, and many suggestions of things to add or change. This information will be particularly useful in the generation of later versions of the platform.

Common positive themes included that the platform was easy to use and time saving, and that the interface was simple. These comments are useful in understanding the components of the Trauma Data Platform that were successful and should be carried into future versions of the platform. This information might also be useful for other projects who are designing technology for this audience.

Common negative themes in focused on the time and personnel resources it would require to implement this Trauma Data Platform. These concerns were not site-specific, which indicates that this is more a reflection of the platform than of the limitations of a specific hospital. This is consistent with the comments of HCPs in other usability studies in a similar setting(91, 92). This will be important to consider when a larger-scale introduction this type of technology is done. While this study mostly focused on increasing the usability of a specific software, the logistics of introducing it, such as adequate training and protected time, also need to be incorporated into the larger plan. These comments highlight the importance of listening to the HCPs in the development of this type of technology. If questions of logistics and resources are not sorted out in the design phase of development, there is a good chance that they will not be used correctly, and time, effort, and resources can be wasted.

Another negative theme that was mentioned was the data security of the platform, which raised an important point about both the protection of data and the logistical elements of setting up a truly secure data storage system in a low-resource setting. This concern was common in other health technology interventions in low-resources settings, particularly when personal phones or computers were going to be used(74, 91).

There were several participants that mentioned that the interface of the Trauma Data Platform needed to be improved. This should be a priority for future versions of this software. Although this was mentioned by five participants, it appears as though this negative critique did not affect the CSUQ scores in a sizeable way. This provides an example of the importance of measuring usability in several different methods before drawing conclusions on the user experience.

Many comments were made about adding specific things to the platform that were not already there. Some were focused on ways to increase the functionality of the data collection, such as free-write space, the addition of specific variables, and a French language module. Some of these suggestions speak more to changes that need to be made in the AFEM Trauma Form, which the platform is based on, rather than the platform itself. Other comments were requests to increase the features of the platform, such as more advanced analytical tools, more security measures, and printable forms. There were five participants who also mentioned including a place to record pre-hospital information, which would provide an opportunity to increase the scope of the

collectable data of the platform. It would also require some specific knowledge about the current state of prehospital care in each country that introduces the Trauma Data Platform.

In response to the question asking what is missing in the Trauma Data Platform that should be included, users included many directions on specific pieces of information related to patient care that HCPs should be prompted to provide. This indicates a potential need to conduct a more in-depth investigation into the structure and content of the Trauma Data Platform and AFEM Trauma Form, which could be accomplished with focus groups at the participating facilities.

6.4 Limitations

While every effort was made to ensure that this research was methodologically sound, this study had several notable limitations.

The population of participants was selected via a convenience sample, and there was no target sample size. This could limit the conclusions of the results for both the qualitative and quantitative portions of the study. The calculations of the CSUQ score could be influenced by the small sample size, and this should be considered in the interpretation of these results. For the qualitative portion of the results, it is possible that thematic saturation of the participant responses was not reached at all study sites, because of the small sample size of participants at the Botswana site.

The survey materials that were used for the background questionnaire that were available in French were not back-translated before use, which could lead to changes in the questionnaire respondents answer to the questions. In future studies of this kind, it is important that survey tools available in a language other than English are back translated to improve accuracy of interpretation.

There are also limitations to the applicability and generalizability of the results of this study. The usability of the platform was measured at three facilities in different countries, but all three hospitals were in urban settings. In addition, participation in this study was limited to Anglophone hospitals, which excludes a large proportion of the African population. Although this is the case, the results of the study are still valid for the population tested and caution would be used when using this information to make assumptions about the data, analysis, and technology needs of other HCPs in Africa.

There was no specific mention of how the introduction of an electronic medical record (EMR) system would change to implementation and introduction of the Trauma Data Platform. Since this is the direction that many facilities are going in, it is important to consider how this would work alongside the pre-existing data collection resources. This also speaks to the participant comments about a concern that there would be double work if the Trauma Data Platform was introduced, which would be the case if an EMR was being used in that facility.

7 CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

Overall, the participant satisfaction with the Trauma Data Platform was high, and the user comments and suggestions will be incorporated into future versions of the platform. This research highlights the importance of considering the feasibility of health technology in its introduction into low-resource healthcare settings.

The aim of this study was to design and measure the usability of a platform for storing and analysing trauma data in the African EC setting. This aim was accomplished through collecting and analysing both qualitative and quantitative information on the reactions of African EC practitioners on their experiences using a technology for the management and analysis of data.

The background information collected on the study population highlighted the great variation in the publication history, data analysis experience, and technology access between study sites. It is important to consider this heterogeneity in the future versions of the Trauma Data Platform, along with the design of other health technologies. This could take the form of flexible and customisable features to accommodate the needs and capabilities of each facility.

Overall, the usability assessment yielded positive feedback on the appearance and functionality of the first version of the Trauma Data Platform. HCPs expressed high satisfaction with usability of the platform and commented on the utility of introducing this type of technology in their work setting.

Dynamic workplaces, such as an African EU, require constant monitoring to understand their needs. Most of the negative suggestions centred around concerns of the feasibility of introducing this type of technology. This indicates that the feasibility of using the platform should be a priority in future studies, which requires investigators to ask bigger-picture questions about the day-to-day use and how it changes workflow in the EU. This could be accomplished using focus groups and observations. In addition, this type of technology should only be introduced with a clear plan for regular monitoring and evaluation to maintain high quality workflow.

There were several comments that mentioned the importance of this type of technology for advancing research in this setting. In this study, the questions asked about research experience were completely objective, and didn't address research priorities

or aspirations for the future. While it was outside of the scope of this study, a future study that includes methods for identifying research priorities, such as focus groups or in-depth interviews, within the context of designing health technology would be illustrative to the role of technology in this evolving discipline.

7.1 Recommendations for the software

The study yielded many recommendations for future versions of the Trauma Data Platform, which include specific changes in content:

- include more information on patient medications,
- add more details on where the patient was referred from and their pre-hospital care,
- add prompts for the different types and length of seizures,
- add more categories for mechanism of injury,
- add prompts for listing child abuse and gender-based violence,
- add more prominent outcomes investigation notes, and
- add more categories for mode of arrival.

Other software design recommendations include:

- improving the overall interface of the platform,
- make a web version,
- add more analysis functions,
- add a way to access and download the aggregate data directly from the platform, and
- add culturally appropriate date and time capabilities (such as the 13-month Ethiopian calendar).

Future versions of the software should also have a way to reduce the amount of double work that is required when a patient is referred into or out of the EU by another department or facility. This will involve some large-scale considerations of the connectivity of the platform with other EMR tools in use.

7.2 Recommendations for future research

Future research on the usability of the Trauma Data Platform and similar health technologies should focus on gaining a deeper understanding of both the usability of

and feasibility of the platform, while also considering more robust ways to measure its role in improving access to data and analysis tools. This could be done by performing a larger sample trial of the platform with a comparison group to measure analysis outputs or other functions of using data. In addition, focus groups will be best for understanding the feasibility and overall acceptability of the platform.

