Piloting a Trauma Registry In Northwestern Pakistan

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Abstract

Introduction. Injuries are one of the leading causes of morbidity and mortality worldwide accounting for 5.8 million deaths, 32% more fatalities than tuberculosis, malaria, and HIV combined. In Pakistan, the burden of injury is significant, being the eleventh leading cause of premature death, fifth leading cause of healthy years of life lost, and the second leading cause of disability. Trauma registries have been shown to be superior to other forms of injury surveillance such as population based surveillance or administrative data. Most of the published literature documenting the state of trauma care in Pakistan is based off of population based surveillance data. A pilot trauma registry was implemented in Khyber Pakhtunkhwa, Pakistan, to accurately describe the epidemiology of injury in the region.

Methods. The trauma registry was piloted at the Lady Reading Hospital (LRH) in Peshawar, Pakistan. The LRH remains the main tertiary referral center for the entire province of Khyber Pakhtunkhwa as well as bordering regions of Afghanistan. The trauma registry used was a twenty-five data point registry developed by the Centre for Global Surgery, McGill University Health Centre. Pilot implementation was carried out for five consecutive days.

Results. A total of 267 patients were included in the pilot registry over the 5-day pilot study. 32.21% of patients arrived via ambulance, while 31.46% arrived via private vehicle, 29.21% used public transport, and 6.37% came on foot. Motor vehicle collisions made up 45.69% of trauma patients, while falls and gunshots caused 23.97% and 5.62% of injuries, respectively. Of the motor vehicle collisions, 45.1% of patients were pedestrians struck by a moving vehicle. Moreover, no patient involved in a car accident was wearing a seatbelt at the time of injury and only 4 patients involved in a motorbike accident were wearing a helmet. 50.56% of patients were treated and send home, 45.32% required admission for further treatment including possible surgeries, 2.25% were taken directly to the operating theatre, and 1.87% of patients died in the trauma bay.

Conclusion. Despite providing a 5-day snapshot, the pilot registry was effective in delineating the epidemiology of injury in the region. Areas where public health policy is required to reduce the staggering number of trauma patients include helmet and seatbelt law enforcement, pedestrian safety, and pre-hospital trauma systems. This pilot registry provides compelling evidence for the implementation of a sustainable trauma registry in the region.

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Contribution of Authors

Omaid Tanoli wrote the thesis in its entirety with editing/suggestions from Dr. Tarek Razek.

Introduction

Injuries are one of the leading causes of morbidity and mortality worldwide accounting for 5.8 million deaths, 32% more fatalities than tuberculosis, malaria, and HIV combined. A disproportionate amount of the global burden of injury is concentrated in low- and middle-income countries (LMICs).[1] Moreover, patients with life-threatening but salvageable injuries are six times more likely to die in LMICs compared to high-income countries.[2] The reasons for this are multiple, however, high-income countries with lower mortality rates from trauma generally have well-developed trauma systems. Following the implementation of trauma systems in high-income countries, the preventable death rate from injuries substantially decreased.[3-5]

One of the cornerstones of an organized and effective trauma system is having a trauma registry. Essentially, a trauma registry is a data-gathering tool used to document the acute phase of hospital care delivered to trauma patients.[6] The benefits of a trauma registry include providing information on the epidemiology of injury, developing and testing hypotheses, identifying opportunities for injury prevention, and to document the medical, social, and economic effects of trauma.[6, 7] Significantly, trauma registries provide a means for quality improvement measures. They allow for quality of care comparisons to be made between hospitals, and can track progress made following implementation of improvement measures.[8, 9] Trauma registries have been shown to be superior to other forms of injury surveillance such as population based surveillance or administrative data.[10, 11] They are prospective in nature; yet also include valuable variables that other forms of surveillance do not, such as physiological and process of care variables.

Realizing the magnitude of the burden of injury worldwide, the Lancet Commission on Global Surgery outlined specific goals to be realized in the coming years. These include providing access to timely essential surgery, increasing the surgical workforce density, have countries track surgical volume and

increase it, track perioperative mortality and set goals to decrease it, provide 100% protection against impoverishing expenditure, and provide 100% protection against catastrophic expenditure.[12] Important strides have been made towards realizing the goals set forth by the Lancet Commission, however, in order to fully realize them it is necessary to further generate country-specific, nationally representative, and population-based data.[13, 14] This will work towards measuring the prevalence of surgical disease, the resources available for the treatment of surgical diseases, and the outcomes of surgical interventions.[15] The current state of global surgery literature has a paucity of data available for LMICs. Gathering epidemiological data from LMICs will highlight the context in which injury occurs. This will in turn allow decision-makers to formulate necessary improvements based on solid evidence.[16] This can be accomplished with the implementation of trauma registries at large trauma hospitals in LMICs.

In Pakistan, the burden of injury is significant, being the eleventh leading cause of premature death, fifth leading cause of healthy years of life lost, and the second leading cause of disability.[17] In order to initiate the process of alleviating the burden of injury in Pakistan, it is necessary to first gather data in order to make informed decisions regarding trauma care and prevention improvement policies. Most of the published literature documenting the state of trauma care in Pakistan is based off of population based surveillance data.[17-19] The only literature regarding a trauma registry in Pakistan came from a privately owned institution with the latest publication coming in 2013.[20, 21] The registry provided invaluable data to inform policymakers of potential target intervention points in order to improve the care of injured patients.[22] The objective of this study is to pilot a trauma registry in Northwestern Pakistan to provide prospectively gathered injury data.

Once implemented, the trauma registry will provide much needed information regarding the epidemiology of injuries in Pakistan. This will provide a means to implement evidence-based

interventions to both improve the quality of care at the trauma institutions, and develop effective injury prevention policies as has been shown in other LMICs.[23, 24] Essentially, the trauma registry will be a quality improvement tool to be used by local stakeholders, but most significantly, will help decrease the morbidity and mortality associated with injury in Pakistan.

Literature Review

Global Surgery Initiatives

In January 2014, the Lancet Commission on Global Surgery was launched in order to combat the pivotal gaps in surgical care worldwide. Based on the information gathered, the Commission identified clear goals to be reached by 2030 – "a minimum of 80% coverage of essential surgical and anesthesia services per country", "100% of countries with at least 20 surgical, anesthetic, and obstetric physicians per 100,000 population", "100% of countries…tracking surgical volume: a minimum of 5000 procedures per 100,000 population", "100% of countries…tracking perioperative mortality", "100% protection against impoverishment from out-of-pocket payments for surgical and anesthesia care", and "100% protection against catastrophic expenditure from out-of-pocket payments for surgical and anesthesia care".[14] Despite the fact that conditions requiring surgical care account for more deaths than malaria, tuberculosis, and HIV/AIDS combined, increasing surgical capacity in LMICs has been largely overlooked.[14]

In a study looking to evaluate the reasons as to how countries prioritize surgical diseases, country-specific surgical disease indicators were found to play an important role in promoting surgical care on national health agendas. For example, in Uganda where surgical disease has a low priority on the national health agenda, there is scarce data on surgical disease.[25] On the other hand, following the establishment of a trauma registry in Yaoundé, Cameroon, findings were presented to Cameroon's Ministry of Public Health. This led to the creation of a National Injury Committee in Cameroon.[24]

Such a committee ensures priority is given to improving the care of injured patients in Cameroon and is instrumental in reaching the 2030 goals for surgical care. In general, there is a paucity of high quality data on surgical diseases in LMICs.[16] Such data is necessary to ensure surgical disease is given a higher priority on national agendas. Moreover, determining the context in which surgical disease occurs in LMICs will aid in the development of prevention policies. An important stride was made towards improving surgical capabilities in LMICs when 194 nations adopted the World Health Assembly resolution 68.15, "Strengthening emergency and essential surgical care and anesthesia as a component of universal health coverage".[26] The adoption of this resolution exemplifies the importance of improving surgical care in LMICs and provides countries with incentives to invest in increasing their surgical capacities.

The paucity of high quality data on the prevalence of surgical disease in LMICs is one barrier to reaching the 2030 goals for surgical care. However, many other barriers exist which need to be tackled. LMICs suffer from a lack of surgical workforce as they only have 20% of the surgical workforce; yet represent 48% of the world's population. To put this into context, high-income countries have 56.9 surgeons per 100,000 people, whereas low-income countries have 0.7 surgeons per 100,000 people.[27] Clearly, there is a misdistribution of the surgical workforce globally, which implies that the vast majority of the world's surgical patients are treated by non-surgeons, non-physicians, or not treated at all. Another barrier to optimal surgical care in LMICs is inadequacies in basic infrastructure. In a study looking at the trauma capacity of district hospitals in LMICs, it was found that only 33% had access to basic resuscitation, 31% to blood banks, 32% to endotracheal tubes, and 32% to tracheostomies and/or cricothyrotomies.[28] These are clear deficiencies that highlight avenues for intervention in order to improve the care of surgical patients in LMICs. Further contextual challenges in LMICs include minimal administrative support at hospitals and poor inter-hospital coordination.[29] In order to reach

the Lancet Commission's goals for 2030, all of these barriers will need to be addressed by countries and organizations.

Trauma Systems

Inclusive trauma systems are an "organized effort within a defined geographic area that delivers the full range of care to all injured patients and is integrated with the local public health system."[2] Two landmark studies highlighted the importance of trauma systems to the care of injured patients. In 1979, West et al studied two counties in California, where one had a trauma system and the other did not. Whereas 2/3s of the non-CNS related deaths and 1/3 of the CNS-related deaths were judged to be preventable in the county without a trauma system, only one death in total was judged to be preventable in the county with a trauma system.[4] Such a mortality benefit was ascribed to the trauma system. Furthermore, in 1986, Shackford et al highlighted the importance of a regionalized trauma system. In their landmark study they compared an audit of the San Diego County's trauma care prior to implementation of a trauma system and after. Importantly, the trauma system, which was implemented, was based upon the initial needs assessment carried out in the audit. This allowed for a system to be implemented that would specifically target the needs of the region. Following implementation of the system, they found a decrease in suboptimal assessment during the initial hospital phase from 22% to less than 1% and delays in evaluation and disposition from 41% to 10%. The most significant finding was a decrease in the preventable death rate from 13.6% to 2.7%.[3] These studies clearly outlined the importance of need-based trauma systems in reducing mortality and improving the care of injured patients.

