

A prototype mobile application for triaging dental emergencies

Corey D. Stein, MS; Xiang Xiao, BS;
Steven Levine, DMD; Titus K.L. Schleyer, DMD, PhD;
Harry Hochheiser, PhD; Thankam P. Thyvalikakath,
DMD, MDS, PhD

The American Dental Association's Principles of Ethics and Code of Professional Conduct states that "dentists shall be obliged to make reasonable arrangements for the emergency care of their patients of record."¹ Immediate assessments are vital for patients experiencing oral trauma, orofacial pain, infections, or similar conditions; however, access to care often is limited by distance and time.² Many dental emergencies

occur during the weekend and evening hours when dental offices are usually closed.³⁻⁷ With few options, many patients seek initial treatment at medical emergency clinics where physicians treat symptoms and may not address causes.^{5,8} Emergency departments have experienced a surge in patient dental emergency visits for which most patients remain untreated and are referred to their dentist for proper care.^{2,9-12} As a result, unnecessary hospital costs accrue while patients remain in discomfort for extended periods. In dental practices, dentists must deviate from routine work flow when caring for patients with emergencies. To prepare for these, many dental practices use telephone-based services to manage out-of-office emergencies. Although effective for notifying dentists of a problem, these services generally do not detail the urgency of a patient's needs nor do they provide adequate information to estimate the time and resources for emergency care effectively.^{13,14}

ABSTRACT

Background. Evidence suggests that dental emergencies are likely to occur when preferred care is less accessible. Communication barriers often exist that cause patients to receive suboptimal treatment or experience discomfort for extended lengths of time. Furthermore, limitations in the conventional approach for managing dental emergencies prevent dentists from receiving critical information before patient visits.

Methods. The authors developed a mobile application to mediate the uncertainty of dental emergencies. The development and study consisted of a needs analysis and quality assessment of intraoral images captured by smartphones, prototype development, refining the prototype through usability inspection methods, and formative evaluation through usability testing with prospective users.

Results. The developed application successfully guided all users through a series of questions designed to capture clinically meaningful data by using familiar smartphone functions. All participants were able to complete a report within 4 minutes, and all clinical information was comprehended by the users.

Conclusions. Patient-provided information accompanied by high-resolution images may help dentists substantially in predicting urgency or preparing necessary treatment resources. The results illustrate the feasibility of patients using smartphone applications to report dental emergencies. This technology allows dentists to assess care remotely when direct patient contact is less practical.

Practical Implications. This study's results demonstrate that patients can use mobile applications to transmit clinical data to their dentists and suggest the possibility of expanding the use of mobile applications to enhance access to routine and emergency dental care. The authors addressed how to enable patients to communicate emergency needs directly to a dentist while obviating patient emergency department visits.

Key Words. Technology; software; emergencies; communication; public health and community dentistry; informatics; access to care; patient relations; computers; electronic data exchange. JADA 2016;■(■):■-■

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Teleconsultations using mobile technologies are a strong candidate for enhancing inadequate patient-provider communications in medical fields.^{15,16} Ubiquitous smartphone use among most demographic groups has created opportunities for clinicians to deliver various health-related interventions in real time by using universally available capabilities.^{17,18} Because emergencies often are subject to delays in care, the smartphone may provide the ability to triage dental patients remotely before conducting chairside assessments. For example, the high-resolution camera on a smartphone permits visual interpretations of patient cases and avoids misleading verbal accounts native to telephone-based systems. The functions of smartphone cameras (autofocus, antimovement, and white balance) permit fine detail and color in dental images.¹⁹ Transmitting these images appended with patients' symptoms to a dentist could improve patient-provider communication in real time and enable dentists to make more timely treatment decisions.

Dentistry has begun to explore mobile technologies for a variety of purposes²⁰ as the smartphones' capabilities for information capture and transmission continue to improve. To date, dental mobile applications have included various functions such as data collection,²¹ symptom checking,²² and photographing and transmitting high-quality dental images.^{19,23} In addition, Namakian and colleagues²⁴ have shown that dentists can assess patients remotely, as well as in person, if accurate information is available. Therefore, with proper information captured remotely, clinical decision making such as treatment plans and resource allocations could be supported. In this article, we address the development of a smartphone application and how it can enable patients to communicate emergent needs directly to a dentist with the goal of obviating prolonged treatments and enduring emergency department visits. For a health application to be effective, we first need to determine the technical feasibility of patients being able to use the application before determining how a dentist may choose to use the data.

Our goal was to explore the feasibility of prospective patients using a smartphone to capture clinical information that helps dentists make fundamental clinical decisions when they cannot examine them directly. We explored potential users' experiences, leveraging the camera and other means of data entry (voice or text) to develop a prototype application for exchanging information about dental emergencies between patients and dentists. We evaluated the prototype to determine the extent to which the application supported information capture by potential users involved in a simulated emergency.

METHODS

The study consisted of 4 phases: needs analysis and quality assessment of intraoral images captured by smartphones,

prototype development, refining the prototype through usability inspection methods, and formative evaluation through usability testing with 20 prospective users. **Figure 1** provides a detailed description of these phases, which are described in the following sections.

Initial development. Needs analysis. Before starting development, we spoke to dentists to understand their needs when patients seek care in emergency situations. Two dentists (T.P.T., S.L.) who worked in the emergency clinic at the School of Dental Medicine at the University of Pittsburgh identified the common conditions for which their patients typically seek urgent care. For each condition, they compiled a list of information they typically review when providing care for these patients. With the request for visual aids, the research team independently evaluated images from different smartphone models, as well as the device used in the study, and reached the consensus that the quality of displaying and identifying oral conditions is sufficient across different manufacturers.

Prototype development. We first developed a paper prototype to design how information would flow through the application and incorporated all the necessary information identified by the dentists during the needs analysis. We included clinical questions intentionally written at an elementary reading level. We designed data entry by using conventional smartphone data-input methods such as text, radio-button selections, voice recording, and capturing and appending photographs. For instance, the prototype application permits users to type additional comments about their symptoms, as well as the ability to leave a voice message for dentists to respond to. The free-speech audio input provides an additional method to report the incident to a provider. In contrast to traditional telephone services, transmitting images through mobile devices allows visual inspection of high-definition images and increases the ability to evaluate care remotely.

Design evaluation. We refined and developed a high-fidelity prototype and evaluated it by using 2 usability inspection methods²⁵: cognitive walk-through to identify potential usability problems in the application's functionality²⁵ and heuristic evaluation to evaluate the extent to which the application's screen design conformed with established design principles.²⁶ We then revised the prototype interface on the basis of the results of these inspections.

We used the cognitive walk-through to determine how a novice user would navigate through the application.²² The developer created and evaluated the application's instructions to complete a task to determine any difficulty that a novice could experience. Following the

ABBREVIATION KEY. HCI: Human-computer interaction. QUIS: Questionnaire for User Interaction Satisfaction.

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