

# Mobile application-based guidelines to enhance patient care and provider education in trauma and acute care surgery

Nicholas A Hakes ,<sup>1</sup> William C Kethman,<sup>2</sup> David Spain,<sup>1</sup> Aussama K Nassar<sup>1</sup>

<sup>1</sup>Section of Acute Care Surgery, Department of Surgery, Stanford University, Stanford, California, USA

<sup>2</sup>Department of Surgery, University Hospitals Research in Surgical Outcomes and Effectiveness Center (RISES), Cleveland, Ohio, USA

## Correspondence to

Mr Nicholas A Hakes, Section of Acute Care Surgery, Department of Surgery, Stanford University, Stanford, CA 94305, USA; hakesn@stanford.edu

This project was scheduled to be presented as an oral podium presentation at the Trauma Association of Canada; Halifax, Nova Scotia, Canada; March 2020 (canceled).

Received 1 April 2020  
Revised 28 May 2020  
Accepted 26 June 2020

## ABSTRACT

**Introduction** Providing up-to-date, universally accessible care guidelines and education within a quaternary care center is challenging. At our institution, trauma and acute care surgery guidelines have historically been published using a paper-based format. Mobile application-based guidelines were developed to address the shortcomings of paper-based guidelines.

**Methods** We assessed the utility, usability, and satisfaction of healthcare providers towards paper-based versus mobile application-based guidelines. A survey was administered to providers within the emergency department and intensive care unit.

**Results** Fifty of 137 providers responded (36.5% response rate). Nearly half (47.4%, 9 of 19) of those who received a copy of the paper-based guidelines lost the guidelines at least once. Regarding usage of the mobile application-based guidelines, 92.6% (25 of 27) were aware of the application; 92.6% (25 of 27) considered the application comprehensive, 85.2% (23 of 27) thought the application was organized, and 66.7% (18 of 27) thought the application was easy to use. Additionally, 88.9% (24 of 27) found the application moderately, very, or extremely helpful and 85.2% (23 of 27) judged the application moderately, very, or extremely necessary. Overall, 88.9% (24 of 27) were satisfied with the application and indicated likeliness to recommend to a colleague. Seventeen of 27 (63.0%) agreed or strongly agreed that the application improved their provision of trauma and acute care.

**Conclusion** This survey demonstrates positive usability, utility, and satisfaction among trauma healthcare providers with the mobile application-based guidelines. Additionally, this quality improvement initiative highlights the importance of having comprehensive, organized, and easy-to-use trauma and acute care surgery guidelines and targeted educational materials available on demand. The successful transition from paper to mobile application-based guidelines serves as a model for other institutions to modernize and improve patient care and provider education.

**Level of evidence** IV.

## INTRODUCTION

With nearly 3 billion smartphones and 3 million mobile applications in existence, mobile technology is revolutionizing healthcare.<sup>1</sup> Medical professionals are increasingly incorporating mobile technology into clinical practice, research, and education. By 2022, an estimated 98% of physicians and 97% of

nurses will be using mobile devices at the point of care.<sup>2</sup>

The acuity and highly protocolized nature of trauma and acute care surgery catalyzed the need for a mobile application to assist in decision-making at the point of care. While a small number of mobile applications for trauma guidelines exist, provider adherence with established guidelines from institutions and professional organizations is highly variable.<sup>3–12</sup> Additionally, continuous quality improvement means that protocols are frequently changing, inhibiting trauma providers from remaining up to date on the most recent guidelines.<sup>3</sup> At Stanford Health Care, trauma and acute care surgery guidelines have historically been published in a paper-based format. An updated copy is printed every 2 years—limiting our ability to update guidelines in real time.

The primary goal of this quality improvement project was to develop mobile application-based guidelines as a comprehensive, organized, and easy-to-use alternative. The platform was designed to provide current, evidence-based protocols, educational materials, active research opportunities, and links to frequently used resources.