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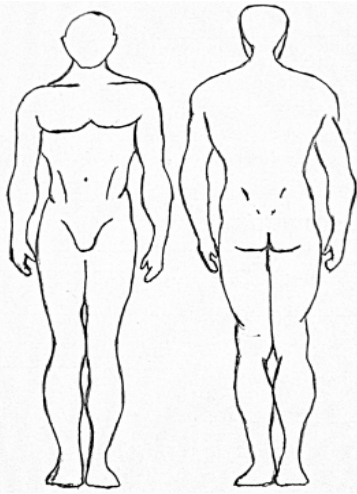
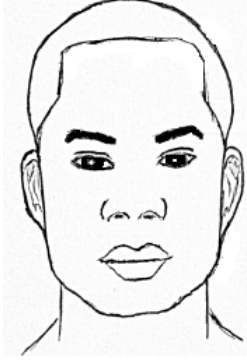
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|--|--|---|---|---|---------------|---|-----------------------------------|---|--------------------------------------|---|--|------------------------|--------------------------------------|-----------------|--|---------------|--|-----------------|--|-----------------------|--|---------------|--|--------|--|---|
| <p align="center">Chest</p> <p>Normal expansion Atraumatic</p> | <input type="checkbox"/> Paradoxical Chest Wall Movement <input type="checkbox"/> Subcutaneous Emphysema/Creptitus <input type="checkbox"/> Palpable Rib Fracture <input type="checkbox"/> Sucking Chest Wounds <input type="checkbox"/> Penetrating Chest Wall Injury <input type="checkbox"/> Superficial Chest Wall Injury Other : | | | | | | | | | | | | | | | | | | | | | | | | | |
| <p align="center">Cardiovascular</p> <p>Normal rate Normal rhythm Normal sounds</p> | <input type="checkbox"/> JVD <input type="checkbox"/> Asymmetric Pulses – Upper Ext <input type="checkbox"/> Bradycardia <input type="checkbox"/> Irregular Heart Rate <input type="checkbox"/> Asymmetric Pulses – Lower Ext <input type="checkbox"/> Tachycardia <input type="checkbox"/> Diminished Sounds <input type="checkbox"/> Murmur Present Other : | | | | | | | | | | | | | | | | | | | | | | | | | |
| <p align="center">Abdomen/GI</p> <p>Nondistended non-tender Soft Normal sounds Atraumatic</p> | DRE : <input type="checkbox"/> Brown NGT/OGT : <input type="checkbox"/> None <input type="checkbox"/> Tenderness <input type="checkbox"/> Evisceration <input type="checkbox"/> Black <input type="checkbox"/> Gastric Content <input type="checkbox"/> Distended <input type="checkbox"/> Mass <input type="checkbox"/> Gross blood <input type="checkbox"/> Blood <input type="checkbox"/> Tense <input type="checkbox"/> Gravid <input type="checkbox"/> Active Bleeding Abdominal Injury : <input type="checkbox"/> Superficial <input type="checkbox"/> Penetrating Bowel Sounds : _____ Peritoneal Irritation Signs : <input type="checkbox"/> Rebound <input type="checkbox"/> Guarding Other : | | | | | | | | | | | | | | | | | | | | | | | | | |
| <p align="center">Pelvis</p> <p>Stable, No pain to palpation</p> | <input type="checkbox"/> Pelvis Unstable <input type="checkbox"/> Superficial Injury <input type="checkbox"/> Pain at Palpation <input type="checkbox"/> Penetrating Injury Other : | | | | | | | | | | | | | | | | | | | | | | | | | |
| <p align="center">Genitourinary</p> <p>NI urine color No blood at meatus Atraumatic</p> | Foley placed? Y/N Urine color : <input type="checkbox"/> Normal <input type="checkbox"/> Dark <input type="checkbox"/> Gross Blood <table border="1" data-bbox="467 1016 1318 1093"> <tr> <td><input type="checkbox"/>Vaginal Laceration</td> <td><input type="checkbox"/>Vaginal Bleeding</td> <td><input type="checkbox"/>Blood at Urethral Meatus</td> <td>GU Injury :</td> </tr> <tr> <td><input type="checkbox"/>Penile laceration/fracture</td> <td><input type="checkbox"/>Priapism</td> <td><input type="checkbox"/>Flank Ecchymosis</td> <td><input type="checkbox"/>Superficial</td> </tr> <tr> <td><input type="checkbox"/>High-riding Prostate</td> <td></td> <td></td> <td><input type="checkbox"/>Penetrating</td> </tr> </table> Other : | <input type="checkbox"/> Vaginal Laceration | <input type="checkbox"/> Vaginal Bleeding | <input type="checkbox"/> Blood at Urethral Meatus | GU Injury : | <input type="checkbox"/> Penile laceration/fracture | <input type="checkbox"/> Priapism | <input type="checkbox"/> Flank Ecchymosis | <input type="checkbox"/> Superficial | <input type="checkbox"/> High-riding Prostate | | | <input type="checkbox"/> Penetrating | | | | | | | | | | | | | |
| <input type="checkbox"/> Vaginal Laceration | <input type="checkbox"/> Vaginal Bleeding | <input type="checkbox"/> Blood at Urethral Meatus | GU Injury : | | | | | | | | | | | | | | | | | | | | | | | |
| <input type="checkbox"/> Penile laceration/fracture | <input type="checkbox"/> Priapism | <input type="checkbox"/> Flank Ecchymosis | <input type="checkbox"/> Superficial | | | | | | | | | | | | | | | | | | | | | | | |
| <input type="checkbox"/> High-riding Prostate | | | <input type="checkbox"/> Penetrating | | | | | | | | | | | | | | | | | | | | | | | |
| <p align="center">Back</p> <p>(Log roll)</p> | <input type="checkbox"/> Spine Tenderness Tenderness Level : _____ <input type="checkbox"/> Penetrating Back Injury <input type="checkbox"/> Spine Deformity Deformity Level : _____ <input type="checkbox"/> Superficial Back Injury Other : | | | | | | | | | | | | | | | | | | | | | | | | | |
|  | <p align="center">Details of ALL Injuries (Draw lacerations and label length. Circle finding below and draw arrow to location.)</p> <table border="0"> <tr> <td>Tenderness</td> <td>Laceration</td> </tr> <tr> <td>Bony Deformity</td> <td>Burns (use %)</td> </tr> <tr> <td>Dislocation</td> <td>Others:</td> </tr> <tr> <td>Amputation</td> <td></td> </tr> <tr> <td>Deep Injury</td> <td></td> </tr> <tr> <td>Ecchymosis / Contusion</td> <td></td> </tr> <tr> <td>Vascular Injury</td> <td></td> </tr> <tr> <td>Motor Deficit</td> <td></td> </tr> <tr> <td>Sensory Deficit</td> <td></td> </tr> <tr> <td>Prolonged Cap. Refill</td> <td></td> </tr> <tr> <td>Pulse Deficit</td> <td></td> </tr> <tr> <td>Oedema</td> <td></td> </tr> </table> | Tenderness | Laceration | Bony Deformity | Burns (use %) | Dislocation | Others: | Amputation | | Deep Injury | | Ecchymosis / Contusion | | Vascular Injury | | Motor Deficit | | Sensory Deficit | | Prolonged Cap. Refill | | Pulse Deficit | | Oedema | |  |
| Tenderness | Laceration | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bony Deformity | Burns (use %) | | | | | | | | | | | | | | | | | | | | | | | | | |
| Dislocation | Others: | | | | | | | | | | | | | | | | | | | | | | | | | |
| Amputation | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Deep Injury | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ecchymosis / Contusion | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Vascular Injury | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Motor Deficit | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sensory Deficit | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Prolonged Cap. Refill | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Pulse Deficit | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Oedema | | | | | | | | | | | | | | | | | | | | | | | | | | |

| | |
|--|---|
| IMAGING RESULTS: <input type="checkbox"/> Pneumothorax <input type="checkbox"/> C-Spine Fracture <input type="checkbox"/> Clavicle Fracture <input type="checkbox"/> Pleural Fluid <input type="checkbox"/> Extremity Fracture Other : _____ <input type="checkbox"/> Rib Fracture <input type="checkbox"/> Pelvic Fracture <input type="checkbox"/> Pulmonary Opacity <input type="checkbox"/> Wide Mediastinum | LABS: UPT : <input type="checkbox"/> Positive <input type="checkbox"/> Negative HGB : <input type="checkbox"/> Normal <input type="checkbox"/> Low <input type="checkbox"/> Done, no results <input type="checkbox"/> Not Done Blood Grouping : <input type="checkbox"/> Done <input type="checkbox"/> Not Done |
|--|---|

