
DENTAL TRAUMA TRACKER: A MOBILE PHONE APPLICATION FOR THE EPIDEMIOLOGIC SURVEILLANCE OF DENTAL AND MAXILLOFACIAL TRAUMA

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Abstract

In the broad field of injury and traumatology, injuries affecting the maxillo-facial region have an important role: dental trauma (DT) makes up 35% of facial injuries, and 31-39% of dental emergencies are consequences of DT. Dental trauma is injury to the soft tissue as well as the teeth. Although in the majority of cases dental trauma is not fatal, it still may cause some long-lasting psychological or physical damage to the victims. Consequently, DT is recognised as a major dental public health problem worldwide. However, lack of data reduces the timeliness and effectiveness of dental trauma research. Thus the ‘Dental Trauma Tracker’ project was established to promote the development of research in dental trauma. The aim of this project was to implement a mobile phone-based application for the epidemiologic surveillance of dental and maxillo-facial trauma. The Dental Trauma Tracker application takes advantage of mobile phone data capture capabilities (text, photo, video, and audio) for epidemiologic surveillance of dental trauma. The initial work to activate larger scale, longer-term studies in the future is described. The goal in the initial stage is to present the development of a working prototype system collecting dental trauma data to provide an overview of the nature and extent of DT, letting researchers view and summarise the collected data, and make greater use of the data for improvements at a local level (e.g., educating on the best first aid, identifying high-risk locations and activities).

Keywords: teledentistry; mhealth; dental trauma

Introduction

In the last century, injuries surpassed disease as the leading cause of childhood mortality and disability and as the leading cause of childhood morbidity in both developed and developing countries.^{1,2} Unintentional injuries and intentional self-harm are among the top 10 leading causes of death in the U.S.³ Oro-dental trauma (DT), makes up 35% of head injuries³ and 31-39% of dental emergencies.⁴⁻⁸ In addition, most poly-traumatised patients having some form of oro-facial trauma.^{9,10} DTs are common in children, with up to a third of children experiencing some form of injury before they leave school. The injuries range from minor tooth fractures to more significant displacement of the teeth with or without damage to the surrounding bone and soft tissues. In addition, most poly-traumatised patients have some form of oro-facial trauma.^{9,10}

Consequently, DT is recognised as a major public health problem worldwide.¹⁰⁻¹² Besides the injury itself, there is damage to the physical integrity of the individual, which may have major long-term physical and psychological effects, as well as impacting on an individual’s quality of life.^{1,10,11} Additionally, dental injuries and their sequelae place a significant socio-economic burden on children’s families.^{1,10,13}

Overall, the prevalence of DT in the population varies, ranging from 6 to 34%, depending on the method of survey, survey populations, definitions of injury, etc.¹⁴ In some cases, the data indicates that falls and collision have been reported as the main causes of dental injuries, in particular falling and collision during playing (58.5%).^{14,15} However, most of the data on dental trauma are not representative of the population,^{13,14} therefore, not appropriate to fully

document the problem. Evidence indicates that, as with most non-fatal injuries, the majority of cases are not taken for evaluation and treatment.^{11,13} This selection bias influences the distribution of, and causation factors for DT.

Although it could be argued that minor injuries do not require treatment, the information available confirms that DTs tend to be neglected. Lack of information from the circumstances surrounding DTs, impedes the development of health promotion and prevention interventions. This general lack of data has been highlighted in several documents, including the WHO’s oral health reports.^{12,16,17} Thus, a major challenge for oral health care services is to improve the accuracy, completion and accessibility of the assessment of DT, as well as its diagnosis and the subsequent management of oro-dental injuries.

For these reasons, the development of an oro-dental trauma surveillance system (the ‘Dental Trauma Tracker’ project) is proposed whereby standard information associated with a DT episode can be entered using a Mobile application (App) to support on-site data collection and storage in a database, followed by interventions and follow-ups to facilitate evaluations of efficacy. This paper describes the development of a model with schools and other institutional catchments in mind to register oro-dental injuries. The trauma Dental Trauma Tracker is under development and will be field tested later in 2017. The

goal of this stage is to implement a working prototype system to collect dental trauma data and allow viewing and analysis of collected data.

System Requirements

The Dental Trauma Tracker application involves both a mobile application and a Web application. The mobile application is designed for general users (e.g., patients, teachers, supervisory staff and other nonprofessional users) to answer the questionnaire, while the Web application is used by researchers to manage the data and collect dental trauma reports. In order to enable a large group of users to access the application, the mobile App was developed on the Ionic framework and is fully cross-platform.¹⁸ Additionally, since this project requires the storage of patient’s reports so that researchers can work with the data in the future, a Client - Server - Database architecture was adopted. (Figure 1). Smartphone users can upload their reports to the server. The server will then store the reports to a noSQL database, MongoDB.¹⁹ Furthermore, researchers or administrators can review or download users’ reports via a web browser.