## METHODS

### Needs assessment

The Stanford Health Care trauma medical director, trauma faculty, trauma leaders from different disciplines, and resident physicians unanimously agreed on the need for mobile application-based guidelines.

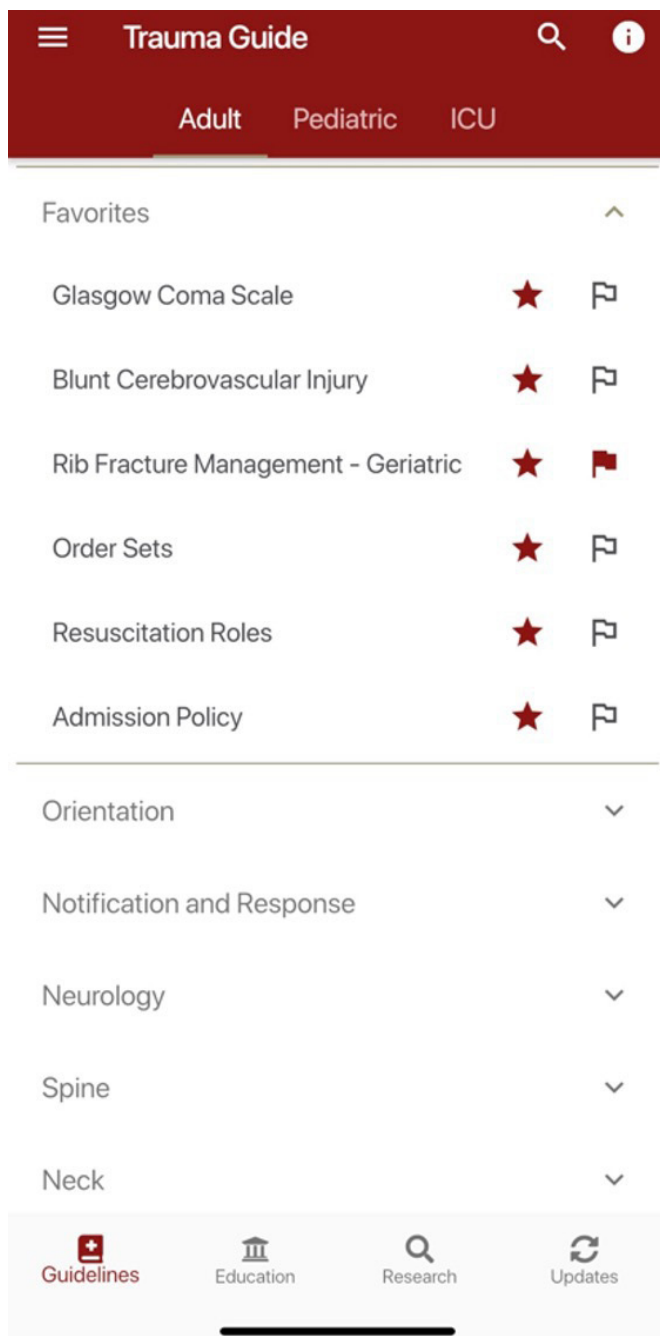
We evaluated the needs of emergency medicine, trauma, critical care, and acute care surgery providers via electronic survey. The electronic survey was designed to assess the usability, utility, and satisfaction among healthcare providers with the mobile application-based guidelines. The anonymous, 22-question survey used a 5-point Likert scale and was analyzed using descriptive statistics. The survey was administered to providers within the emergency department and intensive care unit: paramedics, nurses, advanced practice providers, resident physicians, fellows, and attending physicians. The Stanford University Institutional Review Board exempted the *anonymous* survey as a quality improvement initiative.

