

Improved documentation following the implementation of a trauma registry: A means of sustainability for trauma registries in low- and middle-income countries

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ABSTRACT

Introduction: Trauma registries in low- and middle-income countries (LMICs) are critical for improving trauma care; however, while some registries have been established in low-income settings, few are sustained due to a lack of sustainable funding. In many LMIC institutions, funding is dependent on documentation of trauma patients, but patient records may be of poor quality, missing, or incomplete. The development of a trauma registry and electronic patient registration system could be used to improve documentation of trauma patients in a low-income setting and lead to increased funding for trauma care.

Methods: A retrospective chart review of trauma patients at Mbarara Regional Referral Hospital in Uganda was performed, documenting the monthly admissions from January 2015–July 2016 prior to the establishment of a trauma registry. A trauma registry and electronic patient registration system were established in 2017, and monthly admissions from February 2017–December 2019 were documented. A negative binomial regression analysis was performed comparing the incident rate of admission pre-implementation of the registry compared to post-implementation, adjusting for month and year. Completeness of trauma patient records was also assessed.

Results: Prior to the implementation of the trauma registry and patient registration system (2015–2016), there was a mean of 5.2 (SD 4.4) trauma records per month identified. Following the implementation of the trauma registry, a mean of 103.4 trauma records per month were documented (SD 32.0) for an increased incident rate ratio of 20.9 (95% CI 15.7–27.6, $p < 0.001$). There was also a significant increase in percentage of documents completed (OR 49.1, CI 12.4–193.7, $p < 0.001$).

Discussion: Following the implementation of a trauma registry and electronic patient registration system at this low-income country hospital, an increase of 20.9 times completed trauma patient documentation was identified, and completion of the records improved. This more accurate documentation could be used to apply for increased government funding for trauma patients and sustain the trauma registry in the long term and could represent a means of long-term sustainability for other trauma registries in LMICs.

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Introduction

Trauma in low- and middle-income countries (LMICs) is a significant cause of global morbidity and mortality, and trauma care in these settings is often hindered by a lack of trauma care systems [1,2]. As trauma care systems have been shown to reduce trauma mortality, they are therefore an area of focus for mitigating the disparity in trauma outcomes between high- and low-income countries [3]. One important component for the advancement of

trauma care systems and quality improvement in trauma is the trauma registry: a database of epidemiologic, process, and outcome data of trauma patients seeking medical care [4].

Although several pilot trauma registries have been successfully established in low-income settings, few have been able to maintain their operability in the long-term [5,6]. A few strategies have been identified for maximizing the potential for long-term sustainability, including obtaining buy-in from local stakeholders to act as ‘champions’ for the trauma registry and eliciting the support of local hospital administration and management [7–9]. However, securing a sustainable funding source for a trauma registry in a low-income setting remains an ongoing issue. While research grant funding or external partnerships with high-income countries can be used to support the development of a pilot trauma registry, trauma registries in LMICs are rarely able to rely on external support for the long term [7]. Estimated maintenance costs of trauma registries in LMICs may be as high as \$2,500 to \$15,000 USD annually, and personnel requirements for operating trauma registries can also incur significant costs [9–12]. Ideally, the most ethical approach should be to develop a sustainable funding source built into local institutions in LMICs, in order to build capacity into local trauma systems, decrease reliance on external partnerships, and transition ownership of trauma registries to local partners [13].

It is possible that trauma registries can contribute to cost-savings in LMIC hospitals through ongoing quality improvement, however, this can be difficult to quantify and enact. While some regions have mandated ongoing data submission to regulatory centres in order to receive ongoing funding, many LMIC trauma registries are grassroots hospital-level initiatives, and this approach requires a top-down approach by government or other regulatory bodies [14]. In many LMIC settings, resource allocation for trauma care is tied to data collection and documentation of trauma patients [15]. Patient records in many low-income settings are often of poor quality, difficult to access, and often missing altogether as a consequence of severe systematic limitations and overburdened clinical staff [16]. By pairing trauma registry data collection with the implementation of an electronic patient registration system, improved documentation of trauma patients may occur, and may result in an increase in funding to the institution. This increased funding to the institution could potentially be used to sustain the trauma registry and patient registration in the long-term, as well as fund other improvements in patient care. This study aims to address barriers to the long-term viability of trauma registries in LMICs by demonstrating improvements in documentation to trauma patients following the implementation of a trauma registry and patient registration system.