Mobile application

The data to be collected follows recommendations from the Centers for Disease Control and Prevention’s Minimum Essential Data Set for oro-dental trauma, which represent the standard format for dental trauma data collection. Data such as identifier and demo-

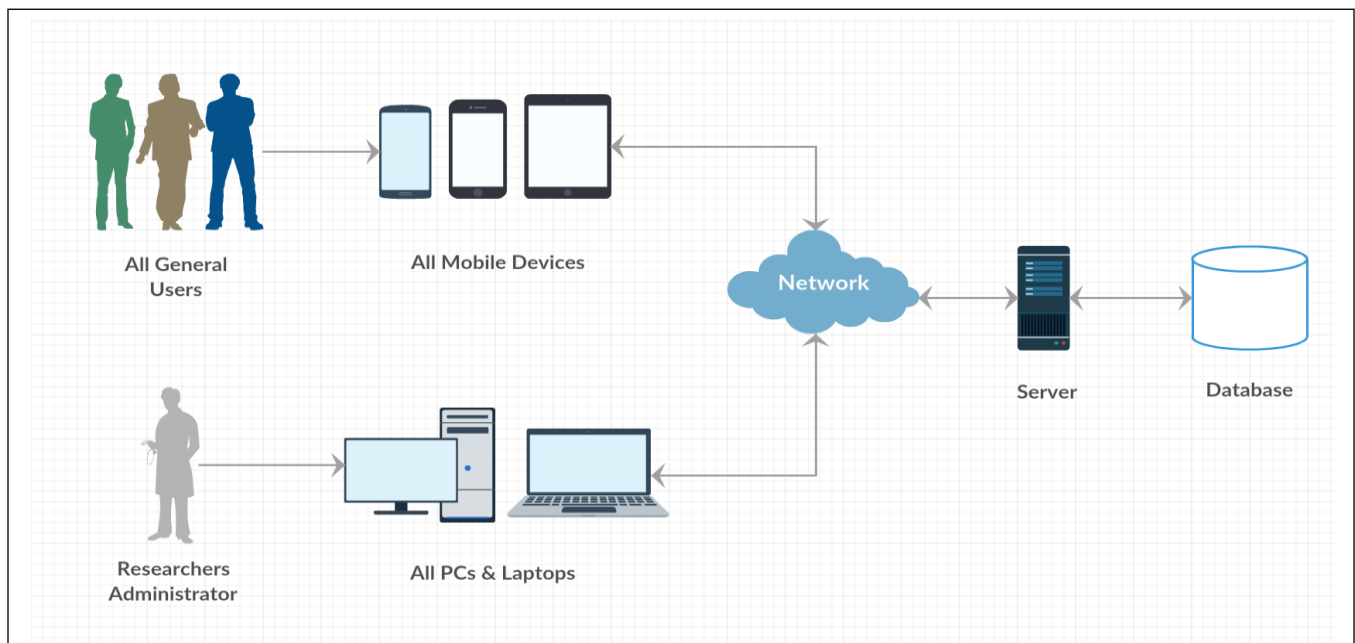


Figure 1. Overall system architecture.

graphics data, accident data (when, where, how), injury data (dentition and teeth affected, type of DT, soft tissues involved, etc.) will be registered.²⁰⁻²² (Figures 2 and 3) Given that the App was designed for general users the questions are easy-to-follow and no overly technical language is used. Users are able to select from a small library of representative injury photographs that most closely match their own case, and they can also upload photographs from their phone's file system and/or take photos of injuries using the in-built camera. (Figure 4)

It is important to note that, apart from emergency services where DT data has been traditionally collected, a victim may not turn to an emergency or dental facility so there are many other potential sources of data that may be useful for oro-dental injury surveillance purposes. In the future, the App will be made available through existing channels for trauma surveillance. The various sources of data to be used in this model include:

- Emergency services records.
- Hospital admission.
- Individuals.
- Health care providers, such as dentists and medical practitioners.

- Health clinics/community health centres; dental clinics specialising in paediatric dentistry.
- Primary and secondary school oral health /health care services.
- Faculty of dentistry.
- Gymnasiums, sport centres, community pools and aquatic centres.

The primary feature of the Trauma Tracker mobile App is providing access to the dental trauma questionnaire. After completing the questionnaire, the data and other necessary resources such as photos will be sent to the server to be stored in the database (Figure 1). At the same time, a copy of the report will be kept in the app so that users can view the report in the future. The Trauma Tracker App supports multiple platforms such as IOS and Android. Moreover, there is also a secure password-protected user login and registration system to ensure privacy and security.