Part of the regionalization effort highlighted in the study by Shackford et al was the designation of trauma centers.[3] Subsequently, comparisons were made with level 1 trauma hospitals versus non-trauma hospitals with regards to care of injured patients across the US. The overall risk of death was

25% lower when care was provided at a designated trauma center than when it was provided at a non-trauma center. Furthermore, following discharge from designated trauma centers, a smaller proportion of patients died compared to non-trauma centers.[30] Following trauma, readmissions are usually quite high, however, receiving care from a trauma center is independently a protective factor for readmissions following trauma.[31] Thus, receiving care from a trauma center helps to alleviate the burden that healthcare institutions face. These studies display the mortality benefits associated with trauma systems and the regionalization of care.

To further add to the evidence regarding the effectiveness of trauma systems, a systematic review of trauma system effectiveness was carried out. The systematic review was enabled using data from trauma registries, displaying the advantage of good quality data collection. The data displayed a consistent 15-20% reduction in the risk of death when comparing regions with trauma systems to regions without trauma systems.[32] The review establishes clear mortality benefits associated with trauma systems, but it is possible the benefits extend further.

Advanced trauma systems are costly and require dedicated personnel to ensure proper functioning. For many LMICs these are hindrances to the establishments of such systems. However, Lipsky et al compared rural trauma outcomes to urban level 1 trauma outcomes after the implementation of a model rural trauma project. The main components of the system were a warning system for the arrival of major trauma ensuring early activation of a trauma team in the emergency department, and periodic system reviews and modifications. After controlling for probability of survival, there were no significant observable differences in outcomes for trauma patients in the rural setting versus the urban setting.[33] This indicates that minor changes in the trauma systems may vastly increase trauma patient survival, without the need for large-scale and costly interventions. Thus, improvements in trauma care

in LMICs may be achieved through low-cost changes if a proper needs assessment is done to determine the deficiencies in the system.

Trauma Registries

In its most basic form, a trauma registry is a database, which documents the care acutely received by patients brought to a hospital with injury. Most trauma registries will include demographic information, mechanisms of injury, procedures undergone, clinical diagnoses, lengths of stay, disposition, and in-hospital mortality. More advanced trauma registries may choose to include costs of interventions, complications, some form of an injury severity score, and functional outcomes.[7] Different registries tend to have differing inclusion and exclusion criteria depending on the resources available in specific settings. However, the primary purpose of all trauma registries is to provide quality data on the epidemiology of injury. By providing such data, trauma registries become a tool for quality improvement as it enables users to assess and determine improvements in care.[7] For example, a pediatric trauma registry was used to describe all-terrain vehicle trauma in West Virginia leading to specific prevention policies.[34] In order to guide a hospital-based injury prevention program in Baltimore, a trauma registry was used to identify the characteristics of injury.[35] Many more examples of how trauma registries have been used to improve care are found in the literature.[36-38] To attest to this, studies have found a decrease in mortality and disabilities following the implementation of trauma registries.[39]

Moreover, trauma registries provide a starting point for hypothesis-generation, which allows for the identification of opportunities for injury prevention. By describing the circumstances around which injuries occur, the trauma registry is a valuable tool in providing evidence for advocacy regarding interventions.[7] Perhaps more significantly, trauma registries provide a means for tracking the effectiveness and efficacy of said interventions. For example, registry data was used to find a decrease

in both the severity and frequency of head injuries when comparing helmeted motorcyclists to non-helmeted motorcyclists.[40, 41] This data helped shape policy regarding the enactment and enforcement of helmet laws. In essence, a trauma registry is a tool to systematically collect high-quality data on injuries in a certain region in order to improve the care of injured patients over time.

There are certain limitations associated with trauma registries. These include a lack of inclusion of pre-existing conditions, functional outcomes, standardization across different regions, and quality assurance. As a trauma registry is primarily concerned with the acute care received by a trauma patient, it becomes difficult to gather information regarding pre-existing conditions.[7] Moreover, very few trauma registries provide information on outcomes other than mortality.[42] The vast majority of trauma patients will survive the initial trauma, however, a large amount will end up with disability.[43] There are many potential functional outcome measures that could be implemented into trauma registries including the 36-Item Short Form Health Survey (SF-36), Functional Capacity Index (FCI), Functional Independence Measure (FIM), modified FIM, the Glasgow Outcome Score (GOS), and the Extended Glasgow Outcome Score (GOS-E). It is important to note that none of these have been validated for use in trauma registries; however, there is some evidence to suggest that the GOS-E can be used with some reliability in trauma registries.[42, 44] However, the cost and manpower required for a registry to consistently gather information on functional outcomes is beyond the scope of most LMICs. Moreover, there is a lack of standardization of data points collected in trauma registries around the world.[45] This limits the ability to compare data amassed from different regions. That being said, there have been efforts to standardize trauma registries across nations as highlighted by the development of a bi-national minimum dataset (BMDS) between Australia and New Zealand.[46] Despite outlining 67 essential data points, the BMDS had little comparability to other international data sets. Yet, no one specific data set has been proven superior at assessing trauma populations over another.[46] Additionally, Brinck et al. compared registry data between Germany and Finland.

Although there were many pitfalls that need to be addressed when comparing international registries, the authors believed they could still provide a feasible method for comparison and quality control.[47]

Importantly, in order for a trauma registry to be effective in assisting in implementing change, it is of paramount importance for the registry to be complete and of high quality. Quality assurance can be simply accomplished through the use of audits.[48] However, audits take time and are not always feasible in certain settings. Thus, it becomes essential to take into account the capabilities of an institution when designing a specific registry to limit missing variables. Moreover, the quality indicators used in trauma registries should be easily followed over time, accessible, and reliable. Quality indicators include measuring the means to undergo a certain procedure (structure indicator), measuring how an activity functions (process indicator), and measuring the outcome (outcome indicator).[49] In a review studying how the quality of data in trauma registries is addressed, there were very few published articles on trauma registries that assess the quality of their data. The authors conclude that at the minimum researchers should include a report on data accuracy, completeness, and capture.[50] Furthermore, a more recent review studying the ways trauma registries address data quality found that the vast majority of data quality is related to completeness.[51] Although this is a good first step, there is a need to develop more standardized ways to assess data quality in trauma registries. Despite the lack of published literature validating the quality of data in specific trauma registries, with an adequate registry design based on the capabilities of the intended institution, one can keep confidence in the findings from such trauma registries.

Many trauma registries tend to include some form of a trauma scoring system. These include the Revised Trauma Score (RTS), Glasgow Coma Score (GCS), and the Abbreviated Injury Scale (AIS). The RTS is the most widely employed pre-hospital triage tool using the GCS, respiratory rate, and the systolic blood pressure to determine a score from 0-12. The GCS measures the severity of head injuries

based on motor, eye, and verbal criteria. Finally, the AIS measures the severity of an anatomic region's injury giving a score ranging from 1-6, with 6 being fatal.[52] One of the many benefits of a trauma registry is the data can be used to develop probability of survival scores. Many survival scores have been developed including the Injury Severity Score (ISS), New Injury Severity Score (NISS), Trauma Score Injury Severity Score (TRISS), ICD-9 Injury Severity Score (ICISS) and the Revised Injury Severity Classification II (RISCII).[52] Following a systematic review comparing the different scores, the NISS was found to be superior to the ISS in most studies, the TRISS score has deficiencies when evaluating trauma systems with predominantly blunt trauma, and the RISCII score has been demonstrated to be superior to other current probability survival scores.[53] Importantly, however, the effect of inter-observer reliability when using injury severity scores has to be taken into account. Recent evidence displays incorrect and inconsistent injury identification while using the AIS scoring system, which argues for improvement in how we assess these scores before using them as benchmarking tools.[54] The importance of probability survival scores is to allow for proper benchmarking of standard of care. However, the choice of which trauma scores and probability survival scores to use is usually limited by the feasibility of data point capture in most LMICs.

Without trauma registries, most of the data regarding trauma patients comes from administrative databases such as police reports, hospital records, and data that is publicly available such as newspapers.[10] Although an aggregation of these types of data may lead to a somewhat complete picture of the state of trauma care, administrative data will lack processes of care and many other specific variables such as severity of injury. With regards to injury surveillance, the WHO has recommended specific variables to be captured and studied. When comparing trauma registry data to administrative forms of data, it was found that the registry data recorded the majority of these variables. Other forms of data collection were missing variables in multiple aspects such as factors leading to accidents, severity of injury, and circumstances of the injury.[10] Moreover, another study found that

trauma registries were significantly superior to All Patient Refined Diagnosis Groups (APR-DRG), a form of administrative data collection, for making recommendations and improvements on trauma programs.[55] It is clear that in order to effectively improve quality of care, good quality data is required. Administrative data have been shown to have a lack of data regarding medical interventions, complications, and specific injuries. By design, trauma registries are built to capture the most significant variables regarding injury surveillance. Therefore, in terms of improving quality of care, trauma registries are superior to other forms of data aggregation.[11]

Trauma Care & Trauma Registries in High-Income Countries

The Victoria State Trauma Registry was a trauma registry established in the Australian province of Victoria. It provides a leading example of optimal trauma care with the use of a trauma registry.[56, 57] This registry was used to describe the context and burden of road traffic injuries in the province, as well as a monitoring system for the implementation of a state-wide trauma system.[56] Following implementation of an organized trauma system, a decrease in mortality, disability-adjusted life years (DALYs), and costs related to road traffic injures were observed.[58] Essentially, the Victorian State Trauma Registry provided a method for checking if newly implemented trauma protocols/systems were working as intended and if they were being implemented correctly.[56] The trauma registry in Victoria has evolved over time and is one of the few registries which gathers information on quality of life measures and functional outcomes.[43] However, in order for this to be accomplished, a form of long-term reassessment was required which is not feasible in many LMICs.[59] The Victoria State Trauma Registry has provided an opportunity for evidence-based injury prevention policies to be implemented, allowed for these interventions to be monitored, and now provides important information on mortality as well as functional outcomes.

Another example of an effective trauma registry is found in Queensland, Australia. Similar to other developed trauma registries, the registry includes information on key aspects of trauma care. However, unique to the Queensland Trauma Registry, minor trauma is now included.[60] It is well known that minor trauma makes up the greatest proportion of trauma visits. However, by including minor trauma in the registry protocol, the burden of such cases can be assessed on the population level. This provides further insight into the effects of trauma on a specific population and provides further avenues for the implementation of policy changes.