ASSESSMENT (include summary and differential diagnosis) AND PLAN (imaging, pain meds, consults, etc):

CONSULT:
Service(s): _____ Time Called: _____
Physician(s): _____ Time Arrived in EMD: _____

CONSULTANT RECOMMENDATIONS:

| | |
|--|--|
| PROCEDURES (include time and outcome): Chest Tube : _____ Splinting : _____ Fracture Reduction : _____ Dislocation Repair : _____ Simple Laceration Repair : _____ Complex Laceration Repair : _____ Regional Block : _____ Suprapubic Catheterization : _____ Pericardiocentesis : _____ Foreign Body Removal : _____ Cricothyroidotomy – Needle : _____ Cricothyroidotomy – Open : _____ Open Thoracotomy : _____ Intubation : _____ Other : _____ | MEDICATIONS GIVEN: Opioid Analgesia : _____ Other Analgesia : _____ Sedation : _____ Tetanus : _____ Antibiotics : _____ Paralytics : _____ Crystalloids : _____ Number of Liters : _____ Blood : _____ Number of Units : _____ Other : _____ _____ |
|--|--|

ED DIAGNOSES: (list all injuries - include all sprains, fractures, lacerations, burns, contusions...)

Number of serious injuries (CIRCLE): 0 1 ≥2

| | | | | | | |
|--------------------------------|-------|----|-----|-----------------------|-------|-------|
| VITALS UPON DISPOSITION | BP: / | P: | RR: | SPO ₂ : on | Temp: | Time: |
| | BP: / | P: | RR: | SPO ₂ : on | Temp: | Time: |

| | |
|---|----------------------|
| DISPOSITION: <input type="checkbox"/> Discharged <input type="checkbox"/> Admitted (service/ward/OT) _____ Other: _____ <input type="checkbox"/> ED Hold, pending: Available Bed Financial Transfer Other: _____ <input type="checkbox"/> Died of (specify cause-- do NOT write cardio-pulmonary arrest): _____ | Time: |
|---|----------------------|

PHYSICIANS NAME: _____ SIGNATURE: _____

For more information on this form, contact trauma@AFEM.info

Appendix 2: Background Survey (Questionnaire I)

Background Questionnaire

Please complete the following anonymous information about yourself (tick the appropriate answer where required). This information will be used in the initial development of the Trauma Data Platform. Please complete the survey, even if you have no previous experience with data analysis platforms. For items that are not applicable, write NA.

1. Age.....
2. Highest level of training/education completed.....
 - a. In what country.....
3. Current occupation:
Hospital: SPECIALIST PHYSICIAN NURSE
Or Pre-Hospital: BASIC LIFE SUPPORT INTERMEDIATE LIFE SUPPORT PARAMEDIC
 OTHER, please specify.....
4. Years of experience in emergency care at current facility in total:.....
5. How would you describe your experience with data analysis?
 EXTENSIVE MODERATE MINIMAL NONE
6. Do you own a personal computer/laptop? YES NO
7. If yes, do you have consistent access to the internet on this device? YES NO
8. Do you use a smartphone for private use? YES NO
9. If yes, for what purpose(s)?.....
.....

The following 4 questions concern the use of web-based data resources and publishing.

1. Do you currently use an application or website for data analysis and visualisation as a healthcare provider? YES NO
 - a. If yes, for what purpose?
2. Have you previously used an application or website for data analysis and visualisation as a healthcare provider? YES NO

- a. If yes, for what purpose?
-
- b. If yes, was the experience good or bad (please explain)?
-
-
- c. If yes, what system have you used?
3. Do you have any formal training in health data management or analysis? YES NO
4. How many peer-reviewed publications have you authored?
- 3 OR LESS 4-10 10-20 20 OR MORE

The following 2 questions are about data reporting.

1) Using the list of variables below, please list types of reports that you think would be of interest in your health facility or useful in publishing.

EXAMPLE: MECHANISM OF INJURY BY YEAR

MECHANISM OF INJURY
ARRIVAL MODE
ARRIVAL DATE
ARRIVAL TIME
INJURY DATE
INJURY TIME
PATIENT DOB

PATIENT AGE
INJURY PLACE
AUTOMOTIVE ACCIDENT ROLE
AUTOMOTIVE ACCIDENT VEHICLE
REFERRED BY (HOSPITAL NAME)
PATIENT SEX
TIME TO EMERGENCY DEPARTMENT

USEFUL REPORT TYPES: 1).....

2).....

3).....

2) Considering the list of variable above, what other variables are of interest to your health facility or research?

.....

.....

Appendix 3: Usability survey/Questionnaire II

BGriffith
UCT

Usability Questionnaire (Questionnaire II)

Questions regarding the training on how to use the **Trauma Data Platform** program

| For each statement below, please place an "X" in the box that best represents your view | Completely disagree (1)-Completely agree (7) | | | | | | | N/A |
|--|--|---|---|--|---|---|--------------------------|-----|
| | 1 Completely Disagree | 2 | 3 | 4 Neither disagree nor agree | 5 | 6 | 7 Completely agree | |
| 1) The following subjects were satisfactorily explained: | | | | | | | | |
| a. Introduction of the Trauma Data Platform | | | | | | | | |
| b. Why I would use the Trauma Data Platform | | | | | | | | |
| c. How to use the Trauma Data Platform | | | | | | | | |
| 2) The trainer was able to support my learning during the training | | | | | | | | |
| 3) I have the knowledge to use the Trauma Data Platform after this training session | | | | | | | | |
| 4) I have the resources necessary to use the Trauma Data Platform | | | | | | | | |
| 5) The length of the workshop was appropriate | | | | | | | | |
| 6) I have the relevant practical and professional skills to use the Trauma Data Platform | | | | | | | | |

1

BGriffith
UCT

Questions regarding the Trauma Data Platform

After completing the workshop, please answer the questions below based on your experiences and expectations using the AFEM Trauma Data Platform.

| For each statement below, please place an "X" in the box that best represents your view | Completely disagree (1)-Completely agree (7) | | | | | | | N/A |
|--|--|---|---|--|---|---|--------------------------|-----|
| | 1 Completely disagree | 2 | 3 | 4 Neither disagree nor agree | 5 | 6 | 7 Completely agree | |
| 1) Overall, I am satisfied with how easy it is to use the Trauma Data Platform | | | | | | | | |
| 2) It was simple to use the Trauma Data Platform | | | | | | | | |
| 3) I can effectively complete my work using the Trauma Data Platform | | | | | | | | |
| 4) I am able to complete my work quickly using the Trauma Data Platform | | | | | | | | |
| 5) I am able to efficiently complete my work using the Trauma Data Platform | | | | | | | | |
| 6) I feel comfortable using the Trauma Data Platform | | | | | | | | |
| 7) It was easy to learn to use the Trauma Data Platform | | | | | | | | |
| 8) I believe I became productive quickly using the Trauma Data Platform | | | | | | | | |
| 9) The Trauma Data Platform gives error messages that clearly tell me how to fix problems | | | | | | | | |
| 10) Whenever I make a mistake using the Trauma Data Platform, I recover easily and quickly | | | | | | | | |
| 11) The information (such as online help, on-screen messages, and other documentation) provided with the Trauma Data Platform is clear | | | | | | | | |

2

| For each statement below, please place an "X" in the box that best represents your view | 1 Completely disagree | 2 | 3 | 4 Neither disagree nor agree | 5 | 6 | 7 Completely agree | N/A |
|---|-----------------------------|---|---|---------------------------------------|---|---|--------------------------|-----|
| 12) It is easy to find the information I needed | | | | | | | | |
| 13) The information provided for the Trauma Data Platform is easy to understand | | | | | | | | |
| 14) The information is effective in helping me complete the tasks and scenarios | | | | | | | | |
| 15) The organization of information on the Trauma Data Platform screens is clear | | | | | | | | |
| 16) The interface of the Trauma Data Platform is pleasant | | | | | | | | |
| 17) I like using the interface of the Trauma Data Platform | | | | | | | | |
| 18) The Trauma Data Platform has all the functions and capabilities I expect it to have | | | | | | | | |
| 19) Overall, I am satisfied with the Trauma Data Platform | | | | | | | | |
| 20) Overall, I am satisfied with how easy it is to use the Trauma Data Platform | | | | | | | | |

What is missing from the trauma data platform that should be included?
.....

