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Smart phone based medical record software for short term surgical missions

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Abstract
Short term medical/surgical missions (STMMs) are a common approach to address the limited access to surgical and anesthesia care in much of the under-resourced world. Documentation on surgical missions offers both a challenge and an opportunity to improve quality and safety of care provided. We describe a novel open-source electronic health record (EHR) software that addresses many of the limitations and safety concerns that currently exist in EHRs used for STMMs. It is usable in austere environments without internet access and is flexible to meet the needs of various types of projects. It contains unique safety features for patient identification with QR bar codes and clearly defined mechanisms for follow up and limitations of duplications of care. Documentation focuses specifically on surgical and perioperative care for short term surgical missions as opposed to medical missions. The software is smart phone-based without the requirement of tablets or laptop computers intended for use at point of care, but maintains the ability to complete post-mission quality and outcomes analysis through exporting data to spreadsheets. The scope of this software is focused specifically for surgical missions, but the open-source and collaborative nature allow for flexibility in specific requirements and details for different types of missions. This open source EHR software has unique accessibility and safety considerations, and facilitates both in-mission surgical care, ongoing follow up, and post hoc mission analysis.

Keywords Global health · Short term medical/surgical missions · Open-access electronic health records

Abbreviations

EHR	Electronic health record
STMMs	Short term medical/surgical missions
LMICs	Low-and middle-income countries
PWA	Progressive Web Applications
DOB	Date of birth
ASA Class	American Society of anesthesiology physical status classification
OR	Operating room

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1 Introduction

Considerable effort and funding are put into short term medical and surgical missions (STMMs) to help address the limited access to surgical and anesthesia care in low- and middle-income countries (LMICs), however most STMMs have no objective means of measuring performance, impact, or sustainability [1, 2]. Collaboration and sharing of data from individual surgical missions is limited, and seriously limits the ability to assess or improve quality of surgical care provided on a larger scale [3]. Solutions such as utilization of Electronic Health Records (EHRs) have been suggested for improving safety, record keeping and limiting duplication of care, facilitating follow-up, and assessing interventions on STMMs [4, 5]. However, the use of EHRs in STMMs is often overlooked and rarely published for peer review or discussion [6].

A 2017 review of EHRs specifically for use on STMMs in LMICs found two publications, the first about the utilization of an iPhone application, iChart, in the disaster response to the Haiti earthquake in 2012, and the second from 2004 about the utilization of a Personal Digital Assistant handheld device and computer based EHR for ambulatory care of patients in a clinic in Kenya [6–8]. A supplemental investigation was completed summarizing the available EHRs in a table regarding their scope, ownership, infrastructure, cost, and other details [8]. Only a few of the reviewed EHRs are currently available and operational (Open MRS, Notesfirst, fEMR, Vitro). These EHRs largely follow the same patterns with some variation; most focus on care provided in a medical clinic-style of practice, with a traditional EHR combined with clinical support tools based off best practices for EHRs in high-income countries [9]. In terms of accessibility, some EHRs are open source and free, while others are proprietary and carry fees limiting ability to adequately evaluate and understand the entire landscape of available EHRs [10]. Content of EHRs for STMMs are often designed following a combination of the preferences or needs of individual projects, giving significant opportunity for improvements and collaboration with recently developed validation tools [11].

The needs for documentation on a surgical mission are different than the needs for a medical mission. Surveys have shown that surgeons believe EHRs allow for improved quality of care and improved productivity when documentation was user-friendly and the responsibility of record-keeping was shared across role groups [12, 13]. Some organizations providing surgical care in LMICs have implemented EHRs at point-of-care, such as Operation Smile using a laptop and tablet-based EHR, but it is still common to have some combination of paper charts and generic electronic database usage for surgical missions [11].

Our intention is to improve safety and quality of care on Short Term Surgical Missions through the use of an open-source her with unique safety tools, designed for surgical missions, with clear mechanisms for facilitating follow-up care and outcomes, utilizing technology commonly available to anyone with a mobile device with periodic access to the internet. With this context in mind, we offer up our program for description of EHR specifically for short term surgical missions: eMission.

2 Methods

eMission is a web-based open-source electronic health record and database record keeper. The program and data are loaded during initial access to the website when internet is available. From that point forward, content can be accessed and added with or without internet connection. When the network is available, it is periodically queried to refresh code and synchronize the changes to content on a central encrypted database. The source code is free and open to the public and meets Progressive Web Applications 'PWA' criteria. eMission is platform-agnostic (e.g. iPhone, Android, tablet, laptop), requiring only a web browser.

