



Using Mobile Text and Media to Complement Teaching in a Facial Reconstruction Training Module in Haiti

Natalie Justicz, MD,^{*,†} Joseph R. Dusseldorp, MD,^{*,†} Jennifer C. Fuller, MD,^{*,†} Myriam Leandre, MD,[‡] Patrick Marc Jean-Gilles, MD,[‡] Jennifer Kim, MD,[§] Tessa Hadlock, MD,^{*,†} and Mack Cheney, MD^{||}

^{*}Department of Otolaryngology, Harvard Medical School, Boston, Massachusetts; [†]Department of Otolaryngology, Massachusetts Eye and Ear Infirmary, Boston, Massachusetts; [‡]Service d'Otorhinolaryngologie et Chirurgie Cervico-faciale et d'Ophtalmologie, Hôpital de l'Université d'Etat d'Haïti, Port-au-Prince, Haïti; [§]Department of Otolaryngology—Head and Neck Surgery, Division of Facial Plastic and Reconstructive Surgery University of Michigan, Ann Arbor, Michigan; and ^{||}Steven C. and Carmella R. Kletjian Foundation Inc, Boston, Massachusetts

OBJECTIVES: (1) To describe electronic communication between global surgeons and trainees in a low-middle income country (LMIC) and to gauge appeal of the WhatsApp platform

(2) To introduce a novel intensive ear reconstruction teaching module for surgical capacity building using simulation in a LMIC.

DESIGN: Prospective cohort study.

SETTING: University-based medical center in Haiti.

PARTICIPANTS: Eleven otolaryngology trainees and faculty in Haiti.

RESULTS: Three months prior to on-site arrival, a WhatsApp Messenger group was created for information-sharing and distribution of teaching materials. A surgical curriculum was created to incorporate didactics, cartilage framework simulation, and live surgery. During the intensive on-site week, WhatsApp was used to distribute materials and to recap learning points from each case, with pre- and postoperative surgical photographs circulated. Postmodule written, oral, and practical testing was conducted on the final day, and a postmodule survey was administered a month later. Post-tests scores were significantly improved from pretests scores. Initial scores on the written, oral, and practical tests averaged

24.6%. Postmodule scores averaged 86.9% ($p < 0.001$). Participants rated the use of WhatsApp to be highly important to their learning and requested further use of mobile health technology.

CONCLUSIONS: WhatsApp Messenger technology complemented a reconstructive surgery education module in a LMIC. WhatsApp provides opportunities for premodule patient screening, real-time discussion, and postmodule review. Its usage was well-received by Haitian otolaryngology trainees and faculty. Our results suggest that the combination of didactic teaching, simulated surgery, and live surgery resulted in successful transfer of both skills and knowledge. (*J Surg Ed* 76:762–770. Published by Elsevier Inc. on behalf of Association of Program Directors in Surgery.)

KEY WORDS: Capacity building, Education, Low-middle income countries, Surgical simulation

COMPETENCY: Patient Care

INTRODUCTION

The demand for surgical services across the world is increasing, and global surgeons have been tasked with meeting this need with sustainable, locally based capacity building that leverages technology.¹ The Lancet Commission on Global Surgery's *Global Surgery 2030* reports that investing in surgical services in low-middle income countries (LMICs) is affordable, saves lives, and promotes economic growth.¹ Currently, a mere 6% of all surgical cases that occur worldwide take place in LMICs, where one third of the world's population lives.¹ Subspecialty surgical care refers to the performance of

Funding source: Facial Plastic Surgery Mission Fund at Massachusetts Eye and Ear Infirmary, The Kletjian Foundation.

Declarations of interest: None.

Financial Disclosures: None.

Correspondence: Inquiries to Joseph Dusseldorp, MS (Plast.)|MB, BS (Hons.) (Syd.)|B Com|FRACS (Plast.), Massachusetts Eye and Ear Infirmary, Department of Otolaryngology, 243 Charles Street, Boston, MA 02114; e-mail: joeduss@gmail.com

highly specialized procedures that may require advanced technical skills and surgical training, such as ear reconstruction. Although some referral hospitals in LMICs may have the resources to provide dedicated surgical care for specific, unusual conditions, the highly developed skillset required for efficient care delivery establishes an additional barrier to care. Thus, conditions requiring surgical expertise have often been managed by vertically integrated, single-procedure programs in LMICs.² These traditional programs, often supported by international funding and surgical missions, are in the midst of a transition to programs that emphasize sustainability, capacity building, and local healthcare worker education. Therefore, an education module focusing on ear reconstruction offers not only a large source of potential disability-adjusted life years, but also a means for advancing global surgical training.³