In the 1970's it became apparent that there was no organized trauma data collection in the United States, which hindered the development of injury prevention policy and trauma care evaluation.[61] To remedy this situation, the American College of Surgeons Committee on Trauma developed the Major Trauma Outcome Study (MTOS). This study collected 5 years worth of trauma data from 139 hospitals across the United States and Canada with the goal of establishing a continuous national trauma database and a reference standard for trauma care.[7, 61] Essentially the data collected in the MTOS from 1982 to 1989 allowed for the creation of national norms of trauma care, which could be used as a standard to compare institutions' performance to. Another significant development from the MTOS was the creation of the Trauma Injury Severity Score (TRISS), a model used to predict the probability of survival for an injured patient.[8] Following the success of the MTOS, the National Trauma Data Bank (NTDB) was established to continue the collection of trauma data across the US.[7] In 1994, the National Surgical Quality Improvement Program (NSQIP) was instituted. With the goal of improving surgical care to trauma patients at VA hospitals, the program led to a 9% decrease in mortality and 30% decrease in morbidity over a 3-year period.[9] The success of the VA NSQIP led to the creation of the Trauma Quality Improvement Program (TQIP), which was a national risk-adjusted quality improvement program.[8] These programs have been effective in impacting change in the areas of trauma care by providing trauma centers with risk-adjusted benchmarking data.[9] Through the

collection of standardized data on trauma patients following the MTOS, the potential for quality improvement and evidence-based policy change was realized.

Despite having a national quality improvement program, there may be added benefits to having smaller regional collaborations. One such example is the Michigan Trauma Quality Improvement Program (MTQIP). Similar to TQIP, the program takes advantage of the hospital registries to collect quality of care data.[62] By virtue of being a smaller program, the opportunities for meetings and discussions of common issues is facilitated. Early results have found a decrease in mortality from 4.9% to 4.1%. Similarly, there has been a decrease in patient complications, leading to better patient quality of life as well as savings in complication-associated costs.[62] Additionally, following the implementation of a specific trauma registry in Ohio, different hospitals and systems now have specific goals to work towards in order to improve the care of trauma patients.[63] The example of how trauma care has evolved and improved in the United States speaks to the importance of effective injury data and surveillance.

Other high-income countries that have established trauma registries include the United Arab Emirates, Saudi Arabia, Taiwan, Scotland, and Germany. In the UAE, the trauma registry data was able to describe the epidemiology of road traffic injuries.[64] By identifying the risk factors for road traffic injuries, effective preventative policies were recommended in order to decrease the risks to the most vulnerable. In Saudi Arabia, the King Abdulaziz Medical City (KAMC) trauma registry was established. The KAMC trauma registry found a 9% mortality from trauma, highlighting the higher mortality burden from road traffic injuries in Saudi Arabia compared to other high-income countries.[65] The KAMC trauma registry was the first step towards identifying areas of trauma improvement in the country. In Taiwan, a trauma registry was established at the Chang Gung Memorial Hospital, a 2400-bed Level 1 trauma center. Through the use of this registry important findings were

established. Patients presenting with a Reverse Shock Index (RSI) of less than 1 were found to be at high risk for adverse outcomes including a larger injury severity score and a longer stay in the intensive care unit.[66] Moreover, this registry was the first of its kind to highlight the effects of obesity on trauma outcomes. Obesity had no effect on mortality; however, obese patients did have a significantly increased length of stay following trauma.[67] With the establishment of this registry, researchers have been provided with ample amounts of data to conduct meaningful research into trauma care and how improvements can be made.

The Scottish Trauma Audit Group (STAG) has been collecting prospectively collected data on all trauma patients throughout Scotland since 2011. Through the use of this registry, it was found that a lower socioeconomic status is an independent indicator for trauma, as it was significantly associated with increased trauma.[68] Interestingly, however, a lower socioeconomic status was not associated with greater adverse outcomes following trauma. This may be true in a high-income country like Scotland, with a well-established trauma system; however, this result cannot be generalized to LMICs. Moreover, in Germany, the German Trauma Registry (DGU) was initiated in 1993 in five hospitals, but now collects data from 640 hospitals across the country. This registry has had a monumental impact on trauma care in Germany. Through its use, the criteria for intubation were altered, the use of volume replacement has decreased, and the treatment and radiologic work-up of coagulopathies of severely injured patients have changed. Most importantly, since the DGU's inception in 1993 there has been a noticeable constant reduction in the risk-adjusted mortality rate from trauma in Germany.[69]

In 1987, in the Canadian province of Quebec, a baseline assessment was carried out which showed that there were significantly higher mortality rates for trauma patients compared to the US and other Canadian provinces.[70] Thus, in 1990, the provincial government prioritized improving trauma care. The first step in implementing change was the establishment of a province-wide trauma registry. This

allowed for identification of issues in the system, and facilitated tracking the effectiveness of policy interventions. Through a series of accreditation programs, changes in the pre-hospital triage system, and standardization of inter-hospital transfers, the mortality rates for life-threatening but treatable injuries decreased from 52% to 8%. Pre-hospital time was also significantly reduced.[71] Although large-scale changes in the trauma system were required to achieve the significant improvement seen in the care for the injured, the role of monitoring and aggregation of quality data provided by the trauma registry cannot be understated. It was instrumental in identifying problem areas, evaluating changes, and long-term sustainability of the program. Essentially, the trauma registry ensured evidence-based interventions were carried out and worked effectively.

Trauma Care & Trauma Registries in LMICs

Trauma registries have been implemented in many LMICs in the past with success in both sustainability and improving quality of care. An important example is found in Thailand at the Khon Kaen Hospital. In 1991, it was estimated that of the 1.2 million injured people who received care at public hospitals, 25,000 died and 600,000 were admitted.[70] Even with such alarming numbers, little could be done to alleviate the issue given there was very little quality data on the epidemiology of injury and the characteristics of the injured. However, among those delivering trauma care, it seemed that there were many pitfalls in the trauma care system. In order to gather high quality data on injured patients, a trauma registry was established at the Khon Kaen Hospital. Piloting the trauma registry was the first step in the quality improvement process, as it not only provided data on the epidemiology of injury, but also on how deaths could be prevented. Over time, the registry included performance indicators and measures to evaluate preventable deaths.[72] Specific pitfalls were identified in the system and these were alleviated. For example, communication between physicians at the hospital was identified as inadequate. As a result, radios were provided to doctors on call to allow for improved communication between different specialist doctors involved in the care of trauma patients. The

registry's use was extended to determine issues with inter-hospital transfers and inappropriate referrals.[70] With the trauma registry as an evidence-based guide, specific policy changes led to improvements in both the process of care as well as outcomes. There was a decrease in delays and errors in diagnoses, incorrect treatments, system inadequacy, and the number of errors leading to mortality. From 1994 to 2000, the mortality of all injured patients decreased from 8% to 4.6%. The preventable mortality rate decreased from 3.2% to 1.3%.[72, 73] The significant improvement in trauma care seen in Thailand displays the importance of monitoring the quality of trauma care. Through this monitoring effort, sustainable and affordable interventions were made possible leading to the dramatic enhancement in the care of trauma patients.

In Kampala, Uganda a trauma registry was established at the Mulago Hospital, the city's major referral center. In a review of the effects of the registry upon trauma care; it was found that mortality decreased from 7.2% to 2.7% in a 6-year period. Moreover, when assessing the functioning of the registry, it was found that complete data was available for 93.5% of the 3,778 patients who had a registry form filled.[74] Although the reasons for the decrease in mortality are multi-fold, the registry enabled recording of this decrease and monitored the effect of the many changes in the trauma system over the time period. Additionally, with 93.5% of the patients having complete data, the feasibility of having a quality trauma registry in a low-income country was demonstrated. To further exemplify the feasibility of establishing trauma registries in low-income countries, a locally developed trauma registry was established in Southwest Cameroon. Despite initial issues with implementation, the quality of data improved over time, and at any time point it was found that the quality of data was far superior to the secondary data that was available prior to implementation of the trauma registry.[75] Furthermore, in Kenya three trauma registries were piloted at three different sites. Although there were site-specific challenges that were faced, all three were successfully implemented. Moreover, through the data collected from the registries it was possible to identify gaps in the care of trauma patients leading to

systemic changes to improve trauma care.[76] In fact, using the hospital-based trauma registries in Kenya, a thorough description of the epidemiology of injury was undertaken. A significant finding was that pre-hospital time was alarmingly high even compared to other low-income countries.[23] By establishing registries in Kenya, it allowed for a clear identification of issues in the trauma system. This allowed for evidence-based interventions to be undertaken in the future. The Nigerian Trauma Registry was an electronic registry that was developed and implemented at two hospitals in Nigeria.[77] It demonstrated the feasibility of establishing an electronic trauma registry in a LMIC. Moreover, it represented the largest report of injury surveillance in Nigeria, which is fundamental in informing policy-makers of the burden of trauma. In India, a pediatric trauma registry was implemented to challenge the notion that RTAs were the leading cause of pediatric trauma admissions. Although it was demonstrated that RTAs still made up the vast majority of pediatric trauma, falls from height were incrementally increasing.[78] Thus, this registry enforced the idea that improving road safety alone would not be enough to decrease the amount of pediatric trauma cases.

In Columbia, two trauma registries were established at two separate hospitals. Some of the significant findings after one year in use were that males between the ages of 18-35 were much more likely to have injuries caused by violence. Moreover, although gunshot wounds made up only 8.2% of injuries, those patients with an ISS$\geq$15 had a 54% mortality rate.[79] Both of these findings provide evidence to initiate violence prevention programs in the 18-35 age group, as they are the most vulnerable population to gunshot wounds. Such programs can lead to a decrease in mortality associated with injuries.