Methods

Establishing a pilot trauma registry and needs assessment

A pilot trauma registry was established at the government-funded Mbarara Regional Referral Hospital (MRRH) in Mbarara, Uganda, in February 2017 in collaboration with the Mbarara University of Science and Technology (MUST, Mbarara, Uganda), the University of Alberta (Edmonton, Canada), McMaster University (Hamilton, Canada), and the non-profit organization Innovative Canadians for Change (ICChange; Edmonton, Canada). A minimum dataset for the trauma registry was created with the involvement of local stakeholders (including researchers, hospital administration, and members of the trauma team) and a literature review.

Hospital patient records were identified as a concern during the initial needs and workflow assessment of the hospital, as patient data was documented using paper-based charting. In most cases, new patient charts were created for each visit and not linked to existing patient records. Documentation was noted to be incom-

plete and difficult to locate within the records department; a previous study done on surgical patients at the same institution found admissions and discharge data to be missing on 41.3% of patients who underwent an operation [17]. An opportunity was thus identified with the implementation of a trauma registry to also improve documentation at the hospital. As trauma registries are by definition anonymized or pseudonymized (with a ‘key’ file linking anonymized patient registry data to clinical records, stored separately from the registry data [18]), an electronic patient registration system with dedicated personnel was established at the hospital entrance to assign each patient a unique record number that could be linked to previous hospital records or trauma registry data. This initiative gained the support of hospital administration as both a potential means of improving trauma care while also creating a registration system that could be utilized by all hospital patients.

Data collection

A retrospective chart review of completed trauma patient charts prior to implementation of the trauma registry was completed. Dates and numbers of monthly trauma admission records were collected from January 2015 until July 2016, and the data fields that would be included in the future trauma registry were extracted retrospectively from charts where possible. A trauma registry and patient registration system were then established at MRRH, and two part-time nurse data collectors were hired to collect data for trauma patients, available seven days a week. Inclusion criteria in the trauma registry included all pediatric and adult trauma patients presenting to the A&E department with a mechanism of injury, and inclusion criteria for the retrospective chart review was the same. Trauma registry data from February 2017–December 2019 was included in the present study and was managed using REDCap (Research Electronic Data Capture) tool—a secure, web-based software platform designed to support data capture for research studies [19]. Trauma registry data were inputted into the REDCap software at weekly intervals by data collectors. Data quality checks for completeness were performed on a monthly basis, and any missing data fields were cross-referenced from paper trauma records. The majority of data fields consisted of categorical or binary data to ensure standardization of responses, with the exception of patient location and a description of mechanism of injury (see trauma registry data collection form in Supplementary File 1).

Costs

The major costs associated with establishing a trauma registry and electronic patient registration system were the costs of hiring data collectors (\$333 United States Dollars [USD]/month) and the initial software development and editing (\$3170 USD). Other materials and supplies (printer, computer server, binders, etc.) were estimated to have a one-time cost of \$2375 USD, with ongoing costs for upkeep and maintenance around \$795 USD per year. This initial funding was provided by McMaster University Surgical Associates Innovation Grant, the University of Alberta Department of Surgery Clinical Research Grant, and the not-for-profit organization ICChange.

