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Improving prehospital trauma care in Rwanda through continuous quality improvement: an interrupted time series analysis

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ABSTRACT

Introduction: Injury is a major cause of premature death and disability in East Africa, and high-quality pre-hospital care is essential for optimal trauma outcomes. The Rwandan pre-hospital emergency care service (SAMU) uses an electronic database to evaluate and optimize pre-hospital care through a continuous quality improvement programme (CQIP), beginning March 2014.

Materials and methods: The SAMU database was used to assess pre-hospital quality metrics including supplementary oxygen for hypoxia (O2), intravenous fluids for hypotension (IVF), cervical collar placement for head injuries (c-collar), and either splinting (splint) or administration of pain medications (pain) for long bone fractures. Targets of >90% were set for each metric and daily team meetings and monthly feedback sessions were implemented to address opportunities for improvement. These five pre-hospital quality metrics were assessed monthly before and after implementation of the CQIP. Met and unmet needs for O2, IVF, and c-collar were combined into a summative monthly SAMU Trauma Quality Scores (STQ score). An interrupted time series linear regression model compared the STQ score during 14 months before the CQIP implementation to the first 14 months after.

Results: During the 29-month study period 3,822 patients met study criteria. 1,028 patients needed one or more of the five studied interventions during the study period. All five endpoints had a significant increase between the pre-CQI and post-CQI periods ($p < 0.05$ for all), and all five achieved a post-CQI average of at least 90% completion. The monthly composite STQ scores ranged from 76.5 to 97.9 pre-CQI, but tightened to 86.1-98.7 during the post-CQI period. Interrupted time series analysis of the STQ score showed that CQI programme led to both an immediate improvement of +6.1% ($p = 0.017$) and sustained monthly improvements in care delivery—improving at a rate of 0.7% per month ($p = 0.028$).

Conclusion: The SAMU experience demonstrates the utility of a responsive, data-driven quality improvement programme to yield significant immediate and sustained improvements in pre-hospital care for trauma in Rwanda. This programme may be used as an example for additional efforts engaging frontline staff with real-time data feedback in order to rapidly translate data collection efforts into improved care for the injured in a resource-limited setting.

INTRODUCTION

Injury is one of the leading causes of death and disability in every country in the world [1]. Responsible for more than 5 million deaths each year, injuries claim more lives globally than HIV/AIDS,

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tuberculosis, and malaria combined [1]. While the development of integrated trauma systems has led to significant reductions in injury-related mortality for high-income countries (HICs) [2–4], such organized trauma care is essentially nonexistent for much of the world; despite the fact that over 90% of all injury-related deaths occur in low- and middle-income countries (LMICs) [5,6].

Most of the injury-related deaths in LMICs occur before the patients ever arrive at a healthcare facility, due to substantial insufficiencies in both availability and quality of prehospital care [7]. Prior work has shown that the proportion of injury-related deaths that occur in the pre-hospital setting are much higher in LMICs than HICs [8] [1]. While a recent review identified 10 middle-income countries with formalized emergency medical services and trauma systems, low-income countries often rely on informal prehospital systems staffed by lay providers with little formal training [9,10]. In an attempt to improve the prevention and care of injuries worldwide Mock et al. call for better evidence regarding effective prehospital treatment strategies for the injured in LMICs [11]. In high-income and upper-middle-income countries, staff training using the Prehospital Trauma Life Support (PHTLS) programme has been shown to result in improvements in pre-hospital care [12,13]. However, a 2014 Cochrane Review found no studies from low-income countries which demonstrated efficacy of advance life support training among prehospital providers [14].

Lack of prehospital data further complicates evaluation of prehospital care. In HIC settings, injury surveillance, most often through the use of large databases, is critically important to assess the epidemiology of injuries, quality of trauma care, and drive policies to improve injury prevention and quality of care [11]. While various efforts to establish trauma registries in low-income countries have been described in the literature [15,16], few examples of prehospital registries in low-income countries exist [17]. Currently, there is a dearth evidence regarding effective interventions that use feedback from pre-hospital trauma databases to improve the quality of pre-hospital trauma care in low-income countries.

