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HOSPITAL BASED INJURY SURVEILLANCE SYSTEM FOR LOW AND MIDDLE INCOME COUNTRIES

Injuries are a major cause of death around the globe. According to statistics, around 5 million people die each year world wide remaining another few millions disabled due to injuries. The world health organizations reveals that more than 90% of the injury related deaths are from low and middle income countries. But the worrying factor is that the most of the injury related deaths in these countries could have been prevented with a concerted effort. Most of the developed countries use injury surveillance systems to monitor injury cases and take preventive measures. However, low and middle income countries can not afford for such systems because of the lack of funds and basic infrastructure, like Internet. This paper proposes an effective injury surveillance system for those countries which can be functioned with minimum resources and minimum cost.

1. INTRODUCTION

Injuries are a major cause of death that had not been given enough consideration until the last decade. Each year several millions of people die due to injuries, remaining another few millions permanently or temporarily disabled. According to the World Health Organization's(WHO) statistics, in year 2004 alone, an estimated 5.8 million people died worldwide due to injuries [4]. Further, WHO reveals that more than 90% of the world's injury related deaths occur in low and middle income countries [6]. However, the total number of cases of injuries may be several times greater than that of the cases of deaths. Besides the cost of human lives, cases of injuries cost a vast amount of money annually that could have been used for development tasks. According to the WHO, annual direct global economic cost of road crashes alone has been estimated as 518 billion US dollars [7]. Whereas, the annual cost of traffic injuries in low and middle income countries is 65 billion US dollars [7]. And it exceeds the total annual amount those countries receive in development assistance. Therefore, the burden of cost of injuries is almost unbearable for low and middle income countries. WHO has already launched some programmes in several low and middle income countries to assist them to cop with this grave issue. The "Disability & Injury Prevention and Rehabilitation" program is one such effort of WHO which has been launched in Africa-region countries [1]. However, still there is a need of a concerted effort for effective and sustainable injury prevention especially in low and middle income countries. Fig.1 depicts the distribution of cause of injuries in annual global injury mortality.

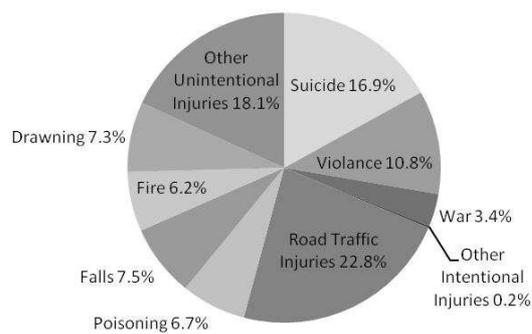


Fig. 1. The distribution of global injury mortality by cause of injury.
 The percentage of each cause of Injury in annual global injury related deaths.
 Source: World Health Organization, Global Burden of Disease Project 2002, Version 1 [7]

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2. INJURY SURVEILLANCE

The standard definition of “surveillance” as used by WHO is: “*surveillance is the ongoing, systematic collection, analysis and interpretation of health data essential to the planning, implementation, and evaluation of health practice, closely integrated with the timely dissemination of these data to those who need to know. The final link of the surveillance chain is in the application of these data to prevention and control*” [5]. In general, injury surveillance involves in keeping records of individual injury cases, assembling information from those records and reporting to the relevant parties. That information can be used for evaluation and effective policy formulation. Thus, an injury surveillance system includes a functional capacity for injury case related data collection, analysis and dissemination linked to public health programs.

2.1. EXISTING INJURY SURVEILLANCE SYSTEMS

Some of the developed countries are using specific types of injury surveillance systems. For example, Injury Surveillance System of National Collegiate Athletic Association of USA was developed in 1982 to provide timely and reliable data on injury trends in intercollegiate athletic [3]. Another is National Electronic Injury Surveillance System (NEISS) of USA, which provides timely data on consumer product-related injuries in the USA [2]. However, these systems are basically designed to work in resourceful environments in developed countries. These types of injury surveillance systems are not suitable for low income countries due to a number of reasons. Followings are some of the main reasons why they are not suitable for low and middle income countries.

1. Since these injury surveillance systems are designed for specific types of injuries, number of different systems has to be integrated to monitor all the types of injury cases.
2. Due to unavailability of high-speed Internet coverage, such types of systems cannot function in low and middle income countries.
3. Comparatively low level of computer literacy in many low and middle income countries makes it difficult to operate those systems in those countries.
4. Generally, these types of systems cause a high operational cost that can not be afforded by the low and middle income countries.

Therefore, there is a need of an effective injury surveillance system for low and middle income countries which can function with limited resources under minimum operational cost.

3. PROPOSED INJURY SURVEILLANCE SYSTEM

The proposed injury surveillance system is aimed to function in resource limited environments in low and middle income countries. The system is designed to use minimum number of computers. The system does not need 24hrs broadband Internet connection for functioning. It is sufficient to have a dialup Internet connection once a week. It has the qualities such as simplicity, flexibility, acceptability, reliability, utility, sustainability and timeliness that have been introduced by the WHO for effective surveillance system [5].