What are the most negative aspects about the platform?
.....

What are the most positive aspects of the platform?
.....

Questionnaire is based on the Computer system Usability Questionnaire by Lewis et al. Lewis JR. IBM computer usability satisfaction questionnaires: psychometric evaluation and instructions for use. International Journal of Human-Computer Interaction. 1995;7(1):57-78.

Appendix 4: HREC Approval Letter



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



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

24 March 2015

HREC/REF: 115/2015

Prof L Wallis
Department of Emergency Medicine
Private Bag x 24 Bellville
7535

Dear Prof Wallis

Project Title: DEVELOPMENT AND USABILITY TESTING OF A DATA VISUALISATION PLATFORM FOR AN AFRICAN TRAUMA REGISTRY (MSc candidate- Bridget Griffith)

Thank you for your response letter dated 16 March 2015, addressing the issues raised by the Human Research Ethics Committee (HREC).

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

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

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

We acknowledge that the following student:-Bridget Griffith is also involved in this project.

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

Please quote the HREC REF in all your correspondence.

Yours sincerely

PROFESSOR M BLOCKMAN
CHAIRPERSON, HSF HUMAN ETHICS

Federal Wide Assurance Number: FWA00001637.

Institutional Review Board (IRB) number: IRB00001938

Hrec/ref:115/2015

This serves to confirm that the University of Cape Town Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Convention on Harmonisation Good Clinical Practice (ICH GCP) and Declaration of Helsinki guidelines.

The Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50, 56 and 312.

Hrec/ref:115/2015

Appendix 5: Consent form

Consent Form A



BGriffith
University of Cape Town

CONSENT TO PARTICIPATE IN RESEARCH: *Development and usability testing of a data visualisation platform for an African trauma data registry*

You are asked to participate in a research questionnaire conducted by researchers at University of Cape Town. The results of this questionnaire will be used in the development of a data visualisation and access platform for trauma data. You were selected as a possible participant in this study because you are a healthcare provider or researcher that works in the realm of emergency care in one of the healthcare facilities where the AFEM Trauma Registry is currently collecting data.

1. PURPOSE OF THIS STUDY

This study aims to assess the usability and functionality of a trauma data visualisation platform with the goal of optimising the platform for use in conjunction with the AFEM Trauma data Registry.

Background: Trauma is a significant contribution to the global burden of mortality and disease, especially in sub-Saharan Africa. The methods for tracking, recording, and analysing the incidence and causes of trauma are underdeveloped. To address this, AFEM developed a trauma form and Trauma Data Registry to collect trauma data in multiple sites in sub-Saharan Africa. To further address the lack of analysis and publishing of trauma data, we created a web-based trauma data visualisation platform for use with the AFEM Trauma Registry Data. This study involves a usability assessment of the data visualisation platform to determine the specific website features and analytical needs of African trauma research facilities.

2. PROCEDURES

If you volunteer to participate in the questionnaire, we would ask that you do the following things:

- Participate in a web-based questionnaire that includes questions about your age, gender, education level, and current occupation, as well as your current of previous experience using software or a website to visualise data.
- At your place of work, complete a one-on-one workshop on the data visualisation platform in which you are asked to accomplish three different data entry and/or data analysis tasks with the platform and sample data. You will be audio recorded during this workshop.
- Complete Questionnaire II, which will assess the usability of the platform. There are a number of questions that ask you to mark an "X" in the box that best corresponds to your agreement or disagreement with the statement provided. You are asked to respond honestly to all the questions presented.
- After completion of the paper survey, you will be asked to participate in a short, audio-recorded interview in which you will be asked to share your comments, criticisms, and suggestions for improvements to the database in a safe, open, and collaborative manner.

It is anticipated that the entire process will take no more than 1 hour of your time.

3. POTENTIAL RISKS AND DISCOMFORTS

There are no foreseeable risks, discomforts, or inconveniences envisaged due to participation.

4. POTENTIAL BENEFITS TO PARTICIPANTS AND/OR SOCIETY

The answers provided in this questionnaire will be used to inform the optimization of a data visualisation platform for use in the respective healthcare facilities of each participant. In that way, participants will benefit from being able to view, store, and analyse trauma data from their health facility for research purposes and to possibly inform clinical decision-making.

5. PAYMENT FOR PARTICIPATION

Participants will receive no payment for completing this questionnaire; however we thank you for your time.

6. CONFIDENTIALITY

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. The only item that shall retain your name is this consent form. The questionnaire used for research purposes will not contain your name or any identifying information. The consent forms will be kept separately from the questionnaires, so no indication may be made as to which participant completed which questionnaire. All collected documents will be kept in the Investigator's office at University of Cape Town, in a locked cabinet. Only the investigator and the researchers involved in the study will have access. The data will be transcribed into an Excel database and will be password protected and stored in a computer in the Investigator's office at University of Cape Town.

All audio files will be kept in the possession of BG until the information is transcribed and coded. At this point, the audio files will be deleted unless the participant has specifically granted IGEC&AFEM permission to use the audio files for informative and or promotional purposes via Consent Form B.

The results of this questionnaire and transcribed audio files will be shared with the international collaborators via email; however, no personal data will be disclosed without your permission. It is not foreseen that this will be necessary. The results of the questionnaire and transcribed audio files will also be published in a peer-reviewed academic journal; however, no identifiable personal details or the participants whatsoever will be included.

7. PARTICIPATION AND WITHDRAWAL

You can choose whether or not to participate in this study; your decision regarding this will not affect your working conditions. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind.

You may refuse to answer any questions you don't want to answer and still remain in the study. The investigator may withdraw you from this research if circumstances arise which warrant doing so. Subjects will be asked if they mind being photographed. This is optional, and it will not prevent you from participating in the study. Those that agree to be will be asked to sign Consent Form C.

8. IDENTIFICATION OF INVESTIGATORS

Miss Bridget C. Griffith MPH and Professor Lee A. Wallis MBChB, MD, DIMCRCSEd, Dip Sport Med, FRCSEd(A&E), FCEM, FCEM(SA), FIFEM, FEMSSA from the Division of Emergency Medicine at University of Cape Town, South Africa and **Dr. Teri Reynolds MD, MS, PhD** from the Division of Emergency Medicine at University of Cape Town, South Africa

If you have any questions of concerns about the research, please feel to contact:

Local Investigator: Prof. Lee A. Wallis
Division of Emergency Medicine
University of Cape Town
+27 079 277 8406
bridgetcgriffith@gmail.com

9. RIGHTS OF RESEARCH PARTICIPANTS

You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights, or remedies because of your participation in this research study. If you have questions regarding your rights as a research participant, contact

Human Research Ethics Committee,
C/o Ms Lamees Emjedi
E 52 Room 24, Old Main Building, Groote Schuur Hospital, Observatory
Telephone: 27 21 406 6338

This study has been approved by the health research ethics committee.