On the web-application, patients identified with a picture, name, or date of birth (DOB). A print-out is formed for each patient that includes their picture, name, DOB, and a QR barcode (Fig. 1). Bar code scanning with any smart phone's camera will bring up the chart of the patient including pictures and past records.

Information on each patient is split between sections navigated on a home-screen accessed via demographic search or QR code scanning. The first is "Demographics" such as photographs, name, DOB, contact info, and local contact. Next is "Medical History" including diagnoses, sex, weight, height, allergies, American Society of Anesthesiology (ASA) Physical status, medications, past medical history, and other details relevant to surgical care. Following this is the "Notes" section. This contains the longitudinal information on patients, including initial evaluations,

Name	Mr Smith
Complaints	
Procedure	Enter new procedure
Length	hr
Surgeon	
ASA	

Age	14.2 years
Sex	
Weight	undefined kg
Allergies	
Meds	
Equipment	

Fig. 1 Identification*

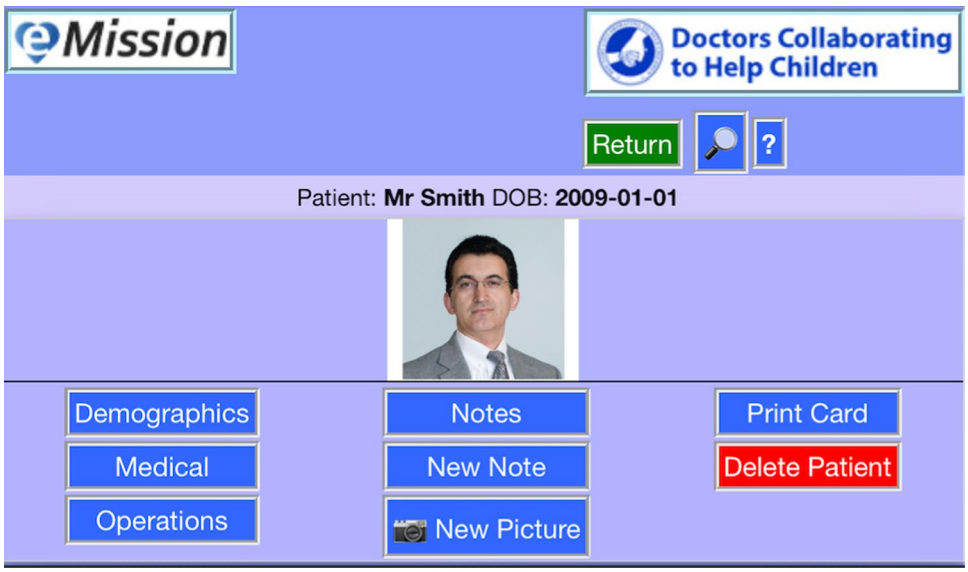

Fig. 2 Home Page*. *Picture is one of the authors of this paper, the supplied details are fictitious)

operation notes, medications prescribed, referrals, post-operative instructions, and follow up visits, all with the ability to add new notes and pictures (Fig. 2).

A separate section entitled "Operations" is available that shows all scheduled and completed operations/procedures. Information regarding the patient, surgeon, procedure, date and timing, and the equipment used is available in this section as well as in the search bar available at the top of the website. In this section, specific details on the operation are included such as operative time, operative note, anesthesia type provided, medications prescribed, post-operative follow up and referral plans.

Where supported by phones, voice-to-text is available, as well as pictures capture and upload. The web application also allows for post-hoc analysis and data archiving without manually searching through individual charts via export in universal spreadsheet file format.

Follow-up notes and images as well as referrals can be uploaded by local physicians & clinicians with access to a smart phone or web-browser, these notes can be viewed remotely and are included in the medical record for future missions or follow-up.

2.1 Economic costs

The software is free and open-source for anyone to use (although access has to be granted to see patient information), and the costs associated are mainly related to server costs and mission specific modifications.

2.2 Privacy considerations

While the system is aimed at ease of use in poorly connected environments, there are moderate safeguards on data. Data is encrypted and has secure transmission, authentication, and storage. Data is certainly safer in this context than on loose-leaf papers or paper charts held by individuals (the norm for most surgical missions). However, some risk for data loss or breach of privacy does exist and further security enhancements are being explored such as two-factor or biometric authorization for access to data or other database storage solutions.