Academic Otolaryngology programs are partnering more frequently with institutions in LMICs to develop collaborative training programs and research partnerships, which can enrich education and promote the exchange of expertise.^{4,5} Efforts to grow the global surgical workforce are increasingly leveraging technology to find innovative methods to enhance international collaboration and augment surgeon training. Surgical simulation and electronic communication, recording, and documentation have become integral parts of United States-based resident education; we propose that these tools might also help optimize teaching of surgical procedures in LMICs. Herein, we describe a novel intensive facial plastic and reconstructive surgery education module that incorporates didactics, surgical simulation, and live operative training supported by WhatsApp. WhatsApp Messenger is a free, encrypted mobile phone application which allows voice and video calls as well as text messaging, and sharing of images, media, and documents.

METHODS

A Haitian Otolaryngology program was identified with an interest in academic partnership and a need for facial plastic and reconstructive surgery capacity building. A surgical accompaniment agreement was made. This was performed as an educational program and as such did not require Institutional Review Board approval. Consent to share patient photos was performed in the native language of each participant by the Haitian team members prior to uploading to WhatsApp.

Four surgeons with expertise in ear reconstruction conducted a longitudinal training module. A rigorous lecture and carving workshop series was developed to cover the basic principles of ear reconstruction for acquired deformities and appropriately challenging testing materials were

constructed. Three months prior to the in-country education module, a WhatsApp group was created for information-sharing between course participants. Premodule testing was carried out remotely over a digital platform (Skype; Luxembourg City, Luxembourg) and then a course syllabus and initial educational material were delivered by WhatsApp. Patients with auricular deformities were given the opportunity to participate in the program and, after consent, their images were shared with experts in auricular reconstruction via the encrypted WhatsApp platform. Patients were then selected for surgery based on the educational potential of each case.

The in-country educational module consisted of a week-long program focused on ear reconstruction, both for traumatic and congenital etiologies (Table 1). Each day was divided between short lectures, practical simulation workshops, and operative exposure. The didactics included a review of relevant anatomy, ear analysis, and surgical management. Lectures were delivered in both English and French. In the simulation workshops, residents planned, carved, and assembled an auricular framework from a synthetic rib (Figs. 1-2). While in-country, the group WhatsApp discussion thread recapped daily key learning points, and images were circulated from carving workshops and operative cases (Figs. 3-5). Pre- and postmodule testing consisted of written, oral, and practical examinations of ear reconstruction. Two versions of the written and oral questions were generated and randomly assigned to the residents. The oral examinations consisted of oral board-style case scenarios. A standardized grading system was used for all testing.

A month after the conclusion of the in-country program, residents completed an anonymous survey in which they were asked to complete survey rating questions on a scale of 1 (low) to 5 (high) regarding WhatsApp, individual lectures, and simulation sessions, as well as free text feedback on the course as a whole.

Pre- and postmodule testing data were analyzed using paired and unpaired *t* testing, under the hypothesis that the educational module would improve testing performance.

RESULTS

Participants included 8 Haitian trainees in the midst of their residency education. These 8 residents participated in pre- and postmodule testing. Additional participants included 1 surgeon who had finished residency but not yet taken a full-time position as well as 2 other Haitian faculty members, including the Otolaryngology department head and an associate department head.

The WhatsApp Messenger thread was in use for 3 months prior to in-country arrival and ongoing discussion

TABLE 1. Module Schedule

Premodule	Creation of WhatsApp Group Remote Screening of Patients Testing	Premodule Written Exam Premodule Oral Exam Premodule Practical Exam
Day 1	Testing Lectures	"Anatomy of the Ear" "Initial Management of Auricular Trauma" Keynote: "Partial Ear Reconstruction" Auricular Framework Fabrication Basic Ear Reconstruction Two Cases
Day 2	Workshop Video Operating Room WhatsApp Daily Recap Lectures	"Microtia" "Temporoparietal Fascial Flap" "Auricular Reconstruction After Cancer" Keynote: "Applications of the Temporoparietal Fascial Flap" Soft Tissue Suturing Techniques Temporoparietal Fascial Flap Two Cases
Day 3	Workshop Video Operating Room WhatsApp Daily Recap Lectures	"Principles of Auricular Reconstruction" "Rib Harvest" "Management of the Recalcitrant Auricular Keloid" Keynote: "Local Flaps for Auricular Reconstruction" Auricular Framework Fabrication Total Ear Reconstruction Conchal Cartilage Harvest Two Cases
Day 4	Workshop Video Operating Room WhatsApp Daily Recap Testing	Postmodule Written Exam Postmodule Oral Exam Postmodule Practical Exam Keynote: "Introduction to Clinical Research"
Postmodule	Lecture Survey Follow-Up on WhatsApp	