SIGNATURE OF RESEARCH PARTICIPANT OR LEGAL REPRESENTATIVE

The information above was described to [me/he participant] by [name of relevant person] in [English/French/other] and [I am/the participant is] in command of this language or it was satisfactorily translated to [me/him/her]. [I/the participant] was given the opportunity to ask questions and these questions were answered to [my/his/her] satisfaction.

[I hereby consent to voluntarily participate in this study/I hereby consent that the participant may participate in this study.] I have been given a copy of this form.

Name of Participant

Name of Legal Representative (if applicable)

Signature of Participant or Legal Representative

Date

SIGNATURE OF INVESTIGATOR

I declare that I explained the information given in this document to [name of participant] and/or [his/her] representative..... [name of representative]. [He/she] was encouraged and given ample time to ask me and questions. This conversation was conducted in [English/French/Other] and [no translator was used/this conversation was translated intoby.....]

Signature of Investigator

Date

Consent Form B

RECORDED AUDIO CONSENT AND RELEASE FORM

The African Federation for Emergency Medicine (AFEM) and the Institute for Global Emergency Care (IGEC)
Private Bag X24
Bellville, South Africa 7535

Without expectation of compensation or other remuneration, now or in the future, I hereby give my consent to AFEM and IGEC, its affiliates and agents, to use any audio-recorded interview statements from me in its publications, advertising or other media activities (including the Internet). This consent includes, but is not limited to:

- (a) Permission to interview and record my voice;
- (b) Permission to use my name; and
- (c) Permission to use quotes from the interview(s) (or excerpts of such quotes), and/or recording of my voice, in part or in whole, in its publications, in newsletters, reports and other print media, on podcasts, radio and electronic media (including the Internet), and in mailings for educational and awareness purposes.

I will make no monetary or other claim, including any and all claims for libel, for the use of the interview and/or video/recording of my voice.

Note exceptions here and/or by crossing out points above to which the interview subject does not agree. Subject reserves the right to decline to answer certain questions and to stop the interview if he/she becomes uncomfortable. He/she may refuse the use of his/her full name and/or of his/her address.

This consent is given in perpetuity, and does not require prior approval by me.

Name of Participant

Name of Legal Representative (if applicable)

Signature of Participant or Legal Representative

Date

SIGNATURE OF INVESTIGATOR

I declare that I explained the information given in this document to..... [name of participant] and/or [his/her] representative..... [name of representative]. [He/she] was encouraged and given ample time to ask me and questions. This conversation was conducted in [English/French/Other] and [no translator was used/this conversation was translated intoby.....]

Signature of Investigator

Date

Appendix 6: MSc Proposal

Development and usability testing of a data visualisation platform for an African trauma data registry

Student: Bridget C Griffith

Student number: GRFBRI002/T0041889

UCT ID:

Email: bridgetcgriffith@gmail.com

Candidate for MSc in Emergency medicine

Degree Code: MM095CHM02

Principal Investigator: Professor Lee A Wallis

Division of Emergency Medicine

University of Cape Town

Email: lee.wallis@uct.ac.za

UCT Staff Number: 01401390

Co-supervisor: Dr. Teri Reynolds

Division of Emergency Medicine

University of Cape Town

Email: reynoldst@gmail.com

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Declaration page

I, *Bridget C Griffith*, hereby declare that the work on which this proposal/ dissertation/ thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

I empower the university to reproduce for the purpose of research either the whole or any portion of the contents in any manner whatsoever.

Signature:

Date:

Abstract:

Introduction: Trauma is a significant contribution to the global burden of mortality and disease, especially in sub-Saharan Africa. The methods for tracking, recording, and analysing the incidence and causes of trauma are underdeveloped. To address this, The African Federation for Emergency Medicine (AFEM) developed a trauma form and Trauma Data Registry to collect trauma data in multiple sites in sub-Saharan Africa.

Methods: To further address the lack of analysis and publishing of trauma data, we created a web-based trauma data visualisation platform for use with the AFEM Trauma Registry Data. This study involves a usability assessment of the AFEM Trauma Data Visualisation Platform to determine the specific website features and analytical needs of African trauma research facilities. This will be done by surveying the individuals from healthcare facilities that are currently using the AFEM Trauma Data Form.

Two types of questionnaires will be administered; Questionnaire I is to gather information on the study population and their expectations for the platform, and Questionnaire II is to assess the usability of the platform after it is introduced. Questionnaire I will be administered before the study population is introduced to the platform. Questionnaire II will be administered after the completion of a workshop on the platform. Surveys will take place in person and online, with the last group of questionnaires being administered on-site at the healthcare facility.

Results: The results of this study will include qualitative information on the participants' experiences and preferences for a data analysis platform. Additionally, the results will include a numerical evaluation of the AFEM Trauma Data Platform and qualitative feedback and suggestions from the survey population.

Discussion: Findings of these surveys will be incorporated into the tailoring of the platform's design and function for African Healthcare providers. It is expected that the results of this study will also be useful in the development of other technology-based tools for African Healthcare practitioners.

Conclusion: Overall, this usability study will garner information on the wants and needs of a data analysis platform tailored for African healthcare professionals. The methods integrate survey techniques with platform development and introduction in order to maintain a proactive approach assessing usability.

Keywords: Trauma, Data Visualisation, data gap, website usability, Africa, Trauma Registry

1. Introduction

9.1 Literature Review

Trauma contributes significantly to the burden of disease and mortality throughout the world, but particularly in developing countries. Although methods for quantifying the incidence of trauma are underdeveloped, it is estimated that trauma contribute approximately 10% to global mortality and 12% to global morbidity(16-19). Much of this is preventable, but prevention efforts are hampered by a lack of published data to demonstrate the need for improvements to health systems and infrastructure that can reduce the incidence of trauma. Without published data, it is not possible to convince policy makers and other stakeholders of the problem and to help prioritize and design effective intervention programs.

In order to address the lack of critical documentation of trauma in sub-Saharan Africa, The African Federation for Emergency Medicine (AFEM) has created the AFEM Trauma Data Registry. This registry is informed by a standardized clinical chart for capturing essential information on injured patients. The database is currently being used to document the burden of injury in multiple countries in sub-Saharan Africa, including Tanzania, Uganda, Ethiopia, Cameroon, and The Democratic Republic of Congo, and it will help to characterise risk factors associated with these injuries. This information from the database will serve as a basis to improve early intervention in injured patients, inform future preventive initiatives, and provided essential information for trauma research.

There is an enormous research gap on trauma in sub-Saharan Africa. This data gap obscures the profound health impact of the lack of access to timely care for injuries, and in many countries, trauma care system development is only slowly becoming a priority. Barriers to publishing trauma data include lack of documentation of trauma and poor reporting, but these barriers also include intrinsic gaps in the research and publishing capabilities of African research institutions. When data do get reported, they are often not analysed and published constructively(21).

In partnership with the AFEM Trauma Database, a web-based data visualisation platform would begin to address the barriers to publishing observed in both trauma and many other types of public health and medical research in sub-Saharan Africa. This data platform would be made available to all institutions participating in the AFEM Trauma Data Project, and it would provide them with a method of uploading, storing, and analysing the trauma data coming from their facility. In this way, as the AFEM Trauma Registry database grows, there is already a platform in place to help the study institutions take ownership of their data.

9.2 Motivation for study

There is a clear gap in the amount of injury-related peer-reviewed literature being published by researchers in Africa compared to other regions of the world.

The great majority of health publications, even those pertaining to health in developing countries, are published by research groups at institutions in high-income countries and are most often published in high-profile, Anglophone journals(21). As of 2005, more than 90% of the publications were produced by scientists in 20 countries, with over one-third of the publications coming from The United States alone(22). This “publication gap” is due to multiple factors, including lack of resources, lack of access to data, and unequal collaboration with overseas partners. Often this results in research focused on broad, regional problems rather than national challenges that are a greater priority for local researchers (23).