The [Trauma Tracker website](#) is designed for researchers/administrators to create and manage dental questionnaires, as well as to collect user reports for further analysis. To enable this App to be used internationally, researchers can create questionnaires in up to eight languages. Since different user groups will have different levels of oral health understanding,

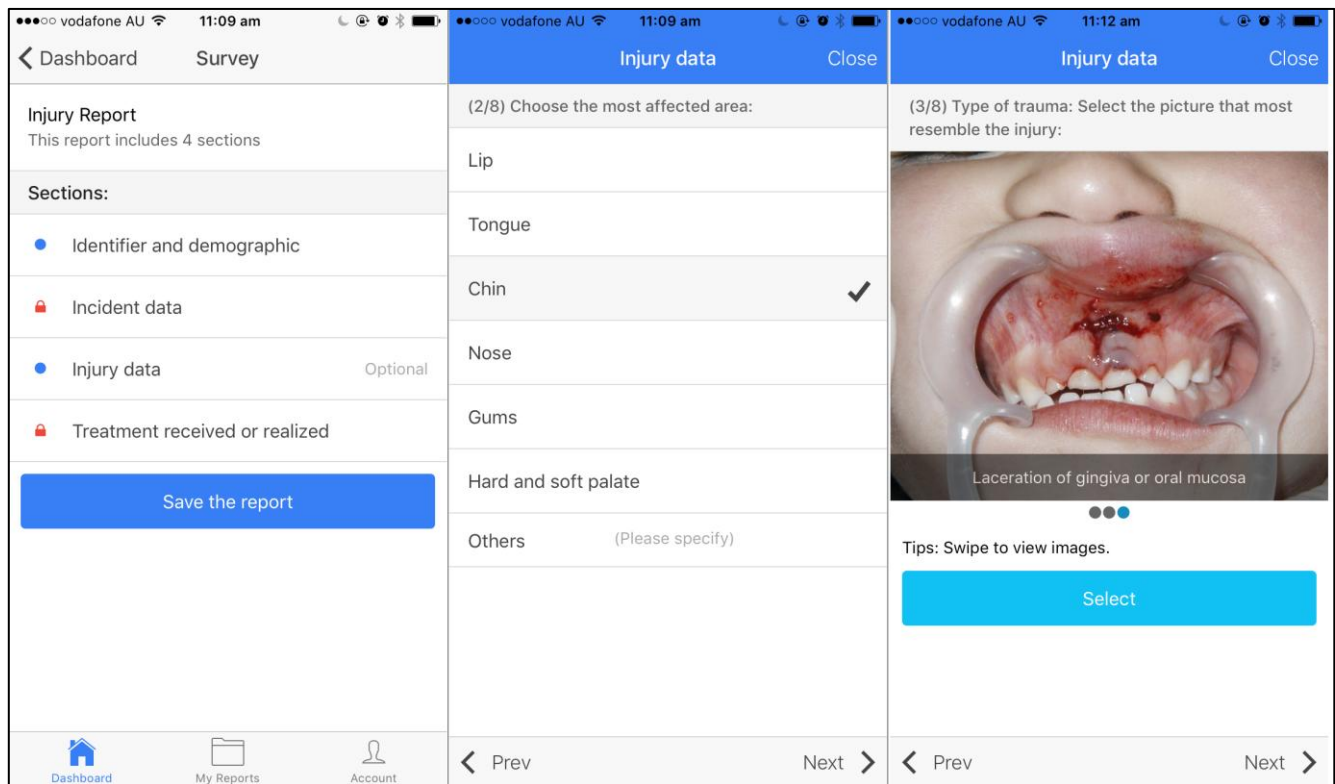


Fig 2. Trauma tracker App dashboard.

Fig 3. Injury data (Soft tissues).

Fig 4. Dental trauma Injury data section.

researchers can create questions aimed at different user groups, such as laypersons and oral health professionals. Since different user groups will have different levels of oral health understanding, researchers can create questions aimed at different user groups, such as laypersons and oral health professionals.

Web application

The web application gives researchers the ability to view both individual reports and the overall report. (Figure 5) For the purpose of analysing the data, all the reports can be downloaded as a table/list form. This will allow the generation of epidemiological indicators such as the incidence rate of TD, determine the distribution of the injury by gender, age groups, location, opportunity of events and generate risk maps in csv format. Moreover, as the system involves patient information, the application adopts the HTTPS protocol to secure the communication network.²³ Our system also uses an encryption algorithm to protect the data.²⁴

Discussion

Using public health surveillance, trends can be established and the scope and extent of health con-

ditions documented, with “timely dissemination of these data to those who need to know”... “to reduce morbidity and mortality and to improve health”.^{21,25}

An injury surveillance system can provide the insights needed for the identification of specific socio-demographic predictors of oro-dental trauma. Knowledge gained of the use protective gear, the circumstances in which injuries occurred, treatment received, etc. will enable more efficiently targeted population-based health education, prevention, and management approaches. This information will allow for the development of health promotion, guidelines, policies and legislation aimed to create safer environments to help prevent accidents and violence; and facilitate cooperation and coordination of work between specialists in the field and public/private sectors in injury prevention.