### Application development

Development of the mobile application-based guidelines was performed by a resident physician at our institution using Flutter (<https://flutter.dev>),

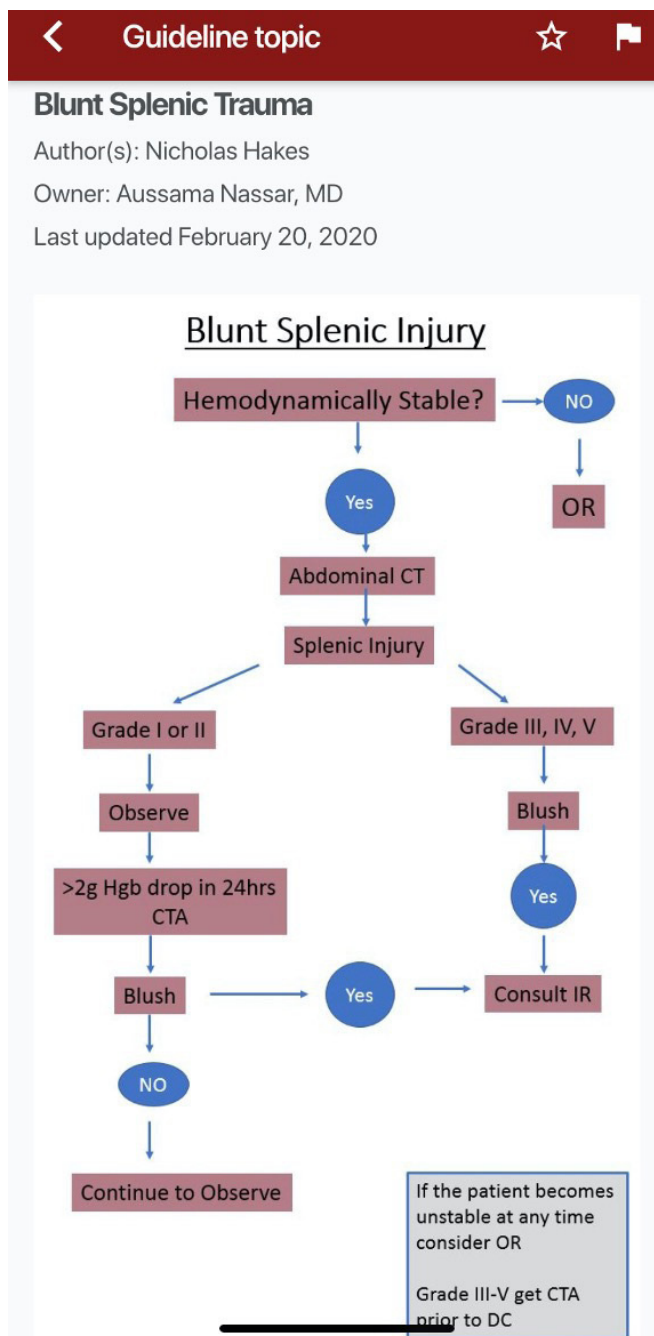
© Author(s) (or their employer(s)) 2020. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

**To cite:** Hakes NA, Kethman WC, Spain D, *et al.* *Trauma Surg Acute Care Open* 2020;**5**:e000479.



**Figure 1** Guidelines tab of mobile application-based guidelines, displaying general organization of topics, including favorited topics and flagged topics for adult, pediatric, and intensive care unit patients.