Statistical analysis

Monthly trauma admission records were compiled for the retrospective period prior to implementation of the trauma registry and electronic patient registration system (January 2015–July 2016) and prospective data collection period after implementation of the trauma registry and patient registration system (February 2017–December 2019). A negative binomial regression analysis was per-

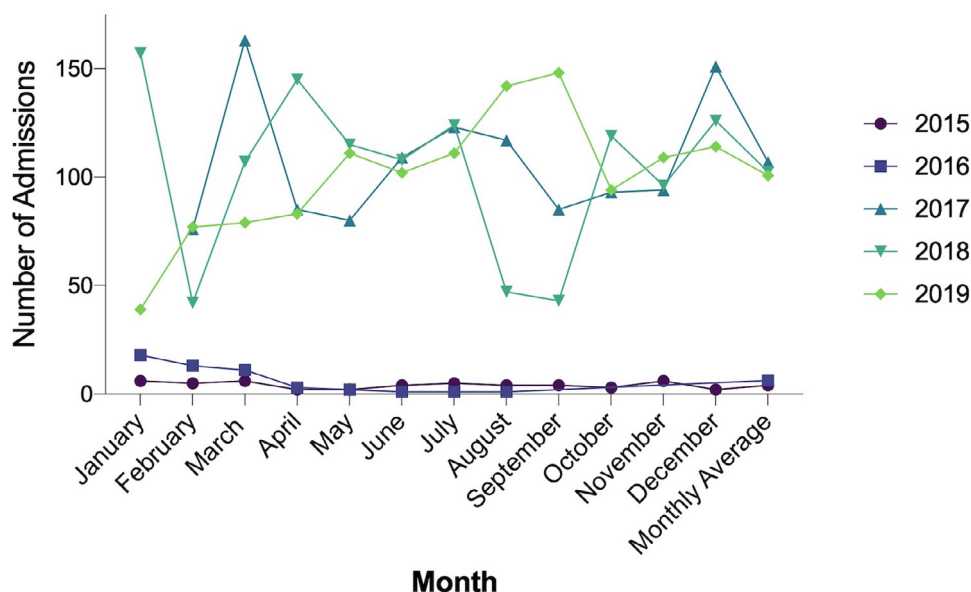


Fig. 1. Number of monthly documented trauma admissions at Mbarara Regional Referral Hospital by year. Data prior to the implementation of a trauma registry and electronic patient registration system took place from January 2015–July 2016. Data following the implementation of the trauma registry and patient registration system are available from February 2017–December 2019

formed comparing the incident rate (IR) of trauma admissions pre-implementation of the trauma registry and patient registration to post-implementation incident rate, adjusting for month. A negative binomial regression analysis comparing each pre-implementation years to each other (2015 to 2016) and post-implementation years to each other (2017 to 2018 to 2019) was also performed.

Secondary endpoints of completeness of the trauma records was also obtained as a measure of data quality. An analysis of the number of incomplete trauma records (as defined by missing at least one data point captured in the trauma registry for prospective data; or one data point that would have been captured by the trauma registry for the retrospective data) was performed using Fisher two-sample proportion testing. A negative binomial regression analysis comparing the number of incomplete fields per each trauma medical record document was also performed using negative binomial regression analysis. Statistical analyses were performed using Stata Statistics/Data Analysis software version 13.0 from StataCorp.

Results

Prior to implementation of the trauma registry and patient registration system (2015–2016), the number of completed documented trauma records that could be identified from paper charts available in MRRH's hospital record department ranged from 1 to 18 trauma patients per month, with a mean of 5.2 per month (standard deviation [SD] 4.4). Following the implementation of the trauma registry and patient registration system, documented trauma records ranged from 39 to 163 trauma patients per month, with an average of 103.4 trauma patients per month (SD 32.0). Monthly changes are visualized in Fig. 1. A total of 3614 adult and pediatric trauma patients seen within 14 days of injury were enrolled into the trauma registry from January 2017 until December 2019 and collection is ongoing.