Most trauma registries established in LMICs tend to be at large trauma referral centers. This makes intuitive sense given the limited amount of resources. For example, in India a trauma registry was established at four large tertiary referral centers in order to determine the 30-day mortality related to

trauma. Their findings, including a 20% in-hospital 30-day mortality rate and a low systolic blood pressure correlating with mortality, could not be generalized to the general population given the registry was only capturing patients at large referral centers.[80] However, district hospital data represent a wealth of untapped information regarding the epidemiology of injury. As such, three district hospitals in Uganda underwent successful piloting of an orthopedic trauma registry. As almost half of the patients included in the registries lived within 10 kilometers of one of the hospitals, these district hospital registries identified information that would have been missed at the larger referral centers.[81] To truly have a complete picture of the epidemiology of injury in LMICs in order to provide evidence-based policy changes, it is necessary to have information from both district hospitals and larger referral centers.

In a review of the published experience of trauma registries in LMICs, only 84 publications covering 47 individual registries from 21 countries were found. The majority was from Iran, China, Jamaica, South Africa, and Uganda. Interestingly, the majority of papers focused solely on the epidemiology of injury, however, much more is possible with the use of these registries. Most of the registries gather data across all variable groups, namely demographic, injury event, process of care, diagnosis/injury severity, and outcome. However, inclusion criteria are very variable across registries as are the number of variables collected.[82] Fortunately, the number of registry related publications from LMICs are increasing over time. Also, despite the large variance across the different registries, it is important to note that such variance allows for registries to function within different settings with varying capabilities.

Trauma Care & Trauma Registries in Pakistan

Pakistan is a lower-middle income country and is currently the sixth most populous country world-wide, with an estimated population of 205 million people.[83] In Pakistan, injury is a severe issue as it

is the 5th leading cause of healthy years of life lost. Moreover, injury is the 2nd leading cause of disability and the 11th leading cause of premature death.[17] Despite these alarming numbers, improving the care of trauma patients has been slow. Following a one-year community survey in Northern Pakistan on surgical emergencies, it was found that the incidence of acute surgical interventions was far below the number of acute abdominal traumas and obstetric emergencies.[84] Moreover, a WHO needs assessment found that most emergency rooms lacked basic emergency equipment necessary for essential surgical interventions. The report identified a lack of basic equipment, drugs, and skilled staff as important barriers to effective care.[85] With regards to road traffic fatalities, Pakistan has an estimated 41,494 deaths per year, making it the 5th leading contributor to road traffic deaths worldwide.[86] Alarmingly, the WHO's report on the global status on road safety found this figure to be increasing in recent years. The report also highlights the need to gather data on variables associated with road-traffic injuries in order to make recommendations on how to prevent further calamities.[87]

Data on trauma in Pakistan is generally collected from police reports or surveys, however, both have been shown to be open to many pitfalls.[17] Apart from trauma registries, there have been initiatives to track some aspects of injury. In Karachi (Pakistan's largest city), a road traffic injury surveillance system was piloted. Using a 20 data-item form, researchers identified patients arriving to the emergency room of three large public hospitals involved in road traffic incidents. This form of surveillance was clearly superior to police records as based off of the results of the study, an estimated half of road traffic injury fatalities are captured by police records, and only 2-3% of non-fatal injuries.[88] Such a disparity in capture not only highlights the need for improved data gathering, but also speaks to the feasibility of more advanced surveillance systems in Pakistani hospitals. Despite identifying possible gaps in the care of the injured, the authors conclude that higher quality data with quality indicators, such as those found in hospital trauma registries is required.[89] Another significant

surveillance system, which was implemented in Pakistan, was the Pakistan National Emergency Departments Surveillance (Pak-NEDS). A single page standardized data gathering tool was used to collect information on patients with bomb-blast injuries arriving at 7 emergency rooms across the country.[18] This wide-scale tool was used to elucidate findings regarding bomb-blast injury epidemiology across the country. In an effort to identify the factors associated with the time-interval for arrival in the emergency room following the decision to seek medical care, a prospective data collection tool was employed at a major public hospital in Karachi. Interestingly, other than ambulances, all other forms of transportation were found to increase pre-hospital time, yet only approximately 21% of patients utilized the ambulance service.[19] Recommendations based off of the data were used to improve trauma care in the region. Another form of prospective data collection was used in Peshawar to identify factors associated with delayed arrival to the hospital for penetrating vascular trauma.[90] All of the above mentioned studies employed a form of prospective data collection to identify gaps in trauma care, and to provide recommendations to improve the quality of care. However, without continued high-quality data, interventions that are undertaken cannot be monitored for effectiveness over time.

The only trauma registry identified in the published literature in Pakistan was from the Aga Khan University Hospital (AKUH) in Karachi, Pakistan. The registry was used to calculate TRISS scores, W, M, and Z statistics (statistics used to compare probability of survival [91]) to validate the use of such statistics in developing countries.[20] Additionally, the registry was used to audit trauma deaths in order to determine areas for improvement. One finding was that 7/18 deaths were thought to be preventable. Reasons determined were a lack of effective pre-hospital care, and a lack of adherence to ATLS protocols.[22] Using the registry, researchers were able to determine specific injuries related to bomb-blast trauma and found a significant association between calcaneal fractures and this type of injury.[92] Moreover, a study looking to determine whether transfer delay had an effect on survival of

injured patients employed the use of the trauma registry. Although no significant difference was found, such a result was thought to be due to filtering out of patients who never made it to the hospital or were dead on arrival.[93] All of these studies used a single trauma registry to describe the epidemiology of the injured population, which could be used to provide evidence-based recommendations on how to improve care.

Methods & Analysis

Study Setting

This trauma registry was piloted at the Lady Reading Hospital (LRH) in Peshawar, Pakistan. Peshawar is the largest city in the Northwestern province of Khyber Pakhtunkhwa (KPK), with an estimated population of approximately 2 million people. The LRH is a 1750 bed hospital with a 30-bed trauma bay and 10 operating rooms dedicated for emergency surgeries. It is the major trauma referral center for the province of KPK, which has an estimated population of approximately 36 million people. Throughout the province of KPK there are multiple civil, district, and teaching hospitals, but the LRH remains the main tertiary referral center for these institutions. Furthermore, it also acts as a trauma referral center for hospitals close to the border in Afghanistan. It is therefore an ideal site to pilot a single-institution trauma registry in KPK, as it will give the most complete picture of trauma.

The hospital has a 24-hour on call trauma team comprising of emergency physicians, residents, house officers, and nurses. General surgery, orthopedic surgery, and neurosurgery are all available on call on a 24-hour basis. Health information and progress notes are written manually on trauma sheets. There are currently no electronic records available in the accident & emergency department. Due to the minimal record keeping, information on patient care is very difficult to determine once the patient

leaves the trauma bay. The trauma bay is equipped with oximeters, blood pressure cuffs, and heart rate monitors making it the most advanced trauma hospital in the region.

Nuances of Working in a LMIC

Working in a LMIC has many nuances and particulars that are not present in the hospital cultures of HICs. Therefore, prior to any on-site visit it is of the utmost importance to understand the dynamics of the selected LMIC and their healthcare needs. Thus, before the scheduled on-site visit to the LRH, research into current events and governmental policies in the region was required. Through local contacts, every effort was made to have a strong understanding of the political climate and how best to conduct research in Peshawar. This inevitably eased the process of piloting the registry, and ensured the safety and integrity of the process and of those involved.

Surveillance Tool

The Centre for Global Surgery, McGill University Health Centre has developed a twenty-five data point trauma registry, which it has successfully implemented in Mozambique and Tanzania. Permission for use of this registry had been obtained, and formed the basis for the trauma registry implemented at the Lady Reading Hospital. Administrative data points include if the patient was transferred from another hospital, time of trauma, time of arrival in the ER department, time of care received, and the patient's identification number. Geographical information includes the origin of the patient and the place of injury. Basic patient information includes the patient's age, sex, mode of arrival, education level, and occupation. Data points regarding the mechanism of injury include the cause of injury, setting where it occurred, intent, and if alcohol was being used at the time of injury. Specifically for road traffic incidents, the type of vehicle, role of the injured, vehicle's sector, and whether the patient was using a helmet or seatbelt were recorded. Physiological data points included blood pressure,

respiratory rate, neurological status, injury severity, and types of injuries. Finally, the registry also included the outcome of the patient from the emergency department.

Establishing Partnerships

In order to pilot a trauma registry at a hospital in KPK, Pakistan it was of paramount importance to identify local stakeholders and members of institutions with a vested interest in trauma care. As previous custodians of trauma registries have identified, the most important aspect of creating a sustainable trauma registry in LMICs is identifying local leadership that can carry the project forward.[94] Therefore, multiple emails were sent to hospital officials in order to find such local champions. One such stakeholder was identified at the Lady Reading Hospital in Peshawar, Pakistan. Discussions and meetings with this local champion led to further interest from other local stakeholders including the Head of the A&E department and an assistant professor in the emergency department at the LRH. These partnerships were pivotal in piloting this trauma registry, as they were able to provide guidance and streamline the process. Importantly, following the piloting period these partnerships were maintained in order to lay the groundwork for a sustainable long-term registry in the future.

Pilot Implementation

Upon arrival in Peshawar, Pakistan, the head researcher met with various local stakeholders including the Head of the Accident & Emergency (A&E) Department and the Hospital Director at the Lady Reading Hospital. Moreover, attempts were made to garner support for the project from the other two major hospitals in Peshawar, namely the Khyber Medical Hospital and the Hayatabad Medical Complex. Although funding for a long-term registry could not be obtained from the hospital at the time, approval to collect data for the registry was received.

Once approval was received, the head researcher was stationed in the trauma bay and collected information on all patients arriving to the trauma bay in that time. For five days, from May 9th, 2018 – May 14th, 2018 patients were prospectively collected on the paper form of the trauma registry. Every attempt was made to enter all the data points for each patient, however, this was not always possible. Once the study period was completed, data from the paper registry was transferred to the online registry. Although patients could have been collected directly to the software registry, the decision to collect on paper initially was to ensure that if missing variables were found they could be added to the software at a later time.

Case Definition

To be included in the trauma registry patients had to have injuries severe enough to present themselves to the trauma bay. The goal of the pilot implementation was to describe the nature of the traumas presenting in the region. Therefore, there were no specific exclusion criteria as long as a patient was transferred or presented to the trauma bay at the Lady Reading Hospital in the time that the registry was being piloted.

Data Analysis

Data collected from the trauma registry was initially assessed for completeness. Using the online registry reports were generated to determine the trends and patterns of injury in the region. Data from the registry was studied to determine populations at high risk for particular injuries and areas where interventions could lead to a decrease in the number or severity of trauma cases. By determining gaps in trauma care, policy interventions were suggested, which may lead to injury reduction in the future.