Even though health research institutions in sub-Saharan Africa are not the main worldwide producers of research, and they are not the main producers even among developing countries, their research activity is significant(25). The lacuna in Africa-based publishing may cause journals to be missing evidence, analyses, perspectives, and nuance essential to solving health problems peculiar to the region(21). This publishing gap has also been linked to “brain drain” in both academia and medicine, incentivising African scientists and healthcare professionals to seek positions in other countries to gain more publishing opportunities (26).

Scientific and statistical tools are noted as a specific cause of the publishing gap in sub-Saharan Africa(21). The data platform seeks to remedy this by providing trauma researchers with a built-in method for analysing the aggregate data coming from their facility and others also participating in the AFEM Trauma Data Registry. The trauma registry, in conjunction with the data visualisation platform, will serve as a conduit for trauma data that drives the evaluation, prevention, and research of trauma care, and it can be used for quality control and planning. (27).

Other research groups have used data visualisation to increase the usability and understandability of global health data to the general public, such as Gapminder(28, 29). Using a similar vision, we aim to design a data visualisation platform that makes trauma data more accessible to Africa-based healthcare workers and researchers in emergency care. This platform will act as a resource for individuals interested in studying retrospective trauma data for the purposes of publishing, policy making, or using data trends to inform changes in clinical practice healthcare facility design. This data visualisation platform will provide users with retrospective data from their respective healthcare facility and aggregate data from all other healthcare facilities using the AFEM Trauma Form. The aim of the visualisation portion of the website is to increase the accessibility of the data by providing built-in analytical tools to create descriptive visualisations of the data.

Usability testing is used in website and mobile application development to measure dimensions including: effectiveness, errors, efficiency, satisfaction, attitude, flexibility, learnability, memorability, operability, accessibility, and acceptability(87). It is also used to improve the functionality of websites and mobile applications delivering health data. Testing in this study will improve the functionality of the program, to ascertain the continuous use of the data visualisation platform.

9.3 Aims and objectives

The primary aim of this study is to create, and assess the usability and functionality of, a trauma data visualisation platform for use in conjunction with the AFEM Trauma data Registry.

The secondary aim of this study is to gather information and opinions regarding the wants and needs of a data analysis platform specifically designed for African healthcare practitioners and researchers.

In order to achieve these aims, this study has the following objectives:

1. To create a web-based data visualisation platform for the pre-existing AFEM Trauma Data Registry
2. To assess the usability of the platform through surveys and user testing to inform the development of an Africa-specific low-bandwidth website that has the potential to
 - a. Reduce data sharing and analysis inefficiencies
 - b. Act as a professional resource
 - c. Improve surveillance of trauma and injury by consolidating information
 - d. Improve usability and utility of raw data for research and publishing

9.4 Research questions

Website features

1. What are the preferred website features and of a data visualisation website, specifically designed for African healthcare facilities, that will improve the accessibility and utility of aggregate data from the AFEM Trauma Registry?

Data Analysis

2. What are the data analytical needs of researchers working in healthcare facilities with the AFEM Trauma Data Form?

10 Methods:

10.1 Study design:

Background questionnaire (Questionnaire I, Appendix B):

In order to increase the functionality of the website, study participants will be asked to participate in a short online questionnaire during the development phase of the website. This survey will collect background information on the individuals'

experience with data analysis, and it will give them the chance to make suggestions about what they want/need out of a data analysis platform. The survey will also ascertain how many years the individual has been working in the medical profession, how many peer-reviewed articles each participant has published, and what their daily internet availability is. This information will help to determine the experience level and professional age of the population.

Development of data analysis platform:

The researcher (BG) is currently working with bespoke web developer to create a functional “phase I” website with a software platform to store data and present basic visualisations. The most important considerations for the design of the platform include:

3. Website and software specifically designed for low bandwidth connections
4. Provide storage and basic analysis tools to researchers and students
5. Be pre-loaded with two years of data from Muhimbili Hospital in Dar es Salaam, Tanzania for the part 1 testing
6. Trends and suggestions from background survey

The development of the website is based on the parameters identified by Dr. Teri Reynolds, principal investigator of the AFEM Trauma Data Project, and insight the MSc candidate, Bridget Griffith, has gained from speaking to multiple bespoke web and software developers.

Website usability testing (Questionnaire II, Appendix C):

The website will be evaluated using paper-based questionnaires. The majority of the questionnaire will measure the usability of the website using quantitative questions modelled after the Computer System Usability Questionnaire(78). The questionnaire will also include several qualitative free-text questions to allow evaluators to make suggestions to improve the platform.

Evaluation of the platform will be conducted in two different settings. The first round of testing will take place in Cape Town, South Africa during the April 2015 conference, the 19th World Congress on Disaster and Emergency Medicine. During the conference, selected delegates will participate in a platform tutorial, a mock assignment/analysis task, and a paper-based questionnaire asking the participants to rate their user experience and ask them to comment on and suggest improvements to the site. This testing will also function as an introduction of the website to the trauma registry participant community and will prime participants for the second phase of on-site website testing.

The second round of testing will take place in-country at healthcare facilities that are currently participating in the AFEM Trauma Data project. The same workshop and a follow-up questionnaire will be offered. This will allow more individuals to become familiarised with the platform and it will facilitate the introduction of the

platform into the facility. It is expected that each facility will require a tailored plan for use of the platform depending on internet availability, security, computer availability, and general hospital workflow.

BG will be the only person to administer surveys at both EMSSA and the on-site visits.

After the visit, the health facility will be offered a copy of the survey for their review and permanent records. However, the study coordinator will make it clear that the survey does not measure the healthcare facility's performance in any way.

Characteristics of the Study population:

The study population is composed of healthcare workers from health facilities that are currently using the AFEM Trauma Data Form. These individuals have leadership role in their respective healthcare facility along with a history or desire to publish peer-reviewed research on the data collected by the registry. Additionally, individuals at the facilities that will be responsible for data collection and entry will be included in the surveys and workshops.

Recruitment and enrolment:

Individuals will be contacted before the conference in April 2015 and asked to participate in the website tutorial and questionnaire at a mutually convenient time during the conference. After receiving an email confirmation of interest in participating, they will be prompted to complete Questionnaire I online using www.surveymonkey.com. Official enrolment in the study will not occur until the participant signs the consent form at the website training session.

For the on-site website training and questionnaire, recruitment will be communicated with the help of healthcare facility emergency care leaders through email announcements and posted fliers. Official enrolment in the study will not occur until the participant signs the consent form at the website training session.

Data safety and monitoring

All surveys will be collected and kept by BG, who will act as both the survey administrator and research coordinator for analysis. Collected data will be compiled and handled by researchers only. Only study investigators will have access to the completed surveys and aggregate data. Specific results of the website design questions will be made available to the bespoke website designers during the creation of the phase II website. The results will not contain any identifying information of the participant.

All data platform access will be username and password protected with specific permissions based on admin level.

The information will not be sold or used for any commercial purpose.

11 Statistical Analysis

This study will involve mixed methods of analysis. It will include a statistical analysis of survey results along with a qualitative approach to analysing thoughts and opinions gathered from the free-text and write-in portions of the survey. Relevant information will be made available to the website developers during the design of a phase II website.

12 Ethical and legal considerations

Ethical and legal considerations include confidentiality and anonymity of survey information and security of country data.

Description of risks and benefits

There are no anticipated risks to this study.

Benefits include the optimization of a data visualisation tool to specifically fit the needs of emergency care healthcare workers and researchers working in sub-Saharan Africa.