3.1. SYSTEM OBJECTIVES

The approach of the proposed Injury Surveillance System is collecting injury related data, analyzing and disseminating valuable information to the people and groups who are connected to injury surveillance practices in low and middle income countries. The following is a list of objectives of the system.

1. Generate medical centre wise, regional and country wide reports of injuries.
2. Identify patterns of injuries and common causes for injuries.
3. Identify regions where people are especially vulnerable for particular type of injuries.
4. Identify seasons and time periods in which people are mostly vulnerable for injuries.
5. Monitor the effectiveness of counter actions which have been already taken to minimize the injuries.
6. Alert the authorities when a threshold value is exceeded for a particular type of injury.

Controlling injuries in a country is not a task that can be performed by a single group. Rather, it is a collaborative effort of number of institutions or groups of people. Therefore, the proposed system may have number of stakeholders who are connected to injury surveillance effort in various means. Some of them are healthcare practitioners, healthcare institutes, government officials, general public, international agencies, and special interest groups, etc.

3.2. DATA COLLECTED BY THE SYSTEM

System collects numerous data that are valuable for effective injury surveillance. Following the WHO injury surveillance guidelines, the system will collect a set of mandatory data, optional data and some conditional data [5]. Tables 1, 2 and 3 respectively show those data.

Table 1. Set of mandatory data to be collected by the system

Data Class	Description	Obligation
Identifier	A unique identifier to distinguish each injury case.	Mandatory
Age	Age of the injured person	Mandatory
Sex	Gender of the injured person	Mandatory
Intent	The role of human intent in the occurrence of the injury incident	Mandatory
Place of occurrence	Type of place where the injury event occurred	Mandatory
Activity	What was the injured person doing at the time of injury	Mandatory
Nature of Injury	The physical nature of the injury	Mandatory
Mechanism of Injury	How the injury was inflicted	Mandatory

Table 2. Optional data to be collected by the system

Data Class	Description	Obligation
Race/Ethnicity	Race or the ethnicity of the injured person	Optional
Date of Injury	Date of incident of injury took place	Optional
Time of Injury	Time incident of injury took place	Optional
Residence	Injured person's residential address	Optional
Alcohol use	Suspicion or evidence of alcohol use before the injury event.	Optional
Other psychoactive substance use	Suspicion or evidence of use of a psychoactive substance, legal or illegal (e.g. heroin, cocaine, benzodiazepam).	Optional
Severity	Severity of the injury.	Optional
Disposition	Action taken or injured person's status after arrival at health facility.	Optional
Incident Summary	A brief description how the injury incident happened	Optional

Table 3. Conditional data that depends on Mechanism of Injury

Data Class	Description	Obligation
Mode of Transport	How was the injured person travelling at the time of injury incident	Conditional : If the Mechanism of injury is traffic accident
Road User	The role of the injured person on the road at the time of injury incident. e.g. pedestrian, driver	Conditional : If the Mechanism of injury is traffic accident
Counterpart	With what the injured person collided?	Conditional : If the Mechanism of injury is traffic accident
Context	Factors that precipitated the assault	Conditional : If the Mechanism of injury is assault or a homicide
Perpetrator/Victim Relationship	The relationship of the perpetrator to the victim	Conditional : If the Mechanism of injury is assault or a homicide
Object Used	The Object that inflicted the injury	Conditional : If the Mechanism of injury is assault or a homicide
Risk Factors	The circumstances that may have led to the suicide attempt	Conditional : If the Mechanism of injury is suicide or attempted
Previous Suicide Attempts	Number of previous suicide attempts	Conditional : If the Mechanism of injury is suicide or attempted

3.3. OVERVIEW: SYSTEM ARCHITECTURE

The system consists of databases that keep records of individual injury cases, Information Processor, Synchronization Handler (Sync Handler), Web Application and a Standalone Application (fig. 2). Since it's less practicable to provide computers to each rural medical centre or interconnect them all through the Internet in low and middle income countries,

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medical centres are grouped into number of groups. This grouping is done based on the availability of computers, the Internet connectivity, staff and administrative concerns. Size of groups also depends on the same factors. Only one medical centre in a group need to have a computer and that should be able to connect to the Internet at least via a dialup connection. In this case, we call it as regional base medical centre. So the other medical centres in the group bring their injury records to the regional base medical centre and enter to the regional database regularly. Operators in the regional database update the central database via the internet regularly. Sync handler facilitates this even with a low speed dialup internet connection.