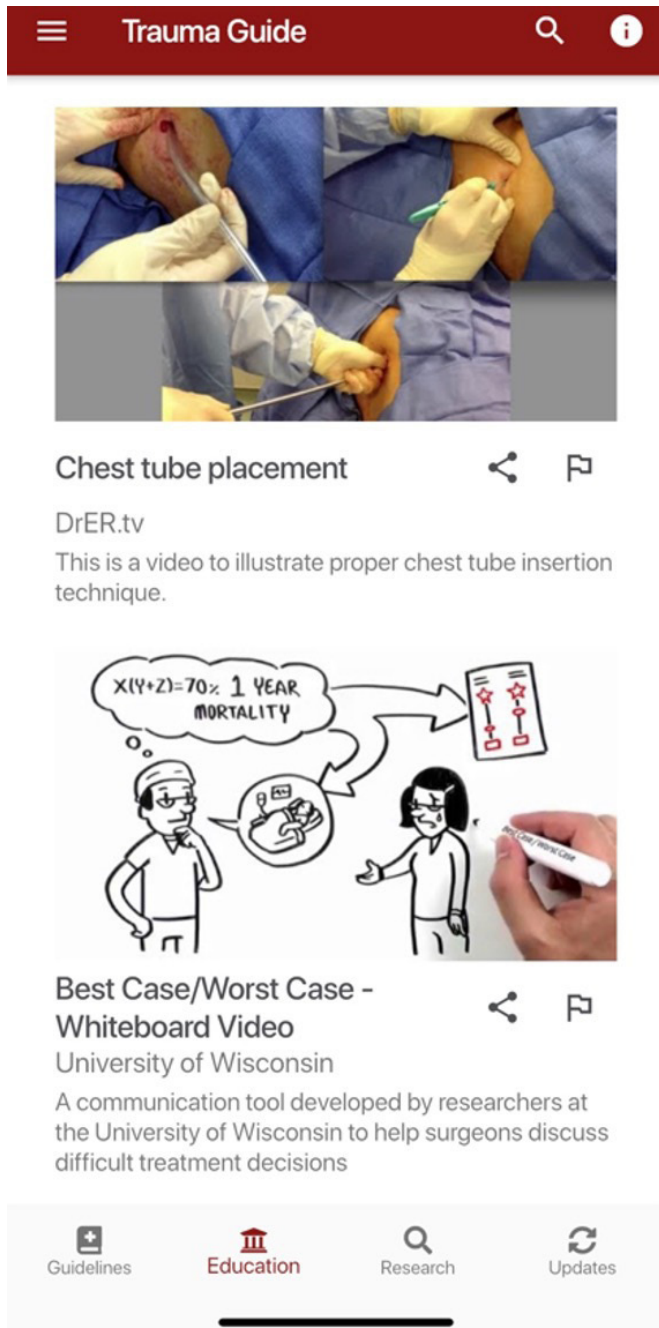
a cross-platform mobile, web, and desktop user interface toolkit developed by Google; Firebase (<https://firebase.google.com>), a real-time database management solution; and Flamelink.io (<https://flamelink.io>), a Firebase content management service. The aforementioned tools provided the necessary framework for a cross-platform mobile application that enabled rapid prototype to production development. Once the application was developed, a team of resident physicians and medical students migrated the content from the paper-based guidelines to the mobile application-based guidelines. Content was re-reviewed by an independent physician for accuracy via independent review of each topic. The components and layout of the mobile application-based guidelines were discussed and decided at our



**Figure 2** Blunt splenic trauma topic, including decision-making flowchart and injury grading scale.

monthly trauma quality improvement meeting. Figures 1–3 illustrate the design and organization of the current application version.

The mobile application-based guidelines, named Trauma Guide, are publicly available on both the Apple App Store (<https://apps.apple.com/us/app/trauma-guide/id1462123331>) and the Android App Store (<https://play.google.com/store/apps/details?id=com.stanfordtrauma.guide>). The mobile application-based guidelines were broadly advertised to providers within Stanford Health Care and the prehospital system. Trauma Guide is also available to emergency medical services, such as local fire departments and air ambulances, and hospitals that frequently transfer patients for a higher level of care.



**Figure 3** Education tab of mobile application-based guidelines, displaying educational videos on how to insert a chest tube and how to discuss difficult treatment decisions.

## RESULTS

Fifty of 137 providers responded (36.5% response rate), though 23 submitted partial responses. All responses to a particular question were analyzed; the partial responses led to differing denominators. The majority of providers (37 of 46, 80.4%) were resident physicians. Of the respondents, 70.4% (19 of 27) were aware of the paper-based guidelines, with 55.6% (15 of 27) having received a copy. Over half (60.0%, 9 of 15) of those who received a copy lost the guidelines at least once. When asked how many times the paper-based format was referenced in the past 6 months, responses ranged from never to more than 100 times.