Ethics Approval

Ethics approval to collect data for the registry was received from both the Hospital Director and Head of the Accident & Emergency department in regulation with the Lady Reading Hospital policies. Moreover, a clear understanding was established and agreed upon among the foreign and local researchers with regards to the dissemination of scholarly work. This was a pivotal agreement, which ensured that local stakeholders would be represented for their efforts in the piloting of this trauma registry.

Results

Demographic Characteristics

Over the course of the 5-day data collection at the Lady Reading Hospital in Peshawar, Pakistan a total of 267 patients were included in the pilot registry. The mean age of the patients was 23.21 confirming that trauma is primarily a disease of younger individuals in the region. 190 (71.16%) patients were male, and 77 (28.84%) patients were female. A majority of patients were from Peshawar (152/267, 56.93%), however, for 57 (21.35%) of the patients their place of origin could not be identified. Within the Peshawar region, the most common districts were Mardan (9/267, 3.37%) and Warsak Road (8/267, 3.0%). However, the district for 75 (28.09%) patients could not be ascertained. The regions of Peshawar (170/267, 63.67%), Khyber Pakhtunkhwa (35/267, 13.11%), and the Federally Administered Tribal Areas (5/267, 1.87%) were the most common injury locations. Additionally, the districts that saw the most injury were Warsak Road (12/267, 4.49%) and Shabqadar (8/267, 3.0%), both of which are within the region of Peshawar. However, 43 (16.1%) and 57 (21.35%) patients did not disclose their regions and districts of injury respectively. In terms of education levels, 145 (54.31%) patients either had no education or a primary level of education. 37 (13.86%) patients had a secondary level of education and only 23 (8.61%) patients had a college or university degree. 23.22% (62) of patients were children who had not yet initiated or were in the process of completing a primary level of education. Of the 267 patients, 30 (11.24%) were manual laborers, 6 (2.25%) were employed by the

police, army, or in security jobs, 1 (0.37%) had an office job, 1 (0.37%) was a farmer, 67 (25.09%) had an occupation not listed on the registry, and 8 (3.0%) were retired. 38 (14.23%) patients were unemployed at the time of injury and 116 (43.45%) patients were either children or students.

Referrals and Transport Characteristics

Of the total 267 patients, 21.72% (58/267) of the patients were transferred from another hospital. 11 (4.12%) patients were transferred from the Mardan Medical Complex (MMC) and 2 (0.75%) patients were transferred from the Khyber Teaching Hospital (KTH), both of which are large teaching hospitals. 25 (9.36%) patients were transferred from various District Headquarter Hospitals (DHQs) and 7 (2.6%) were transferred from various Tehsil Headquarter Hospitals (THQs). 8 (3.0 %) patients were transferred from other large government hospitals and 2 (0.75%) were transferred from private hospitals.

The most common mode of arrival for trauma patients was through an ambulance (86/267, 32.21%). However, 84 (31.46%) patients arrived in a private vehicle, 78 (29.21%) arrived using public transport, 17 (6.37%) came by foot, and 2 (0.75%) were brought by the police.

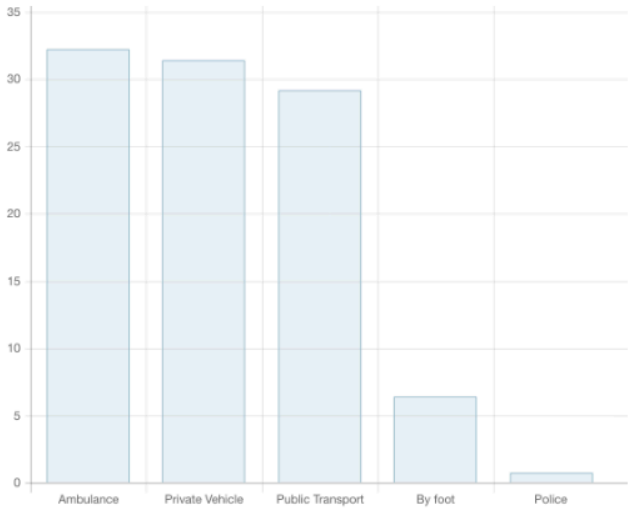

Figure 1: Mode of arrival for trauma patients.

Injury Characteristics

The most prevalent cause of injury was motor vehicle collisions, making up 45.69% (122) of trauma patients. In descending order the other causes of injuries were falls (23.97%, 64/267), blunt assaults (8.99%, 24/267), stabs/cuts (7.87%, 21/267), gunshots (5.62%, 15/267), crush injuries (3.37%, 9/267), burns (3.0%, 8/267), and blasts/landmines (1.5%, 4/267). 231 (86.52%) injuries were deemed unintentional, while 35 (13.11%) were assaults, and 1 (0.37%) was self-inflicted. Although alcohol was included in the registry no patients were deemed to be under the influence at the time of injury.

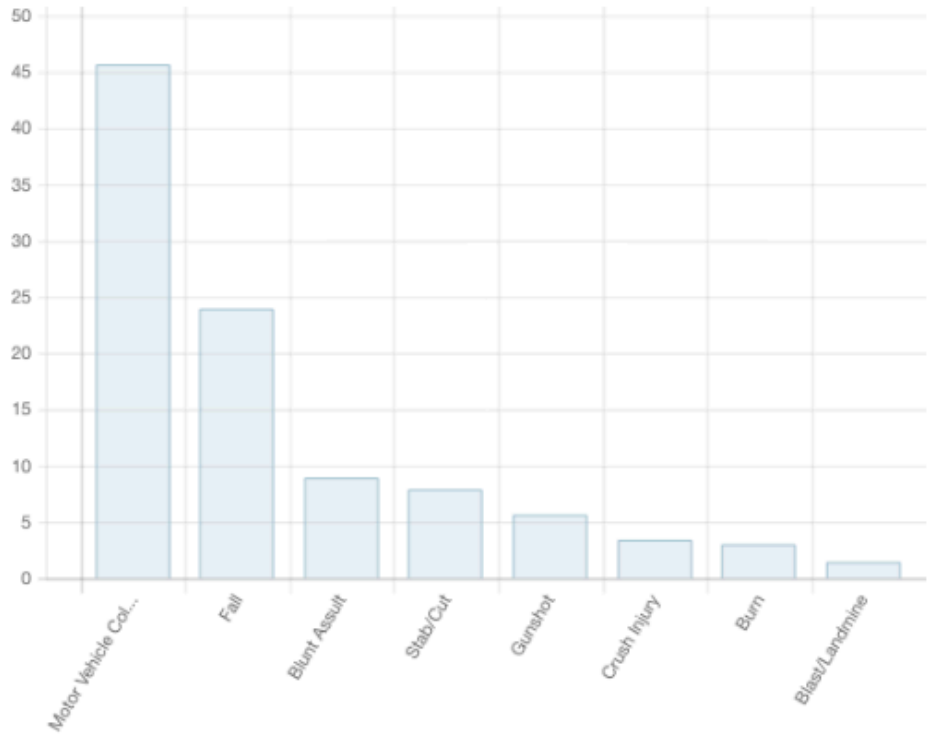

Figure 2: Cause of injuries.

The settings of the injuries varied substantially. 123 (46.07%) were transportation accidents, 88 (32.96%) happened at home, 28 (10.49%) occurred at work, 21 (7.87%) were sustained through leisure/sport, and 7 (2.62%) happened at school.

There were a total of 390 distinct injuries in the 267 patients presenting to the trauma bay. The most common form of injury was a cut/open wound, making up 37.4% of the injuries. Other common injury types were head injuries (108, 27.7%), sprain/strains (29, 7.4%), closed fractures of the lower extremities (26, 6.7%), closed fractures of the upper extremities (18, 4.6%), burns (13, 3.3%), thoracic injuries (11, 2.8%), abdominal injuries (10, 2.6%), open fractures of the lower extremities (9, 2.3%), and open fractures of the upper extremities (6, 1.5%).

Value	Frequency	Percentage
Cut/Open wound	146	54.68%
Head injury	108	40.45%
Sprain/Strain	29	10.86%
Closed Fracture lower extremity	26	9.74%
Closed Fracture upper extremity	18	6.74%
Burn	13	4.87%
Thoracic injury	11	4.12%
Abdominal injury	10	3.75%
Open Fracture lower extremity	9	3.37%
Open Fracture upper extremity	6	2.25%
Closed Fracture spine no paralysis	2	0.75%
Neck injury	2	0.75%
Dislocation upper extremity	2	0.75%
Dislocation lower extremity	2	0.75%
Closed Skull fracture	2	0.75%
Closed Fracture spine with paralysis	1	0.37%
Closed Facila Fracture	1	0.37%
Open Fracture spine with paralysis	1	0.37%
Closed Pelvic fracture	1	0.37%

Table 1: Injury patterns.

Motor Vehicle Collision Characteristics

The type of vehicles involved in the 122 motor vehicle collisions included motorbikes/rickshaws (72, 59.0%), cars (34, 27.8%), buses (8, 6.6%), trucks (4, 3.3%), bicycles (2, 1.6%), and donkey wagons (2, 1.6%). Private vehicles (81, 66.45%) were the most common sector for the motor vehicle collisions. However, public transit accidents made up 28.7% (35) and commercial vehicle accidents made up 4.9% (6) of the injuries. The role of the injured patient in the motor vehicle collisions was most often a pedestrian (55, 45.1%), followed by the passenger (38, 31.1%), and finally the driver (29, 23.8%).