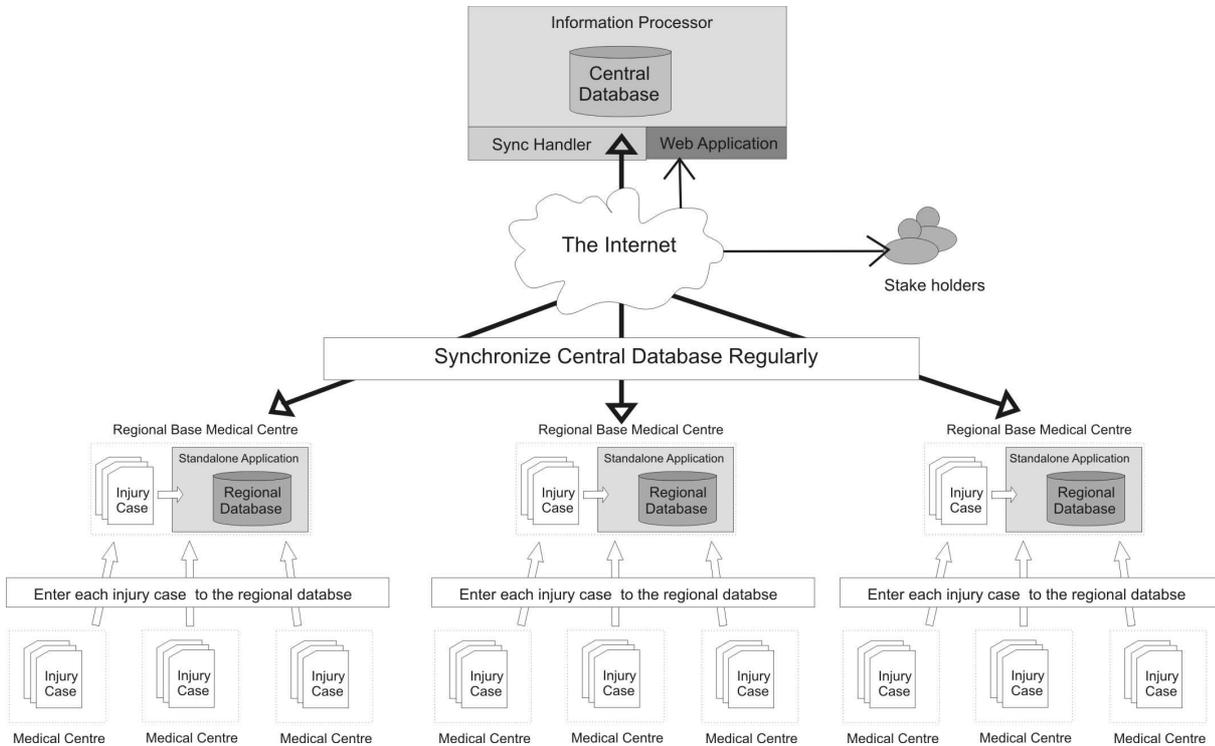


Fig. 2. The overview of the proposed injury surveillance system

Table 4. Description of each component of the system

Component	Description
Central Database	This is the central database that keeps the records of individual injury cases.
Regional Database	Regional databases keep the records of several medical centres that are grouped together.
Sync Handler	Sync handler facilitates to update the central database with most current data of the regional databases even with a slow internet connection securely.
Information Processor	This processes and generates timely and important information from the collected data in central database.
Standalone Application	Standalone application is used to enter individual injury cases into regional databases.
Web Application	Web application makes the information that is generated by the Information processor available for the stakeholders.

3.4. HOW TO MINIMIZE THE COST

Cost of operation, maintenance, development and initial setup have been a major concern in the system design. Since the system is mainly aimed to function in low and middle income countries, system architecture is designed with the concept of minimum cost and minimum resources. The following is a list of methods that have been followed to minimize the operational, maintenance, development and initial setup cost.

1. Conceptually attaching several medical centres into groups, reduces the number of required computers and number of trained staff to operate the system.
2. Only the regional base medical centre of a group, needs to connect to the Internet regularly, this avoids the requirement of the Internet infrastructure for each and every medical centre.
3. Since the data entry application is designed as a standalone application, it reduces the usage of the Internet.
4. Standalone applications are light enough to run in normal computers.
5. The system is developed using only open source tools and software.

4. DISCUSSION

Currently, a prototype of the system has been successfully deployed in two major hospitals in Laos. And another 3 customized prototypes are being developed for Cambodia, Vietnam and Sri Lanka. Purpose of these prototypes is to study the effectiveness of the final system in real environments while starting collection of necessary data sets in advance to the final system deployment. A website has been published under the <http://www.wbiss.org> to provide more information on this research to the interest groups and people.

The proposed system is aimed to operate in low and middle income countries. The main significant feature in this system is the ability of running effectively in limited resources environments in low and middle income countries. Usage of minimum number of personal computers, utilization of existing slow speed Internet connections, simplicity of the user interfaces and minimum staffing requirement are some of the main features that distinguish this proposed system from the already implemented systems in the world.

Although the system is designed to run in minimum resources environments, it can run in resourceful environments more effectively. For an instance; a country which has a good Internet infrastructure and capable of spending some extra amount of money for other resources like personal computers and staffing, can setup computers and install the standalone data entry application in each and every medical centre. And, they can configure the system to synchronize with the central database several times a day, since there is a good internet infrastructure. Thus, the system architecture ensures the maximum deployability of the system in maximum number of countries. The system design follows the WHO injury surveillance guidelines which have been derived from the results of numerous surveys. Therefore, it adds an additional accountability on the system generated information, and on the system itself.

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