A significantly higher number of trauma admissions were documented following registry implementation with an incident rate ratio (IRR) of 20.9 (95% Confidence Interval [CI] 15.7–27.6, $p < 0.001$) as calculated by negative binomial regression analysis (Fig. 1). There were no significant effects of monthly variation on the analysis, and no statistically significant difference within the pre-

implementation years (2015 and 2016; $p = 0.2$) or within post-implementation years 2017, 2018, or 2019; $p = 0.7$).

Prior to the implementation of the trauma registry, 98.1% of records were incomplete (missing at least one data point that would have been captured by the trauma registry); while following the implementation of the trauma registry, only 5.6% of records were incomplete (OR 49.1, CI 12.4–193.7, $p < 0.001$). The average percent of data points that were missing in each individual medical record prior to the implementation of the trauma registry was 8.3%, compared to 0.1% of data points missing once the trauma registry was implemented (IRR 1.09, CI 1.05–1.13 $p < 0.001$).

Discussion

While the feasibility of developing pilot trauma registries in LMICs has been demonstrated in the short-term, strategies for sustainability need to be a key consideration going forward. In this study of a pilot trauma registry in Uganda, we demonstrate a potential means of self-sustainability for a trauma registry in a low-income country. By considering the implementation of the trauma registry as an opportunity to improve overall trauma patient registration and documentation for hospitals this could in turn be used to apply for an increase in funding for the hospital.

In this case study in a public hospital in a low-income country, trauma patient registrations were poorly documented and difficult to identify in a paper-based charting system. Following the implementation of a trauma registry and concurrent electronic patient registration system, we were able to demonstrate an increase of 20.9 times in completed trauma patient documentations that could be identified, as well as a significant improvement in data quality. Funding for the initial start-up costs of the trauma registry was provided by research grants and not-for-profit development funding, however, these sources of funding are not set up to support recurring costs of the trauma registry, and therefore a more sustainable source of funding is required moving forward. As government funding for trauma care at MRRH is dependent upon documentation of number of patients seen and treated, this significant improvement in patient documentation and registration following the implementation of a trauma registry could result in an increase in funding for trauma patients. This funding could then

be used to justify and support the ongoing existence of a locally run trauma registry. A similar strategy could be considered for the implementation of trauma registries in other low-income settings where funding is contingent on number of patients seen and documented.

When considering the data quality as expressed through the number of medical records completed, a significant improvement in completion was seen after the implementation of a trauma registry. It should be noted that the use of the trauma registry data-points to define completion of retrospective charts was not merely arbitrary, as the minimum dataset in the trauma registry was determined in conjunction with local stakeholders to represent the data of highest value for trauma care in Mbarara. The lack of this data in the retrospective medical records therefore represents a deficit of information that could be used for creating trauma quality and process improvement most useful for this institution. The higher rates of data completeness in the trauma registry records therefore represent an improved repository of functional and practical data for Mbarara Regional Referral Hospital.

In addition to creating a functional database for quality improvement and potentially providing a sustainable source of funding for the trauma registry at MRRH, the concurrent implementation of a patient registration system created unique patient identifiers for all patients seen in the A&E Department of the hospital (including non-trauma patients). By creating identifiers for all patients, it provided an opportunity to improve care for all patients at the hospital by reducing duplication of patient records and improving accessibility of patient records by providing reliable means of linking records from repeated visits [20]. The inclusion of a patient registration system with a trauma registry was an additional motivator for hospital administration to participate in a partnership to develop a trauma registry. Future directions of study include the incorporation of the trauma registry into a fully functioning open-source mobile electronic medical record system for MRRH.