has continued for months after the module's end. The WhatsApp group discussion contains a written and pictorial record of the course, including the confidential screening of patients, the recap of the week of didactics and

surgical cases, as well as follow-up questions and discussion. More than 14 potential patients were screened via WhatsApp to yield the 6 most appropriate surgical candidates for this module. Over 130 photographs and videos

**FIGURE 1.** Drs. Hadlock and Cheney oversee an auricular reconstruction carving workshop.



FIGURE 2. Carving a cartilage framework.



FIGURE 3. Partial auricular reconstruction. Case courtesy of J.R. Dusseldorp.

were exchanged, as well as over 8000 words of conversation. The majority of this conversation involved patient screening, preparation, and communication regarding materials and resources, and teaching (Fig. 6). While participants introduced themselves and responded to questions, there was minimal casual conversation and the conversation remained professional.

All participating residents completed premodule testing and all but one completed postmodule testing. Average initial scores on the written, oral, and practical tests were 30.4%, 25.0%, and 18.6%, respectively, yielding a composite average of 24.6% (standard deviation 7.8; Table 2). Average postmodule scores on the written,

oral, and practical tests were 87.5%, 86.7%, and 86.7%, respectively, yielding a composite average of 86.9% (standard deviation 7.5). Written, oral, and practical post-tests were significantly better than the pretests ($p < 0.001$). Training with synthetic cartilage frameworks had a significant impact on the students' ability to carve an ear framework ($p < 0.001$).

Seven of the 8 residents completed the 41 questions' postmodule survey. Thirteen of the questions were related to WhatsApp (Table 3). The remaining 28 questions comprised numeric feedback specific to individual teaching and workshop sessions as well as free text feedback.



FIGURE 4. Subtotal auricular reconstruction. Case courtesy of J.R. Dusseldorp.

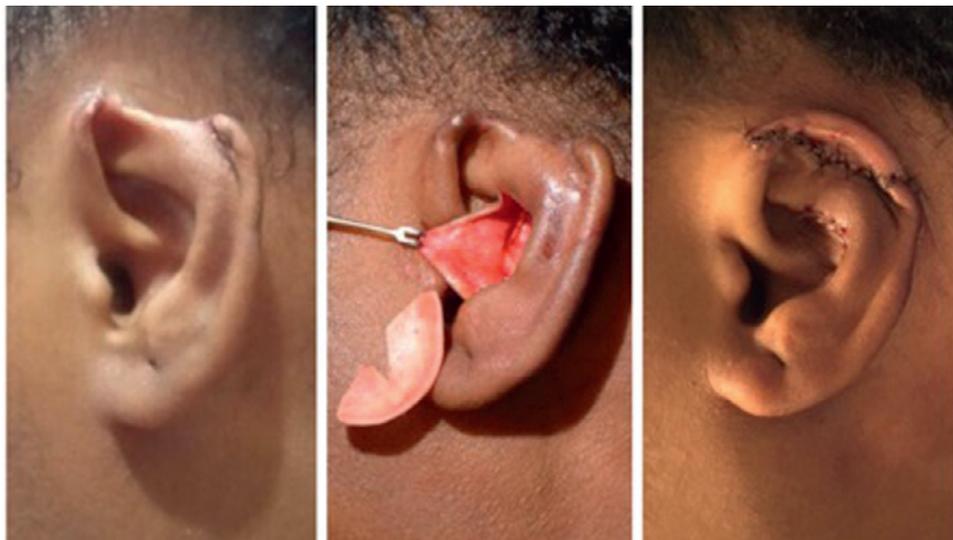


FIGURE 5. Partial auricular reconstruction. Case courtesy of J.R. Dusseldorp.