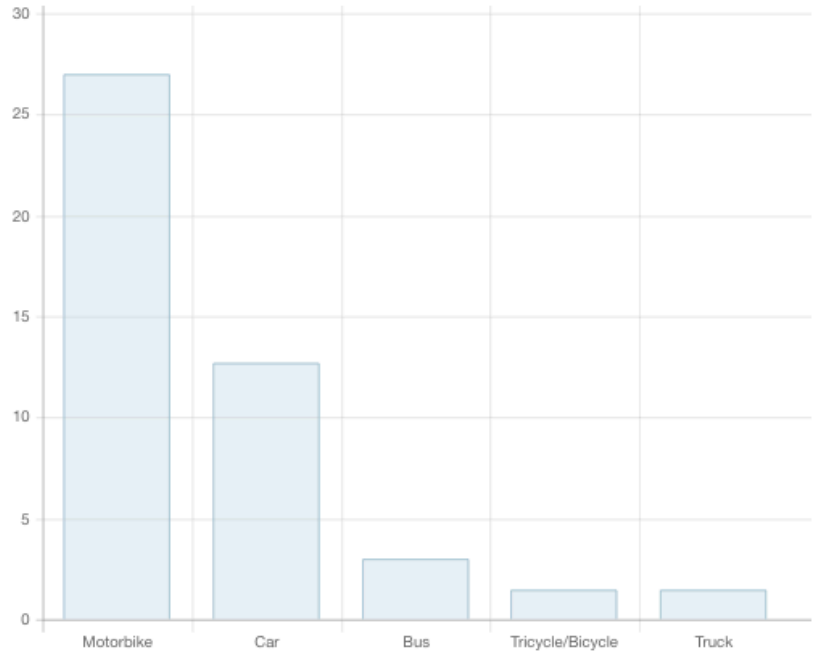

Figure 3: Types of vehicles involved in MVCs.

Of the 78 motorbike and bicycle accidents, in total only 4 patients had a helmet on at the time of collision. Moreover, not one patient involved in the 46 car, bus, and truck accidents wore a seatbelt at the time of the injury.

Injury Severity

Four measures were used to determine injury severity: arterial pressure, respiratory rate, neurological status, and if the injury was deemed to be serious. 253 (94.76%) of the 267 patients presented with an arterial pressure greater than 89 mmHg, 12 (4.49%) had a pressure between 50-89 mmHg, and 2 (0.75%) had a non-detectable blood pressure. Additionally, 254 (95.13%) patients had a respiratory rate between 10-29 breaths/minute, 7 (2.62%) had greater than 29 breaths/minute, and 6 (2.25%) had less than 10 breaths per minute. In terms of neurological status, 237 (88.76%) patients were alert on arrival, 15 (5.62%) responded to verbal stimuli, 9 (3.37%) responded to painful stimuli, and 6 (2.25%) were unresponsive. A serious injury was defined as one which required admission to the hospital, operating room, or another ward. 19 (7.12%) patients had more than one serious injury, 113 (42.32%) had one serious injury, and 135 (50.56%) did not have any serious injury.

In terms of outcomes, 50.56% (135) of patients were treated in the emergency department and sent home. On the other hand, 121 (45.32%) of the trauma patients required admission for further treatment including possible surgeries. 6 (2.25%) patients were taken directly to the operating theatre, and 5 (1.87%) patients died in the trauma bay.

Data Completeness

During the period in which the data collector was on site, no patients were missed. However, in the recording of variables in the registry, the identification numbers of 97 (36.33%) patients were not recorded on the registry. Moreover, as stated in the demographics section many patients were missing the variables “origin of patient” and “location of injury”. Also, 3 of the referred patients did not have the name of their referring hospital on their registry sheets. All other variables were completed for every patient in the pilot registry.

Discussion

The Lady Reading Hospital in Peshawar, Pakistan encounters a high volume of trauma patients as can be seen from the pilot registry. It is the major trauma referral center for the province of KPK as well as bordering regions of Afghanistan. As the foremost trauma center in the region it was chosen to be the site for piloting of a trauma registry in the hope that the success of the pilot project would lead to further investment in trauma data collection and buy-in from local stakeholders.

Results of the Pilot Registry

After piloting the registry for five days a total of 267 patients were captured by the trauma registry. This represents a substantial number of patients, and speaks to the volume of trauma patients that this institution receives. To put this in context, if this sample is representative of the whole year, then the LRH would attend to upwards of 20,000 trauma cases per year. This is an incredible number of patients even accounting for the fact that this is a LMIC. Additionally, the mean age of patients arriving to the trauma bay was 23 years old. In combination, this equates to a large number of young patients suffering from injuries causing a substantial decrease in the disability adjusted life years (DALYs). Therefore, it is of the utmost importance to ensure that the care that these patients are receiving is of the highest quality. However, more importantly, it is necessary to take steps to reduce the number of injured patients in the region. As will be shown, this can be done with the implementation of a long-term trauma registry.

The majority of trauma patients seen at the LRH were male. Although trauma does not have a gender bias, the reasons for this outcome can be explained by the cultural norms of the society in Northwestern Pakistan. Generally, males make up the bulk of the workforce especially in manual labor. This may expose them to a greater risk of trauma outside of the house. Moreover, there may be a difference in healthcare-seeking behavior, which could contribute to this difference. Another important factor, which

was ascertained from the data, was that the vast majority of the patients did not have a higher education. The overall literacy rate of KPK was estimated to be around 50% in 2012.[95] Although this is a low literacy rate, from the data gathered it seems that the proportion of injured patients without an education is higher than the population proportion. Intuitively, in Pakistan there have already been efforts to educate children on road safety through storybooks, which have been proven to increase children's knowledge of how to prevent road traffic incidents.[96] The findings of this registry provide further evidence to increase efforts to educate the public on how to prevent injuries, both in and out of school.

The most common single occupation to be associated with trauma was manual labor. There are very few laws in Pakistan when it comes to the safety of workers engaging in manual labor and construction. Moreover, the workers and supervisors alike have very little knowledge of the safety processes in place.[97] Clearly, to decrease injuries in KPK, greater occupational safety regulations need to be implemented for manual laborers and other workers alike. Along with that, however, is a need to educate workers and supervisors on the current laws that are in place to ensure worker safety. This will ultimately lead to a reduction in traumas and deaths related to work-place accidents.

Approximately 21% of the patients treated at the LRH during the study period were referrals from other hospitals. In the five days that the pilot study ran, 22.4% of the referrals were from other large tertiary care facilities, namely the Mardan Medical Complex (MMC) and the Khyber Teaching Hospital (KTH). Both of these hospitals have full trauma capabilities, and it is therefore alarming that they would transfer trauma patients to the LRH. This represents a non-optimal utilization of resources. As discussed previously, the LRH sees an enormous trauma patient load, and part of improving trauma care is improving the pre-hospital and transfers system. Improving pre-hospital systems has been shown to increase trauma patient survival.[98] This represents an opportunity for administration from

the mentioned hospitals to clearly outline transfer policies and how best to utilize the resources at the various hospitals. In so doing, they would be able to create a more clear-cut referral policy, one that improves the survival and care of the injured patients.

On the other hand, 55.1% of transfers arrived from various DHQs and THQs. These represent the secondary and primary hospitals in the Pakistani hospital system. Referrals for trauma from these smaller hospitals are to be expected, as they do not have the capabilities to deal with major traumas. It is important to identify that the referral system among the DHQ/THQ hospitals and the LRH is intact. Of the patients transferred from DHQs and THQs 19.3% had no serious injuries, 51.6% had one serious injury, and 29.0% had more than one serious injury. Thus, the vast majority of patients had serious injuries, which probably could not have been treated at the smaller district hospitals. This displays the integrity of the referral system from these smaller hospitals. With a long-term registry, trends in the amounts and appropriateness of referrals from various regions could be quantified and then used to investigate an unusually large or small amount of referrals from certain hospitals. This would be an integral part of improving the pre-hospital trauma system in the region, and would certainly improve trauma care in the region.

The amount of patients arriving to the trauma bay by ambulance, private vehicle, and public transport was approximately equal. In a perfect pre-hospital system, all serious traumas should be arriving via ambulance with trained paramedics to ensure safe, quick, and effective transport. However, in LMICs with limited resources this is not always a possibility. In order to address this deficiency, the WHO has recommended training layperson first responders as an initial step in setting up an effective pre-hospital system. Other LMICs have instituted effective layperson first responder training with considerable success. In Madagascar taxi drivers were successfully given first responder training.[99] Additionally, in Uganda motorcycle taxi drivers were trained to deliver first responder care and improvements were

seen in bleeding control, airway and breathing management, recovery position, scene management, and safe patient transport.[100] Given that the majority of trauma patients in Peshawar are arriving via public transport, private vehicles, or on foot there is a treatment gap that can be filled in the region. Moreover, upon discussion with emergency room staff at the LRH, it became clear that the vast majority of the ambulances being used were from private institutions rather than the hospital. These private institution ambulance drivers were not always trained in first responder or paramedic care, which, in their opinion, was leading to unsafe transport. In order to optimally utilize the limited resources available it is necessary to identify those individuals who are most likely to be first responders, for example, taxi drivers vs. rickshaw drivers vs. private ambulance drivers. Using the trauma registry, over 60% of patients arrived via taxi or ambulance. In order to optimize and improve pre-hospital care, layperson first responder training should begin with these individuals. This will ensure optimal use of resources and based on experiences from other LMICs will help to improve the care of injured patients in the region.

While first responder training will ensure the pre-hospital care of trauma patients improves, the trauma registry identified a large proportion of patients arriving via foot and private vehicles. These patients would not benefit from such training programs. The registry does not have the power to identify why patients arrive via these two mechanisms. However, given that the LRH is located in a busy and densely populated part of Peshawar, it is likely that those arriving on foot were injured in the surrounding area. On the other hand, there could be a multitude of reasons for private vehicle transport. Despite the reasons, one could argue that there is a need for an increase in the number of ambulances to ensure more trauma patients could be safely and effectively transported to the hospital. Importantly, these ambulances should be staffed by trained paramedics to increase the public's trust and reliance on these services. Through lay person first responder training and an increase in ambulance services in

KPK, a more effective and safe pre-hospital system can be established, which can be monitored through a long-term trauma registry.

Motor vehicle collisions (MVCs) were the most prevalent cause of injury in the pilot registry. This is in keeping with the fact that Pakistan has an estimated 25,781 road traffic deaths per year.[87] Clearly, MVCs is a major public health issue that needs to be tackled in Pakistan as a whole and in the province of KPK. The data from the registry also shows that no person involved in a MVC was using a seatbelt at the time of injury. Moreover, only 4 patients in total had a helmet on while operating a motorcycle or bicycle. Although Pakistan does have a national seat-belt law, it does not specifically apply to both front and rear seat passengers. Moreover, the enforcement of this law was judged to be a 3/10, with 10 being full enforcement. Pakistan also has a national motorcycle helmet law, however, the law does not ensure that the helmet has to be fastened and makes no mention of the helmet standard. The enforcement of this law was adjudged to be a 2/10, with estimated helmet wearing rates of 10% for both motorcycle drivers and passengers. In fact, Pakistan does not have any laws in line with best practice for speeding, helmet and seat-belt use, and child restraints.[87] All of the above mentioned laws have been empirically proven to decrease injury severity and reduce mortality in the event of MVCs.[40, 101-104] The data from the registry regarding MVCs confirms previous data and estimates regarding injuries, seat belt, and helmet use in Pakistan. Moreover, it adds further evidence to incentivize lawmakers and government officials to take notice of this epidemic. With the ever-growing population it is necessary to enforce stronger laws regarding road safety to ensure a decrease in MVC injury severity and mortality.