2.3 Data availability statement

No datasets were generated or analyzed during the current study.

3 Discussion

Utilization of electronic health records at point-of-care on STMMs has had slow uptake, and significant obstacles exist for their broad implementation, but the promises of improved quality and safety make it a worthy endeavor [10, 11]. Current available open-source electronic health records for short term medical missions have limitations in their safety features at point-of-care, their relevance to surgical missions versus medical missions, facilitation of post-op/follow-up care, and ability to perform post-mission analysis and data interpretation. Born out of a desire to improve the safety and quality of care that is delivered on Short Term Surgical Medical Missions while keeping simplicity at the center of its implementation, we offer up our experience with such a program on STMMs: eMission.

This program is an open-source database and record keeping program that seeks to address the need for clear communication and collaboration between providers, a way to keep track of patients, cases, and equipment, and a way to keep a visual record of injuries and documentation of follow-ups. This program has been tested and utilized successfully for various STMMs including surgical burn and reconstructive missions for children in Ukraine, Peru, and Colombia.

Patient identification is a significant concern in providing care for patients that speak a different language or have varying levels of literacy. This concern can be simply addressed with printed cards containing basic demographic information and scannable QR Bar code that can be physically carried by patients; this method has a built-in safety mechanism that allows for multiple identifiers (picture, DOB, QR Bar code scan, name) that help minimize risk of errors in the setting of any language/literacy barriers. This also allows for easy access to records and prior documentation at point-of-care. Past medical history, allergies, and prior surgical history including images and prior follow-up can be accessed on a mobile device in real time in the Operating Room (OR) or wherever care is being provided.

Thought was given to how to make meaningful use of the EHR relevant to surgical missions. Simplicity is of utmost important when supporting clinicians carrying out surgical care in austere locations. Organizing patient information between basic sections and navigating by simple buttons on a home-screen allows for clinicians to start using the software with minimal to no training. Quick and reliable access to necessary patient information in real-time without concern of the reliability of internet access is crucial. Patients should be found easily, documentation should be simple with a combination of text and check boxes, voice-to-text utilization when available on mobile-device, and the ability to upload photos and attachments with a single click for efficiency allows for streamlined documentation. Mobile phone based design allows for real time point of care use in pre-op, in the OR, and on follow-up.

Facilitating follow-up with text fields dedicated specifically for follow-up instructions, and easy collaboration with local physicians having access to records and the ability upload images and notes helps to improve patient care and limit unnecessary investigations or duplication of work. While many STMMs rely on paper charts located in a single location with limited capability to share this information with multiple clinicians across multiple sites, an electronic health record allows for centralized and easily accessible information to be shared among stakeholders. Documenting interventions

and follow ups clearly serves as a precursor to allowing for quality assessments or post-hoc mission analysis without increasing clinician workload. Exporting of data to spreadsheets and/or databases allows for the facilitation of outcomes analysis and potentially publication on the care provided on these surgical missions.

Anticipated difficulties with implementing eMission in STTMs are mostly focused on familiarity with the software and the timing required to learn a new program. It is our hope that the simple text and image based and mobile-phone appropriate design allow for ease of use and learning of program with minimal training required. The source code is available to all and it is our hope that others will review the design and offer unique solutions and ideas on how to improve the program to better support the mission.

The goals with the eMission program were simple, we wanted a program that is smartphone/mobile based for specifically perioperative use in austere environments, a program that has computer-based data storage for ease of entry and post-hoc analysis at later dates, open source for collaboration and flexibility to meet the needs of a variety of projects, and that it would be designed utilizing a user friendly interface and patient safety features such as bar codes/QR codes for patient identification and record finding at point-of-care. Our hope for the future of STMMs is that a communal focus on quality and safety interventions will allow us to provide better care for our patients.

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Author contributions PA contributed all of the source code, website design, and is an author of this manuscript. CB contributed as an author of this manuscript. GF contributed to the design and implementation of the software, and is also an author of this manuscript.

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Data availability All of the source code for the program is open access and readily available.

Declarations

Ethics approval and consent to participate No patient data or information was used for the creation of this manuscript.

Consent for publication The appropriate involved parties gave consent for publication.

Competing interests The authors declare that there are no competing interests.

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