Informed consent process

Participation in the questionnaire is voluntary, and all participants will be given the option to decline. The participants will be asked to sign a formal consent form which will contain information about the study along with their individual rights with regards to the study methods. Participants will be asked to sign this form, stating that they have read and understand their rights.

Confidentiality of survey data

Any information that is obtained in connection with this study and that can be identified with an individual will remain confidential and will be disclosed only with your permission or as required by law. The only item that shall retain your name is this consent form. The actual questionnaire used for research purposes will not contain your name or any identifying information. The consent forms will be kept separately from the questionnaires, so no indication may be made as to which participant completed which questionnaire. All collected documents will be kept in the Investigator's office at University of Cape Town, in a locked cabinet. Only the investigator and the researchers involved in the study will have access to the key. The data will be transcribed into an Excel database and will be password protected and stored in a computer in the Investigator's office at University of Cape Town.

Data security

Collected data will be compiled and handled by the researchers only. Only study investigators will have access to the completed toolkits and results. The data analysis platform will include be protected by username and password. Only the investigators listed in this study will have certain high-level admin privileges will have access to all country data. The results will not contain any identifying information about the participant. The information will not be sold or used for any commercial purpose.

Reimbursement for participation

There is no reimbursement for participation in this website usability questionnaire.

13 Limitations

The qualitative information gathered from this study is not generalizable to other website usability studies due to its small sample size and specificity of the data analysis platform.

The development of the platform may be limited due to budget constraints.

14 Resources

Budget

| Category | Details | Cost per country | Total |
|--|--|----------------------------------|------------|
| Website | Bespoke design and monthly maintenance fee for 12 months | n/a | R50,000.00 |
| Airfare | South Africa to location and return | R 7,700 | R30,800.00 |
| Lodging | | R 280 per day R 1960 per week | R 7840.00 |
| Travel in-country | | R 116 per day R 810 per week | R 3,240.00 |
| Other costs | Photocopy, office supplies | R1200 | R 1200.00 |
| Total Budget for four countries = R93,080.00 | | | |

All financial resources needed for the study will be fully funded by the African Federation for Emergency Medicine. No other financial contributions will be required.

15 Study Timeline

| 2015 | | Jan 2015 | Feb 2015 | Mar 2015 | Apr 2015 | May 2015 | Jun 2015 | Jul 2015 | Aug 2015 | Sep 2015 | Oct 2015 | Nov 2015 |
|----------------------------------|-------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Ethics Review | | | X | X | | | | | | | | |
| Website development | | X | X | X | X | | | | | | | |
| Data collection | Q I* | | | X | | | | | | | | |
| | Q II* | | | | | X | X | X | | | | |
| Data Compilation and Analysis | | | | | X | | | X | X | | | |
| Compilation of Final Report | | | | | | | | | X | X | | |
| Submission of MSc | | | | | | | | | | X | | |

* Questionnaire I and II

16 Reporting and implementation of results

The results of this study will be made available to AFEM and all participating healthcare facilities. The final product of this questionnaire will be generated into a report that will be sent to the bespoke website designers for incorporation into the subsequent phases of the platform design. A paper will be published reporting the findings or the usability study in a peer-reviewed journal.

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Appendix A

Consent Form

CONSENT TO PARTICIPATE IN RESEARCH

*Development and usability testing of a data visualisation platform for an African
trauma data registry*

You are asked to participate in a research questionnaire conducted by researchers at University of Cape Town. The results of this questionnaire will be used in the development of a data visualisation and access platform for trauma data. You were selected as a possible participant in this study because you are a healthcare provider or researcher that works in the realm of emergency care in one of the healthcare facilities where the AFEM Trauma Registry is currently collecting data.

1. PURPOSE OF THIS STUDY

This study aims to assess the usability and functionality of a trauma data visualisation platform with the goal of optimising the platform for use in conjunction with the AFEM Trauma data Registry.

Background:

Trauma is a significant contribution to the global burden of mortality and disease, especially in sub-Saharan Africa. The methods for tracking, recording, and analysing the incidence and causes of trauma are underdeveloped. To address this, AFEM developed a trauma form and Trauma Data Registry to collect trauma data in multiple sites in sub-Saharan Africa. To further address the lack of analysis and publishing of trauma data, we created a web-based trauma data visualisation platform for use with the AFEM Trauma Registry Data. This study involves a usability assessment of the data visualisation platform to determine the specific website features and analytical needs of African trauma research facilities.

2. PROCEDURES

If you volunteer to participate in the questionnaire, we would ask that you do the following things:

- Participate in a web-based questionnaire that includes questions about your age, gender, education level, and current occupation, as well as your current of previous experience using software or a website to visualise data.
- Then, during the 2015 EMSSA conference and/or at your place of work, complete a short workshop of the data visualisation platform in which you are asked to accomplish three different tasks with the website and sample data. Then, complete a Questionnaire II, which will assess the usability of the platform. There are a number of questions that ask you to mark an “X” in the box that best corresponds to your agreement or disagreement with the statement provided. You are asked to respond honestly to all the questions presented.

- It is anticipated that this questionnaire will take no more than 20 minutes of your time.

3. POTENTIAL RISKS AND DISCOMFORTS

There are no foreseeable risks, discomforts, or inconveniences envisaged due to participation.

4. POTENTIAL BENEFITS TO PARTICIPANTS AND/OR SOCIETY

The answers provided in this questionnaire will be used to inform the optimization of a data visualisation platform for use in the respective healthcare facilities of each participant. In that way, participants will benefit from being about to view, store, and analyse trauma data from their health facility for research purposes and to possibly inform clinical decision-making.

5. PAYMENT FOR PARTICIPATION

Participants will receive no payment for completing this questionnaire, however we thank you for your time.

6. CONFIDENTIALITY

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. The only item that shall retain your name is this consent form. The actual questionnaire used for research purposes will not contain your name or any identifying information. The consent forms will be kept separately from the questionnaires, so no indication may be made as to which participant completed which questionnaire. All collected documents will be kept in the Investigator's office at University of Cape Town, in a locked cabinet. Only the investigator and the researchers involved in the study will have access to the key. The data will be transcribed into an Excel database and will be password protected and stored in a computer in the Investigator's office at University of Cape Town.

The results of this questionnaire will be shared with the international collaborators via email, however no personal data will be disclosed without your permission. It is not foreseen that this will be necessary. The results of the questionnaire will also be published in a peer-reviewed academic journal, however no identifiable personal details or the participants whatsoever will be included.

7. PARTICIPATION AND WITHDRAWAL

You can choose whether to be in this study or not, your decision regarding this will not affect your working conditions. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. You may also refuse to answer any questions you don't want to answer and still remain in the study. The investigator may withdraw you from this research if circumstances arise which warrant doing so.

8. IDENTIFICATION OF INVESTIGATORS

Miss Bridget C. Griffith MPH and

Professor Lee A. Wallis MBChB, MD, DIMCRCSEd, Dip Sport Med, FRCSEd(A&E), FCEM, FCEM(SA), FIFEM, FEMSSA from the Division of Emergency Medicine at University of Cape Town, South Africa and

Dr. Teri Reynolds MD, MS, PhD from the Division of Emergency Medicine at University of Cape Town, South Africa

If you have any questions or concerns about the research, please feel to contact:

Local Investigator: Prof. Lee A. Wallis

Division of Emergency Medicine

University of Cape Town

+27 079 277 8406

bridgetcgriffith@gmail.com

9. RIGHTS OF RESEARCH PARTICIPANTS

You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights, or remedies because of your participation in this research study. If you have questions regarding your rights as a research participant, contact

Human Research Ethics Committee,
c/o Ms Lamees Emjedi

E 52 Room 24, Old Main Building, Groote Schuur Hospital, Observatory

Telephone: 27 21 406 6338

This study has been approved by the health research ethics committee.