DISCUSSION

An intensive facial plastic surgery education module covering ear reconstruction was successfully piloted in Haiti. Despite the current shift in global surgery toward sustainability and capacity building for local surgeons,^{4,5} quantitative data establishing the effectiveness of global surgical teaching has been lacking. Pre- and postcourse testing demonstrated the education

module's efficacy in transferring knowledge and operative skills related to ear reconstruction. Through a combined approach using lectures, simulation workshops, and participation in live surgery, scores improved significantly across written, oral, and practical testing. Based on prior global surgery experiences, we believe WhatsApp greatly improves the continuity and rigor of the education module. Surgical simulation with the support of WhatsApp demonstrates a tangible way to

BREAKDOWN OF WHATSAPP DISCUSSION THREAD

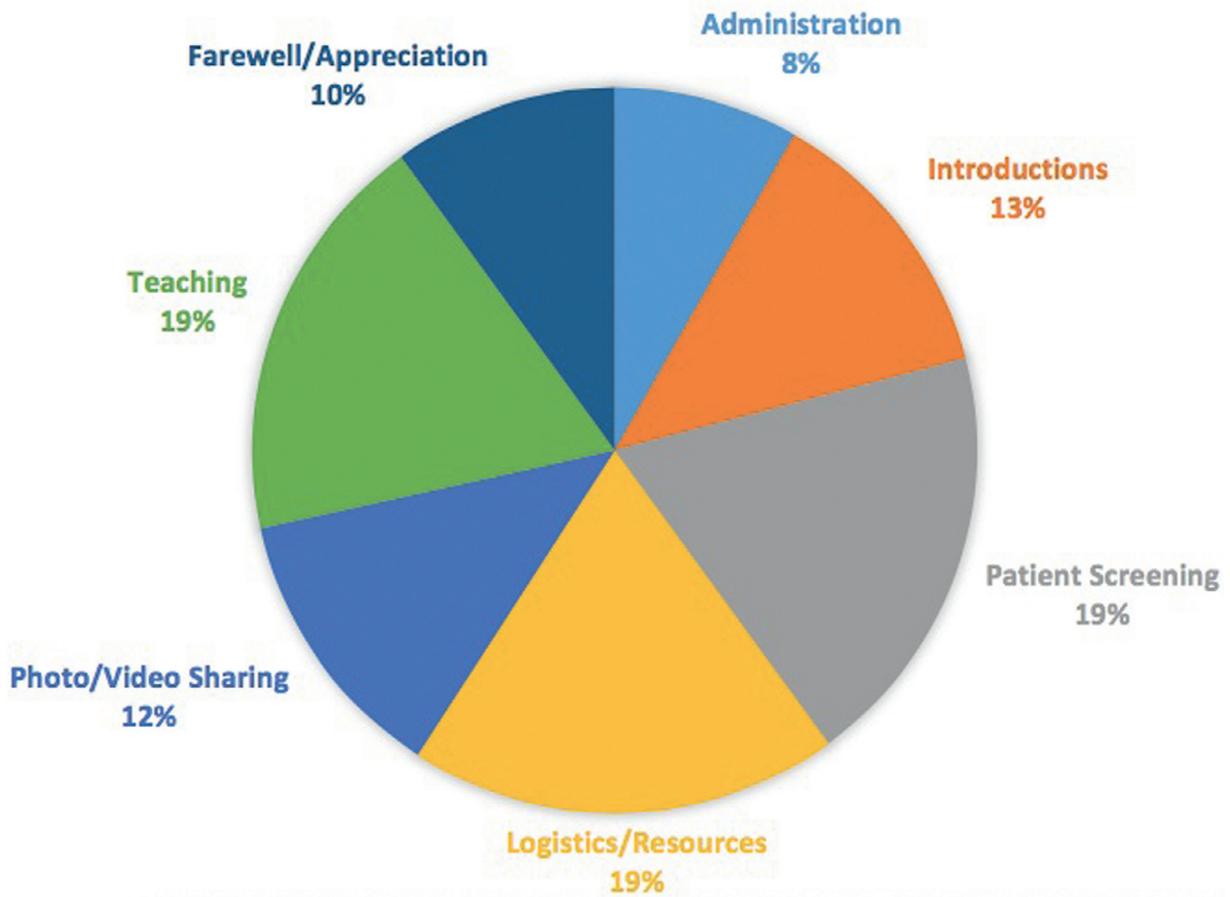


FIGURE 6. Breakdown of WhatsApp discussion thread.

incorporate technology into a global surgery education module.