We have previously described Rwanda's model development of an electronic prehospital care database [17]—one of the only prehospital databases in sub-Saharan Africa. In this study, we sought to evaluate the impact of continual data feedback from this novel database to frontline staff, on improving prehospital care in Rwanda. Specially, our aims were (1) to compare pre-hospital process measures for trauma care before and after implementation of a continuous quality improvement (CQI) programme, (2) to determine the immediate impact of the CQI programme on prehospital trauma care, and (3) to determine the impact of the CQI programme over time.

Materials and methods

Study context and setting

Rwanda is a landlocked country in East Africa with a population of over 11 million [18]. Despite the catastrophic losses of human resources and physical infrastructure that resulted from the 1994 genocide, over the past decade Rwanda has been a model of economic growth and primary health care in the region [18–20]. Rwanda's GDP has grown 7% annually over the last 10 years, and the post-1994 gains in life expectancy and maternal and child health have been some of the sharpest increases ever recorded [18–20].

Rwanda is also one of the only countries in sub-Saharan Africa with a publically run, national ambulance service. Established by the Rwandan Ministry of Health in 2007, the pre-hospital care service is known as the *Service d'Aide Médicale Urgente*, or SAMU. SAMU serves the greater Kigali area (Rwanda's capital city) and receives approximately 1200 calls monthly at their centralized call centre. The call centre staff's decision to dispatch an ambulance team is made according to the patients' clinical status and the availability of ambulances and staff. In Kigali, SAMU has a fleet of approximately 10 ambulances and employs approximately 60 anaesthesia technicians, nurses, and drivers. The main call centre and majority of staff are based at the University Teaching Hospital in Kigali. There is no formal certification programme in prehospital care at this time (e.g. paramedic, EMT) but the SAMU staff in Kigali have received training in Pre-Hospital Trauma Life Support and Basic Life Support. A typical responding team consists of one ambulance and three team members—one driver, one anaesthesia technician, and one nurse.

Dataset and patient sample

In 2013, through a partnership with two academic medical centres in the United States, an online database was established to house the clinical information that the SAMU staff record during their ambulance runs. The development of this database has previously been described in detail [17]. This prospectively collected database contains information on patient demographics, details of injury or disease state, clinical information regarding the patient when encountered on the scene, and information regarding treatment administered by SAMU staff en route to a healthcare facility. SAMU has always maintained detailed paper records on run-sheets that are filled out by staff in real time. However, the development of an online platform for data entry has allowed staff to enter their own data in a few minutes after each ambulance run. Those electronically entered data are then stored online through a secure REDCap data management platform [21]. Subsequently, these data can then be aggregated, downloaded, and analyzed in real time.

For this study, we evaluated all patients over the age of 15 years with a primary indication of injury, managed by SAMU staff during a 29-month period. This study period encompasses the March 2014 initiation of the quality improvement programme and includes 14 months of complete data pre-implementation (dating back to the onset of the online database in January 2013) as well as 14 months of post-implementation data for comparison (Fig. 1).

Continuous quality improvement programme

The SAMU Continuous Quality Improvement (CQI) Programme began in early March, 2014. The purpose of the CQI programme was to use output from the SAMU database to improve the quality of pre-hospital care at SAMU by feeding results back to frontline staff in real time. This began with establishing definitions for high quality prehospital care. As there are no established prehospital quality metrics for LMICs in the literature and the prehospital training of SAMU staff varies significantly, we asked the SAMU leadership to convene and establish best practice process measures that could be measured using the SAMU database. The SAMU leadership decided on five process measures for injured patients, further described below: (1) provision of supplemental oxygen in the setting of hypoxia, (2) application of a cervical collar (c-collar) for any patient with altered mental status, (3) administration of intravenous (IV) fluid bolus in the setting of hypotension, (4) administration of pain medications for long bone fractures, and (5) application of a splint for long bone fractures.

After these process measures were established, the entire SAMU staff were oriented to the CQI programme during a special departmental meeting. The scope of the CQI programme included three components: (i) monthly presentations by the authors to the SAMU team during staff meetings reviewing the proportion of patients for whom the above process measures were completed,

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