SIGNATURE OF RESEARCH PARTICIPANT OR LEGAL REPRESENTATIVE

The information above was described to [me/he participant] by [name of relevant person] in [English/French/other] and [I am/the participant is] in command of this language or it was satisfactorily translated to [me/him/her]. [I/the participant] was given the opportunity to ask questions and these questions were answered to [my/his/her] satisfaction.

[I hereby consent to voluntarily participate in this study/I hereby consent that the participant may participate in this study.] I have been given a copy of this form.

Name of Participant

Name of Legal Representative (if applicable)

Signature of Participant of Legal Representative

Date

SIGNATURE OF INVESTIGATOR

I declare that I explained the information given in this document to[*name of participant*] and/or [his/her] representative.....[*name of representative*]. [He/she] was encouraged and given ample time to ask me and questions. This conversation was conducted in [*English/French/Other*] and [no translator was used/this conversation was translated intoby.....]]

Signature of Investigator

Date

Appendix B

Background Questionnaire

NOTE: The content of the background portion of the questionnaire will be offered as an online survey for convenience and easy distribution before the EMSSA Conference. A backup paper version of the survey will be offered on the same day as the workshop beforehand.

Please complete the following anonymous information about yourself (tick the appropriate answer where required). This information will be used in the initial development of the Trauma Data Platform. Please complete the survey, even if you have no previous experience with data analysis platforms.

For items that are not applicable, write NA.

1. Age.....
2. Highest level of training/education
completed.....
 - a. In what country.....
3. Current occupation:
Hospital: SPECIALIST PHYSICIAN NURSE
Or Pre-Hospital: BASIC LIFE SUPPORT INTERMEDIATE LIFE SUPPORT
 PARAMEDIC
 OTHER, please
specify.....
.....
4. Years of experience in emergency care at current facility in
total:.....
5. How would you describe your experience with data analysis?
 EXTENSIVE MODERATE MINIMAL NONE
6. Do you own a personal computer/laptop? YES NO

7. If yes, do you have consistent access to the internet on this device? YES

NO

8. Do you use a smartphone for private use? YES NO

9. If yes, for what

purpose(s)?.....

....

.....

.....

The following 4 questions concern the use of web-based data resources and publishing.

1. Do you currently use an application or website for data analysis and visualisation as a healthcare provider? YES NO

a. If yes, for what purpose?

.....

.....

2. Have you previously used an application or website for data analysis and visualisation as a healthcare provider? YES NO

a. If yes, for what purpose?

.....

.....

b. If yes, was the experience good or bad (please explain)?

.....

.....

.....

c. If yes, what system have you used?

.....

3. Do you have any formal training in health data management or analysis?

YES NO

4. How many peer-reviewed publications have you authored?

3 OR LESS

4-10

10-20

20 OR MORE

The following 2 questions are about data reporting.

1) Using the list of variables below, please list types of reports that you think would be of interest in your health facility or useful in publishing. EXAMPLE: MECHANISM OF

INJURY BY YEAR

MECHANISM OF INJURY

ARRIVAL MODE

ARRIVAL DATE

ARRIVAL TIME

INJURY DATE

INJURY TIME

PATIENT DOB

PATIENT AGE

INJURY PLACE

AUTOMOTIVE ACCIDENT ROLE

AUTOMOTIVE ACCIDENT VEHICLE

REFERRED BY (HOSPITAL NAME)

PATIENT SEX

TIME TO EMERGENCY DEPARTMENT

USEFUL

REPORT

TYPES:

1)

.....

.....

2).....

.....

3).....

.....

2) Considering the list of variable above, what other variables are of interest to your

health facility or

research?.....

.....

.....

.....

Appendix C

Usability Questionnaire (Questionnaire II)

Questions regarding the training on how to use the **Trauma Data Platform** program

| | Completely disagree (1)-Completely agree (7) | | | | | | | |
|---|--|---|---|----------------------------|---|---|------------------|-----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | N/A |
| | Completely Disagree | | | Neither disagree nor agree | | | Completely agree | |
| The following subjects were satisfactorily explained: | | | | | | | | |
| 1) Introduction of the Trauma Data Platform | | | | | | | | |
| 2) Why I would use the Trauma Data Platform | | | | | | | | |
| 3) How to use the Trauma Data Platform | | | | | | | | |
| The trainer was able to support my learning during the training | | | | | | | | |
| I have the knowledge to use the Trauma Data | | | | | | | | |

| | | | | | | | | |
|---|--|--|--|--|--|--|--|--|
| Platform after this training session | | | | | | | | |
| I have the resources necessary to use the Trauma Data Platform | | | | | | | | |
| The length of the workshop was appropriate | | | | | | | | |
| I have the relevant practical and professional skills to use the Trauma Data Platform | | | | | | | | |

Questions regarding the Trauma Data Platform

After completing the workshop, please answer the questions below based on your experiences and expectations using the AFEM Trauma Data Platform.

| | Completely disagree (1)-Completely agree (7) | | | | | | | |
|---|--|---|---|---------------------------------|---|---|-----------------------|-----|
| For each statement below, please place an "X" in the box that best represents your view | 1 Completely disagree | 2 | 3 | 4 Neither disagree nor agree | 5 | 6 | 7 Completely agree | N/A |
| Overall, I am satisfied with how easy it is to use the | | | | | | | | |

| | | | | | | | | |
|--|--|--|--|--|--|--|--|--|
| Trauma Data Platform | | | | | | | | |
| It was simple to use the Trauma Data Platform | | | | | | | | |
| I can effectively complete my work using the Trauma Data Platform | | | | | | | | |
| I am able to complete my work quickly using the Trauma Data Platform | | | | | | | | |
| I am able to efficiently complete my work using the Trauma Data Platform | | | | | | | | |
| I feel comfortable using the Trauma Data Platform | | | | | | | | |
| It was easy to learn to use the Trauma Data Platform | | | | | | | | |
| I believe I became productive quickly using the Trauma Data Platform | | | | | | | | |
| The Trauma Data Platform gives error messages that clearly tell me | | | | | | | | |

| | | | | | | | | |
|--|--|--|--|--|--|--|--|--|
| how to fix problems | | | | | | | | |
| Whenever I make a mistake using the Trauma Data Platform, I recover easily and quickly | | | | | | | | |
| The information (such as online help, on-screen messages, and other documentation) provided with the Trauma Data Platform is clear | | | | | | | | |
| It is easy to find the information I needed | | | | | | | | |
| The information provided for the Trauma Data Platform is easy to understand | | | | | | | | |
| The information is effective in helping me complete the tasks and scenarios | | | | | | | | |
| The organization of information on the Trauma Data Platform screens is clear | | | | | | | | |

| | | | | | | | | |
|---|--|--|--|--|--|--|--|--|
| The interface of the Trauma Data Platform is pleasant | | | | | | | | |
| I like using the interface of the Trauma Data Platform | | | | | | | | |
| The Trauma Data Platform has all the functions and capabilities I expect it to have | | | | | | | | |
| Overall, I am satisfied with the Trauma Data Platform | | | | | | | | |
| Overall, I am satisfied with how easy it is to use the Trauma Data Platform | | | | | | | | |

What is missing from the trauma data platform that should be included?

.....

.....

.....

What are the most negative aspects about the platform?

.....

.....

.....

What are the most positive aspects of the platform?

.....

.....

.....

Questionnaire is based on the Computer system Usability Questionnaire by Lewis et al.

Lewis JR. IBM computer usability satisfaction questionnaires: psychometric evaluation and instructions for use. *International Journal of Human-Computer Interaction*. 1995;7(1):57-78.