Moreover, one of the main forms of public transport in Pakistan is auto-rickshaws. These are motorcycle-powered and by design have no seatbelts for either driver or passengers. Although this pilot registry did not differentiate between auto-rickshaws and other forms of transport, future registries

should include this. It would allow for prospective data on the amount and severity of injuries involving this commonly used means of transportation.

Along with reducing the morbidity and mortality associated with MVCs when they do occur, the data from the pilot registry exemplifies the need to substantially reduce the number of MVCs in Pakistan. There are many avenues that can be taken to decrease the amount of MVCs in the region. Canada has demonstrated a good example of how a nation can work to drastically reduce the number of MVCs. In Canada, a national road safety strategy was adopted with the vision to reduce the number of deaths from MVCs to zero by 2025. Part of this strategy was engaging the public and raising awareness about road safety, improving communication and collaboration among various stakeholders, enhancing and enforcing road safety legislation, improving road infrastructure, and implementing new technology and innovative strategies.[105] Data from this pilot registry displays the needs for such an endeavor to be initiated in Pakistan. To highlight some areas where there could be substantial improvement is in pedestrian safety, as 45% of the patients involved in an MVC were pedestrians. This is an unusually large number of patients, and highlights the need to decrease the amount of pedestrians involved in MVCs. This can be tackled through multiple initiatives including more sidewalks, pedestrian overpasses, and public education on safe walking strategies. Regardless of the methods used, it is clear that the number of MVCs and especially those affecting pedestrians is too high in the region. The need for a national and subnational effort to mitigate the issue is required along with further long-term injury surveillance to monitor any changes and identify the most effective interventions.

The second most common cause of injury in this population was falls. In a region where there is practically no snowfall this is an alarming number. It argues that these patients were predominantly falling from heights both at home and in the workplace. Houses in the region are built with flat roofs and it is very common for children to spend a lot of their leisure time playing various games there (kite

flying, cricket, etc.). This data argues that there is a need for greater safety mechanisms in place to prevent falls especially at home. However, another possible method to reduce the chances of falls would be to create safe environments where children can play away from their roofs, such as parks and recreational facilities. More in depth study into the mechanisms of these falls is required in order to determine a public health approach, which would effectively decrease the amounts of falls in the region.

In only 5 days, the LRH saw 15 patients with gunshot wounds. Although guns are widespread throughout Pakistan, this is an alarming number of patients arriving with gunshot trauma. The evidence is clear on gun-violence – the fewer guns available to the public, the fewer gunshot injuries and deaths as has been demonstrated in Australia.[106] Moreover, stricter firearm legislation leads to a decrease in the number of firearm inflicted deaths and injuries.[107, 108] With long-term injury surveillance more data could be gathered to demonstrate the destructive effects that firearms have on society. However, even with this small snapshot of injury epidemiology in Northwestern Pakistan, it is clear that gun-violence is a major contributor to trauma numbers. Perhaps it is time for stricter laws to be placed on firearm ownership and an effort should be initiated to reduce the absolute number of firearms in circulation.

No injured patients recorded by the trauma registry were found to be under the influence of alcohol. However, no patients were tested for alcohol use, as this was not part of the standard of care in the trauma bay at the LRH. Alcohol in Pakistan is an illegal substance by law; however, it can still be found in many regions. In fact, in a study evaluating the use of alcohol and marijuana by commercial drivers in Pakistan, an estimated 10% and 30% of truck drivers used alcohol and marijuana, respectively, while driving.[109] Given that alcohol and marijuana could be increasing the risks of injuries, especially MVCs, it would be beneficial to include alcohol and other drug tests as part of the

standard evaluation of trauma patients. Moreover, given the high usage of marijuana in the region, future injury surveillance mechanisms should include this as a variable to be studied.

Approximately 50% of patients were deemed to have at least one serious injury. At the same time, that means that around 50% of patients did not have a serious injury and were still brought to a large trauma facility. In keeping with the seriousness of injuries, approximately 50% of patients were treated and sent home. This exemplifies the effectiveness of triage care once the patients do get to the trauma bay. However, given the massive trauma patient burden that the LRH faces there is room to refine the pre-hospital triage system. Many of the patients seen at the LRH could be treated at other smaller institutions, which would inevitably decrease the patient load on the facility. Yet, given that the pre-hospital system, especially ambulance care, is primitive, there could be a bias for selecting healthier patients. More seriously injured patients may die prior to reaching the hospital. This could explain the large number of non-serious injuries. Moreover, the pilot registry allowed for calculation of the Kampala Trauma Score (KTS), an injury severity score developed for low-resourced settings. It has been shown to predict mortality with equal efficacy to other more advanced scoring systems.[110] The KTS ranges from 5-16, with lower scores indicating more serious injuries.[111] Overall the KTS in this dataset ranged from 7-16, with an average KTS of 14.92 indicating that the majority of patients did not have very serious injuries. This further adds to the argument that although the LRH should be receiving the most serious injuries in the region, those patients are either not being brought there or dying prior to transport.

Trauma Registry Utility

This project represents the first attempt at instituting a trauma registry at a trauma hospital in Northwestern Pakistan. Despite piloting the trauma registry for five days, we were able to effectively describe the epidemiology of injured patients in the region. Moreover, the data collected was

prospective in nature, capturing variables that have not previously been studied and are missing from other forms of data collection. Almost all of the variables were completed for every patient excluding the origin of patient, origin of injury, and hospital identification codes. Many patients were missing identification numbers upon presentation to the trauma bay and only received them after treatment, and were resultantly missed. Moreover, the data collector faced difficulties in determining the place or origin of injury due to language barriers and a lack of knowledge of KPK's geography. Apart from these variables, the data collection was complete and was very informative of the nature and causes of injuries in the region.

Data from the Pakistan Health and Demographic Survey estimated injuries accounting for 6% of all deaths in Pakistan, or 42 per 100,000 population. Moreover, by itself, road traffic injuries (RTIs) are the 18th leading cause of death in the country, causing an estimated 23,445 deaths per year. Alarmingly, 46% of the RTI deaths occurred in the 20-39 age group representing a serious loss of productivity.[112] Moreover, the global burden of disease profile for Pakistan lists road injuries as the 13th leading cause of years of life lost (YLL) with other forms of injuries as the 15th, 16th, 18th, 20th, 21st, and 25th causes of YLLs. If looked at together, these causes of injuries would be the 4th leading cause of YLL, after lower respiratory infections, neonatal encephalopathy, and diarrheal disease. Despite the heavy burden of injuries on the Pakistani population there has been an ineffective response to curb the issue, as there has been a 50-100% increase in the disability adjusted life years (DALYs) from 1990 to 2010 from road injuries, falls, and self-harm.[113] DALYs and YLL are very important metrics that help us understand the scope of the issue, however, it is important to realize the massive economic impact of injuries. In Pakistan, the estimated cost of road traffic injuries alone is 1.3% of the GDP, or USD 1.6 billion.[114] Although this represents a significant loss of productivity to the nation as a whole, on the individual level a study found the average out of pocket healthcare costs from road injuries to be USD 271. Approximately 87% of the patients studied earned less than USD 248, and around half of the

patients were the primary breadwinners for their families.[115] These numbers are truly staggering, however, there are real concerns that the estimates of injuries are being under-represented given the lack of reliable data sources and under-reporting of work-related injuries.[116] Thus, it is very possible that the true burden of injury on the Pakistani people is even greater than presented, and more reliable and accurate forms of data collection are required. Although this pilot registry provides a 5-day snapshot at a single large trauma institution, the amount of trauma patients captured is overwhelming. Yet, despite its short course, the prospectively collected data offers insights into how effective injury prevention policies can be formulated displaying its value and utility.

From the data collected, pedestrians and motorcycle injuries made up the bulk of MVCs. With limited resources, these represent two areas where effective interventions can be applied to reduce the amount of MVCs overall. As stated earlier, providing more pedestrian friendly streets would work to decrease the amount of pedestrians being struck by vehicles. This is especially important considering the out of pocket expenditure for pedestrians involved in MVCs is significantly higher than the average MVC patient.[115] Thus, by decreasing the amount of pedestrians involved in MVCs two goals would be reached. Firstly, the absolute number of injured patients and therefore, the burden of injury would decrease. Secondly, progress towards decreasing the amount of patients with impoverishing expenditure and catastrophic expenditure on healthcare would decrease, both of which are goals of the Lancet Commission on Global Surgery.[14] Moreover, enforcing traffic laws, especially the use of helmets on motorcycles will help to decrease the seriousness of these injuries. The pilot registry was extremely effective in highlighting these two over-represented injury types. But, most importantly, once policy and change is implemented, a long-term trauma registry will be able to identify if the interventions are effective. In that, it would be able to identify if there is a decrease in the number of injuries, whether there is a substitute effect, and if the interventions are only benefitting a certain region or group of people in the province. These are all important variables that must be considered when

carrying out change. Effectively, a long-term version of the pilot registry is what is required for optimal interventions to be carried out to alleviate the issue of injuries in Pakistan.

Another important characteristic of the trauma registry is that it allowed for identification of transfers from other hospitals. This is an extremely important piece of information concerning the trauma system in KPK. Currently, based on the data collected it seems that KPK is running on an 'exclusive trauma system'. Essentially, this is where trauma care is organized around a few high level hospitals that can deliver definitive trauma care. However, the more recent notion of 'inclusive trauma systems' has been shown to increase survival of severely injured patients.[117] An inclusive trauma system is one where all medical facilities are designed to deliver care to trauma patients to the extent that their resources allow. Inevitably, to improve the care of injured patients in Pakistan, work needs to be done to develop a more inclusive trauma system. A trauma registry will allow for the evaluation of such an effort. It can provide meaningful data on which hospitals are issuing appropriate referrals and whether or not they are working towards an inclusive system. As trauma care evolves in Pakistan, a trauma registry will be able to identify where and how the system of trauma care can be improved and made more inclusive.