Regarding usage of the mobile application-based guidelines, the mobile application has been actively used by a total of 203 individuals, 64 (31.5%) and 139 (68.5%) on Apple or Android devices, respectively, within the last 30 days as of March 21, 2020. Of surveyed users, 92.6% (25 of 27) were aware of the application, with 66.7% (18 of 27) using the application sometimes or often. A large majority (25 of 27, 92.6%) considered the application comprehensive, whereas 85.2% (23 of 27) thought the application was organized and 66.7% (18 of 27) thought the application was easy to use. Additionally, 88.9% (24 of 27) found the application moderately, very, or extremely helpful and 85.2% (23 of 27) judged the application moderately, very, or extremely necessary. Overall, 88.9% (24 of 27) were satisfied with the application, with 63.0% (17 of 27) rating the quality above average and 88.9% (24 of 27) indicating likeliness to recommend to a colleague. Seventeen of 27 (63.0%) agreed or strongly agreed that the application improved their provision of trauma care. The application contains 105 topics which were viewed approximately 6000 times. The most viewed topic, which can be employed to target education, was C-spine evaluation with approximately 400 views.

## DISCUSSION

Trauma and acute care surgery guidelines have historically suffered from inadequate availability and accessibility. Paper-based guidelines are frequently misplaced and not readily available at the point of care. With an updated copy being printed every 2 years, established and rotating trauma providers alike are challenged to remain up to date on the most recent guidelines. We found that mobile application-based guidelines addressed the shortcomings of paper-based guidelines.

There is a paucity of literature on the design and implementation of mobile application-based guidelines in clinical practice. However, the principal finding of our study—that mobile application-based guidelines are helpful and facilitate the provision of patient care—is consistent with current research. A recent study concluded that urological mobile-based guidelines could be improved by increased adherence to recommendations based on up-to-date evidence, especially for the management of recurrent urinary tract infections.<sup>13</sup> The findings support our commitment to including and continuously updating the mobile application-based guidelines with current recommendations and evidence-based guidelines. Another recent study found that medically accurate content and sufficient usability are imperative for providers addressing complex situations like cardiac arrest.<sup>14</sup> For mobile application-based guidelines designed for use in time-sensitive situations, such as trauma resuscitation, the configuration and operation of the mobile application-based guidelines must be highly intuitive and accessible. There is no time to first become acquainted with the software. Our team recognized the importance of high usability, as demonstrated by the 85.2% (23 of 27) who considered the application organized and the 66.7% (18 of 27) who considered the application easy to use. Furthermore, the mobile application was designed such that the guidelines were available independent of internet connectivity and across mobile platforms. The importance of accessibility across platforms is witnessed by over 68.5% of providers accessing the application from Android devices.

While our study is limited by a small response rate and partial responses, the results show that mobile application-based guidelines facilitate access to clinical guidelines, research, and education within emergency medicine, trauma, critical care, and acute care surgery. This survey demonstrates positive usability, utility,



and satisfaction among trauma healthcare providers with the mobile application-based guidelines. Additionally, this quality improvement initiative highlights the importance of having comprehensive, organized, and easy-to-use trauma and acute care surgery guidelines and targeted educational materials available on demand. The successful transition from paper to mobile application-based guidelines serves as a model for other institutions to modernize patient care and provider education. Further study is recommended to evaluate whether mobile application-based guidelines increase guideline adherence and improve patient outcomes.

**Contributors** NAH: application development, literature review, survey design and administration, data analysis, article writing and revision. WCK: application and software development, article writing and revision. DS: application development, article writing and revision, project supervision. AKN: team lead, application development, survey design and administration, article writing and revision, project supervision.

**Funding** The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

**Competing interests** None declared.

**Patient consent for publication** Not required.

**Ethics approval** The Stanford University Institutional Review Board exempted the survey as a quality improvement initiative (ID: 52535). Informed consent was not required since the anonymous survey did not collect any identifiable information and posed no risk to participants.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** All data relevant to the study are included in the article or uploaded as supplementary information. All data relevant to the study are included in the article. Please direct inquiries to the corresponding author.