There are a number of limitations to this study. The most significant limitation is that trauma documentations could have increased as a result of an actual increase in number of traumas occurring in the district that were seen at the hospital. Unfortunately, there were no police records available to us to demonstrate the number of traumas encountered in the district, nor is there any census information available after 2014 in Uganda to assess whether or not these changes are due to an increase in population in the district. However, given such a dramatic increase in patient records (an average increase of 98 patients per month from the pre-registry period in 2015–2016 to post-registry period in 2017–2019), it is unlikely that actual rates of trauma increased by such a substantial amount. Also, as we found no statistically significant difference between trauma records documented between the pre-registry years (2015 and 2016) or between the post-registry years (2017, 2018, and 2019), any change in trauma rates would have had to reflected a dramatic shift between August 2016 and February 2017 while the registry was being implemented, which is highly unlikely given no significant event was noted by hospital staff. While it is probable that neither data set represents a fully accurate picture of all trauma that occurred in Mbarara district from 2015–2019 (and this is, in fact, a recognized limitation of all hospital trauma registries), it remains most feasible that an improvement in documentation is responsible for the changes, rather than a sudden increase in trauma patients seen by the hospital.

Another potential limitation is that the pre-registry trauma admissions represent the completed trauma patient files that investigators were able to identify in the hospital records department from January 2015 onwards. It is possible that further trauma records existed at the hospital pre-registry that could not be identified by study investigators due to the structural and organizational challenges inherent in the record keeping system. Regard-

less, the inability to identify further records indicates that it is unlikely they are being used in the most efficient manner to demonstrate an accurate number of trauma patients actually being seen at the hospital. Finally, actual funding data was not available to the authors of this paper at time of publication which represents a further limitation; the presence of actual financial hospital data could potentially have strengthened the findings of this study.

The results of this analysis demonstrate a potential means of financial sustainability for a trauma registry in LMICs. By demonstrating improved documentation of trauma patients at Mbarara Hospital with the implementation of a trauma registry and a patient registration system, the hospital may be eligible to apply for more governmental funding for trauma patients at this institution. As the initial startup costs of the trauma registry and registration system have been covered by research funding from an external partnership, the ongoing maintenance costs of the trauma registry and registration system could be funded going forward by a portion of the increased funds from the improved documentation. The hospital also benefits from the improved quality of trauma patient records and the implementation of a patient registration system. Alternatively, this could motivate government funding agencies to prioritize funding for trauma registries, patient registration systems, and electronic health records in LMICs, as improved documentation allows the government to more accurately collect information for resource allocation while improving trauma care systems and outcomes in the region [21,22]. Moving forward, the utilization of this strategy to more sustainable funding for trauma registries in LMICs can be incorporated with lessons learned from other studies to promote the long-term maintenance of registries, including *a priori* needs assessments, utilization of electronic and mobile health technologies, identification of a local champion to advocate for the ongoing use of the registry, involvement of local hospital healthcare workers and administration, and responsiveness to feedback [6,7,12].

Conclusion

The development of trauma registries is an important consideration for improving trauma care in low-income settings. While several pilot trauma registries have demonstrated feasibility, there are few studies demonstrating long-term success of trauma registries in LMICs, and most are limited by financial constraints. This study demonstrates a potential source of long-term funding for trauma registries in LMICs by linking the establishment of a trauma registry with an electronic patient registration system, resulting in significant improvements to documentation of trauma patients. This improved documentation can allow hospital institutions to apply for increased funding for trauma patients, funding which can be used to support and sustain a trauma registry and health records system moving forward.

Ethics Approvals

Ethical approval for secondary analysis of trauma registry data for this study was obtained through the Mbarara University of Science and Technology Research Ethics Committee (MUST-REC) in Mbarara, Uganda and the University of Alberta Research Ethics Board in Edmonton, Canada. The original implementation of the trauma registry also obtained ethics approval from MUST-REC and McMaster University.

Declaration of Competing Interest

CG, CT, CS, TR, DE, DB, and MS have no affiliations or involvement in any organization or entity with any financial interest in the subject matter or materials discussed in this manuscript. AS

is Chief Executive Director and Co-Founder of a not-for-profit organization Innovative Canadians for Change (ICChange) which contributed funding for the establishment of the Mbarara Regional Referral Hospital trauma registry.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:[10.1016/j.injury.2021.07.030](https://doi.org/10.1016/j.injury.2021.07.030).

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