A final key area where the pilot registry proved its worth was in determining the modes of arrival of trauma patients and the seriousness of injuries. As discussed, the overall severity of injuries was not that high, however, it is very possible that those patients with very serious injuries were not being brought to the hospital in time. In fact, a study from Karachi found that 58% of trauma patients died prior to hospital arrival.[118] Although these patients would be missed on a trauma registry, they would be found in coroner or police reports. With a long-term registry, data from the registry could be compared with data from these other forms of injury and mortality reporting. With an improvement in the pre-hospital system, a pivotal statistic to follow would be the amount of patients arriving with serious injuries compared to pre-hospital deaths from police data. Over time, one would expect the

amount of seriously injured patients to increase and the number of mortalities pre-hospital to decrease, as patients' survival times would be prolonged enough for them to reach the hospital and receive care. This important measure of pre-hospital improvement would only be possible with a trauma registry, displaying both the importance and utility of having this prospective data collection tool.

Through the 5-day pilot trauma registry an immense amount was learned about the state of trauma care and the epidemiology of injury in KPK. Data from this snapshot of trauma care can already be used to develop targeted strategies to decrease the burden of trauma in the region. Yet, despite being so useful, perhaps the most important aspect of this pilot registry was that it was not expensive nor was it time intensive. The registry per patient took an average of 2-3 minutes, and the cost to implement such a project was limited to the travel expenses of the data-collector. In reality, the LRH already has a paper-based trauma registry where basic data-points are collected. However, given that it is paper-based, to develop analyses from it is time consuming, and to date, the data has never been used. Using the registry provided here, nurses would be able to complete the registry on their phones or hospital provided tablets. Data would be accumulated and automatic reports would be generated. This would make the job of collecting effective data very feasible and useful.

There is a misconception when it comes to improving surgical care in LMICs. Much of the funding and global health efforts in the past few decades have focused on infectious and communicable diseases. However, the fact is that some surgical interventions are more cost-effective than vaccines or bed nets for malaria prevention. Moreover, almost all surgical interventions have been found to be more cost-effective than HIV treatment.[119] Pakistan is facing an injury epidemic and action needs to be taken to decrease the mortality and morbidity from this preventable disease. This pilot trauma registry has only touched the surface with regards to the impact and utility of a long-term registry. When such a

project is bound to save lives and requires minimal financing and manpower, it is essential that it becomes a part of the healthcare infrastructure in Peshawar.

Steps Moving Forward

Following the promising results from this piloted trauma registry in Northwestern Pakistan, the next step is to develop a long-term and sustainable trauma registry in the region. This will facilitate the local actors to improve trauma care through evidence-based interventions. In order for this to become a reality some key features of the trauma registry need to be addressed.

Although funding is not the biggest aspect of developing a successful trauma registry, it is nevertheless a key feature of any sustainable trauma registry. To that end, identifying long-term funding partners is of paramount importance. Funding could be received from the local government, the hospitals themselves, or local NGOs with a vision for improving patient care in Pakistan. Although foreign funding may be useful in the early stages of a trauma registry, they should not be relied upon in the long-term. Foreign funds tend to diminish once the foreign stakeholders' goals are met. Local funding resources tend to have goals that are in line with the local stakeholders, which ensures the establishment of a long-term trauma registry. Therefore, in order to establish a sustainable trauma registry in Peshawar, local funding sources need to be acquired.

Part of the funding process is to ensure that funds are being used efficiently, which can be addressed with another key feature of successful trauma registries; staffing.[94] Many successful trauma registries previously employed in LMICs have used the concept of dual roles for data collection in order to cut costs. In these institutions, doctors or nurses were charged with the completion of the trauma registries in addition to their clinical duties. These have definitely proved fruitful in terms of cutting costs, however, especially in LMICs there is a huge clinical demand on the healthcare teams as is. In the case

of Peshawar, all three of the largest hospitals, namely the Lady Reading Hospital, the Khyber Medical Complex, and the Hayatabad Medical Complex, had dedicated staff in charge of data collection in their trauma bays. However, the data they were collecting was basic and was not being used to drive change in the care of injured patients. Therefore, as part of building an efficient system, those same data collectors could easily be charged with the completion of a more meaningful and useful trauma registry. This would decrease the amount of funding required and would not increase the workload on the already extremely busy trauma staff.

When working in LMICs a key feature that needs to be addressed is information technology. Unlike in most HICs, institutions at LMICs do not always have the most advanced technology or even continuous Internet connections. The most effective means of filling out a trauma registry would be on a portable tablet. This would lead to direct uploading of data onto the registry software, which would decrease the chances of inputting errors. Moreover, it would decrease the amount of funding required in the long-term as it would erase the need for a data-entry post and paper costs. However, in order for this to be possible it would require a software that could run offline in the event that there is not a continuous Internet connection and would require an initial larger fund for the tablet technology. Currently, the software that was used in the pilot trauma registry is capable of functioning offline, meeting the abovementioned criteria. Moreover, funding for tablet technology is one of the few things that can be sought from foreign funding or foreign collaborating partners. With tablets and the software already provided by the Centre for Global Surgery – MUHC, the IT issues of developing a sustainable trauma registry could be addressed.

Another key feature of a successful trauma registry is ensuring good quality data. In many LMICs, there is a paucity of complete and meaningful patient records. Part of the reason for this has to do with the immense clinical load, leaving little time to ensure accurate patient records. Additionally, in some

instances the necessary infrastructure is lacking, for example, in certain hospitals bp cuffs could be lacking leading to no blood pressure records. At the Lady Reading Hospital in Peshawar, the necessary infrastructure is definitely in place, however, it is not always utilized for trauma patients. With the development of a trauma registry which requires physiological data to be completed such as blood pressure, respiratory rate, and neurological status, it will encourage physicians to take the necessary time to assess and record these pivotal parts of trauma care. Additionally, the trauma registry form could easily become a part of the patient's chart improving the transfer of information within the hospital. Most importantly, the quality of the data will be of high quality by using dedicated data collectors who have been trained to use the trauma registry. This will allow for greater confidence in the data, and will lead to more successful interventions to improve trauma care in the long run.

Related to data quality is the utilization of such data. In order for a trauma registry to be truly successful there should be a clear initiative in place on how the data will be used.[94] The current software used in the pilot registry can generate reports itself. Prior to implementing the registry, a timeframe should be agreed upon for these reports to be analyzed such as bi-weekly or monthly. These reports will allow hospital governance to draw conclusions on how to improve trauma care within their own hospital. Moreover, if the registry were to be established at multiple institutions, these reports could then be used for benchmarking among the different sites. It should be made clear that the data gathered from the registry is there to improve trauma care on the whole, and not to single out or defame individual staff members. This is an important aspect of data utilization to guarantee the buy-in of the trauma physicians and allied health professionals. Additionally, as stated previously, another important aspect regarding data utility is if the registry were to become a part of the patients' charts, it would work to improve communication and knowledge transfer within hospitals.

Perhaps the most important aspect of establishing a successful trauma registry in a LMIC like Pakistan is having a local champion to further the project. Inevitably, foreign involvement is bound to decrease over time, and in order to ensure a successful lasting project, a local champion has to take ownership of the registry and progress it further. Countless examples exist where registries have been established in LMICs, however, once foreign involvement ceases, the registry also ceases to exist. This is extremely counter-productive and does not address the issue of decreasing injuries. Therefore, in order for the Peshawar trauma registry to be effective, it will require a local champion, a person on the ground who shares the same vision for decreasing trauma and improving the healthcare of injured patients. They will be required to have the necessary motivation to drive the project forward leading to a sustainable trauma registry.

A local champion alone, however, will not ensure a successful registry. Buy-in from higher up officials in the hospitals and government will also be necessary. Support from such individuals will allow for a more streamlined process and will assist with any road bumps along the way. Their support will be instrumental in dealing with all the red-tape bureaucracy that comes with working in a LMIC. Along with the local-champion they will form a solid foundation upon which the trauma registry can depend on. In Peshawar, the Head of the Accident & Emergency department has already shown his support for the trauma registry project. In addition, many staff from the department have displayed a willingness to use this tool in their daily work. A local researcher from the Khyber College of Dentistry, Peshawar has shown interest in being the local champion for this project moving forward. These are promising signs of support from the local doctors and researchers and will ensure the longevity of this trauma registry.

Governance of the trauma registry is another important issue that needs to be addressed prior to implementing a long-term registry.[94] Strong leadership is the first principle that falls under governance. Without this, the registry will have no direction and will inevitably fail. Therefore, the

local champions will need to ensure a clear focus for this registry and all those involved. Moreover, as initially there will be some foreign involvement, it is of the utmost importance to certify that there is local ownership of the data. There is inherently a mistrust of foreign involvement in LMICs, especially Pakistan. In order to alleviate this, it is necessary to mitigate any mistrust and suspicion by ensuring local ownership of the data through the local champions.

There are many principles that need to be adhered to in order to establish a long-term trauma registry that is effective in alleviating the burden of injuries and their effects on individuals. While all of these are necessary, persistence is the key to effectively accomplishing this. Working in LMICs can be difficult and can come with multiple challenges; however, the difference between success and failure will ultimately be persistence. The dedication and work required to establish a trauma registry in Peshawar, Pakistan cannot be understated, yet, by adhering to the principles stated above, a long-term and successful trauma registry in Peshawar could become a reality – and with that the first step to tackling the injury epidemic in Pakistan.

Conclusions

The epidemiology of injury in Peshawar, Pakistan was described accurately for the first time following the successful implementation of this pilot trauma registry. The data collected clearly underlines the need for public health interventions in order to reduce the amount of injuries in the region. Specifically, future efforts should work towards improving workplace safety, pre-hospital and referral systems, motor vehicle and pedestrian safety, and fall prevention. Moreover, this pilot registry highlights the feasibility of establishing a long-term trauma registry in the region. The lessons learned from this pilot registry could guide future endeavors in the areas of injury surveillance, ultimately assisting in reducing the morbidity and mortality associated with injury.

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