**Open access** This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

#### ORCID iD

Nicholas A Hakes <http://orcid.org/0000-0002-6718-1075>

#### REFERENCES

1. Silver L. Smartphone ownership is growing rapidly around the world, but not always equally. Pew Research Center. 2019. <https://www.pewresearch.org/global/2019/02/05/smartphone-ownership-is-growing-rapidly-around-the-world-but-not-always-equally/> (Accessed Mar 2020).
2. Zebra Technologies. The future of healthcare: 2022 hospital vision study. 2017. [https://www.zebra.com/content/dam/zebra\\_new\\_ia/en-us/solutions-verticals/vertical-solutions/healthcare/white-paper/2022-hospital-vision-study-en-global.pdf](https://www.zebra.com/content/dam/zebra_new_ia/en-us/solutions-verticals/vertical-solutions/healthcare/white-paper/2022-hospital-vision-study-en-global.pdf) (Accessed Mar 2020).
3. Dekonenko C, McDonald T, Winfield RD. Smart trauma: improving the delivery of evidence-based trauma care. *J Surg Res* 2019;242:252–7.
4. Hamada SR, Gauss T, Pann J, Dünser M, Leone M, Duranteau J. European trauma guideline compliance assessment: the ETRAUSS study. *Crit Care* 2015;19:423.
5. Spanjersberg WR, Bergs EA, Mushkudiani N, Klimek M, Schipper IB. Protocol compliance and time management in blunt trauma resuscitation. *Emerg Med J* 2009;26:23–7.
6. Godwin Z, Tan J, Bockhold J, Ma J, Tran NK. Development and evaluation of a novel smart device-based application for burn assessment and management. *Burns* 2015;41:754–60.
7. Wurzer P, Parvizi D, Lumenta DB, Giretzlehner M, Branski LK, Finnerty CC, Herndon DN, Tuca A, Rapp T, Smolle C, *et al*. Smartphone applications in burns. *Burns* 2015;41:977–89.
8. Mina MJ, Winkler AM, Dente CJ. Let technology do the work: improving prediction of massive transfusion with the aid of a smartphone application. *J Trauma Acute Care Surg* 2013;75:669–75.
9. Freshwater ES, Crouch R. Technology for trauma: testing the validity of a smartphone APP for pre-hospital clinicians. *Int Emerg Nurs* 2015;23:32–7.
10. Wang SC, Anderson JAE, Evans R, Woo K, Beland B, Sasseville D, Moreau L. Point-Of-Care wound visioning technology: reproducibility and accuracy of a wound measurement APP. *PLoS One* 2017;12:e0183139.
11. McKenzie LB, Roberts KJ, Clark R, McAdams R, Abdel-Rasoul M, Klein EG, Keim SA, Kristel O, Szymanski A, Cotton CG, *et al*. A randomized controlled trial to evaluate the make safe Happen® app-a mobile technology-based safety behavior change intervention for increasing parents' safety knowledge and actions. *Inj Epidemiol* 2018;5:5.
12. Antonise-Kamp L, Beaujean DJMA, Crutzen R, van Steenberghe JE, Ruwaard D. Prevention of tick bites: an evaluation of a smartphone APP. *BMC Infect Dis* 2017;17:744.
13. Vaggers S, Puri P, Wagenlehner F, *et al*. A content analysis of mobile phone applications for the diagnosis, treatment, and prevention of urinary tract infections, and their compliance with European association of urology guidelines on urological infections. *Euro Urology Focus* 2019.
14. Metelmann B, Metelmann C, Schuffert L, Hahnenkamp K, Brinkrolf P. Medical correctness and user friendliness of available Apps for cardiopulmonary resuscitation: systematic search combined with guideline adherence and usability evaluation. *JMIR Mhealth Uhealth* 2018;6:e190–12.