A mobile phone-based communication data collection application for epidemiologic surveillance of the dental trauma may involve actors who are not normally involved (e.g. by school teachers). This would assist the gathering of DT information at a local level to provide an overview of the nature and extent of DT in these environments, and greater use of the data locally: for example, educating on the best first aid and identifying high-risk locations and activities at

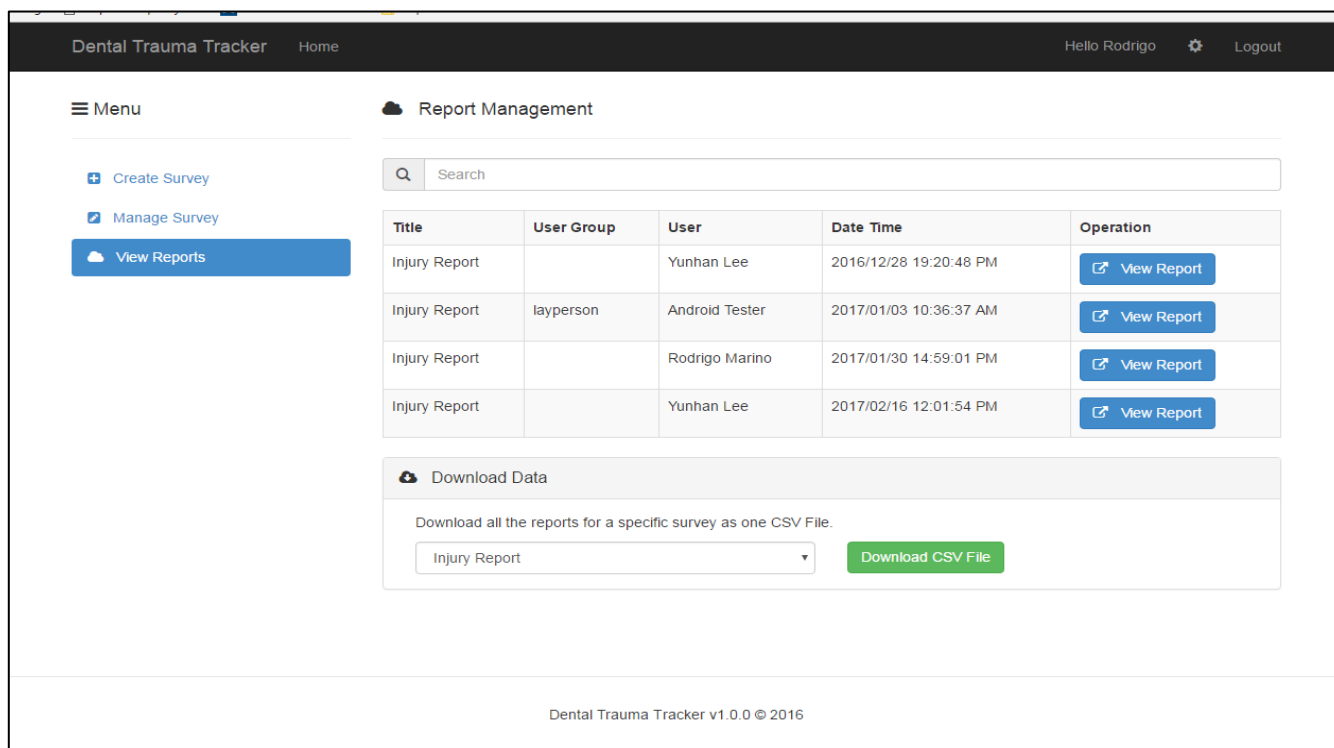


Figure 5. Dental trauma report management interface.

schools. These data would provide the basis for better clarifying potential risk factors for oro-dental trauma and identify those most at risk. It would also provide information for the correct assessment of the treatment outcome as well as evaluation of the effectiveness of health promotion and disease prevention measures, and the economic burdens that result from various causes of injury.¹⁷ The proposed surveillance system should be viewed as one component of a larger system of public health trauma surveillance. This will allow for a common-risk approach, as most violence and accidents are also the cause of other injuries and/or death.²² It is expected that, in the future, a real-time communication feature can be added to this system. This would enable live consultation with a dental trauma consultant to assess the trauma and receive treatment suggestions.

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Conflict of interest. The authors declare no conflicts of interest.

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