Surgical simulation has gained increasing popularity in the US medical curriculum. Through deliberate practice, simulation improves clinical knowledge, procedural skills, teamwork, and communication with longer lasting results compared with traditional clinical education.⁶⁻⁸ Workshops involved procedural simulation of carving auricular cartilage from synthetic rib, which was

previously piloted by our group in conjunction with a teaching module in Ecuador.⁸ In a resource-limited environment, this simulation allowed novice surgeons to quickly gain practice and understanding of the surgical techniques without ease of access to cadavers. The simulation used in our study allowed all residents to efficiently practice surgical procedures under the instruction of visiting surgeons. The skills learned in these workshops were subsequently actualized in the

TABLE 2. Pre- and Postmodule Testing Scores

	Premodule Average (%) [SD]	Postmodule Average (%) [SD]	p Value
Ear reconstruction			
Written	30.4 [22.7]	87.5 [11.2]	0.002
Oral	25.0 [8.0]	86.7 [14.1]	<0.001
Practical	18.6 [18.6]	86.7 [10.3]	<0.001
Total Average	24.6 [7.8]	86.9 [7.5]	<0.001

TABLE 3. Postmodule WhatsApp Survey Results

On a Scale From 1 (Low) to 5 (High), Please Rate Your Agreement With the Following Statements:	Average (1-5)
1. I enjoyed learning new information through WhatsApp.	4.9
2. WhatsApp is an effective learning tool for me.	4.3
3. I found it easier to stay engaged in the WhatsApp discussion than a typical classroom conversation.	3.1
4. I felt comfortable asking questions to the group on the WhatsApp thread.	3.4
5. During the program, I felt like my instructors were readily available to answer questions through WhatsApp.	4.1
6. I continue to reference the WhatsApp conversation to review concepts I learned during this program.	3.9
7. I find that the information stored on WhatsApp is easy to utilize.	4.7
8. I am comfortable with the level of security/encryption provided by WhatsApp.	4.3
9. I would like to continue to use WhatsApp to stay connected to the people/instructors who I met during this program.	5.0
10. I would like to use WhatsApp in the future to learn new material.	4.6
11. It was beneficial to scrub on selected cases that were designed to teach certain points.	4.9
12. The lecture material related well to the OR cases.	4.7
13. Lecture material, WhatsApp discussions and OR cases prepared me well for the testing material.	4.3

operating room, further cementing the concepts taught. Surgical simulation offers a promising adjunct to lectures and more traditional models of teaching in LMICs for surgical capacity building, and could even incorporate virtual reality, robotics, telemedicine, and gaming in the future. Surgical simulation provides a natural companion to mobile health (mHealth) technology.⁹

From electronic medical records to communication platforms, medical care is increasingly reliant on information systems and technology. While mHealth was initially described by Robert Istepanian to refer to the use of mobile communications and network technologies for healthcare,¹⁰ Siegal et al. have labeled a mHealth evolution that incorporates smartphone capabilities to serve increasingly complicated medical and health-related needs.¹¹⁻¹⁵ Mobile communication can provide an efficient means of exchanging medical data among patients, caregivers, patients' support groups, and others involved in healthcare.¹¹⁻¹⁵ Many platforms have mHealth mobile communication abilities, such as Instagram, Facebook, and Twitter in addition to WhatsApp. Facebook groups can be closed to allow a modicum of privacy. However, Instagram, Facebook, and Twitter are inherently social media platforms,¹³⁻¹⁵ and none provides healthcare workers with the same degree of privacy as WhatsApp since the introduction of end-to-end encryption in 2016.^{12,13} When not used carefully, all mHealth systems can violate patient confidentiality; however, in a review of 17 papers using WhatsApp in global health, Mars and Scott find that the benefits outweighed the risks.¹³ They noted that many global surgery papers did not mention patient confidentiality or the consent process, which we have deliberately sought to remedy.¹⁵

WhatsApp relies on advanced end-to-end encryption and strong security measures to protect transmitted information. Although Health Insurance Portability and

Accountability Act rules do not apply outside of the United States, we believe that all patients deserve safe and private communication. Health Insurance Portability and Accountability Act compliance relates to how the users use the software in addition to the software itself. In our study, photos were de-identified and no patient identifiers were transmitted. Security controls were installed on smartphones to authenticate users, which is required by our home institution. We used all confidentiality measures available to us via WhatsApp.

WhatsApp has recently been described in the mHealth literature for a wide range of applications including communication,¹⁶ palliative care,¹⁷ for the classification of plain radiographs and computed tomography scans of tibial plateau fractures,¹⁸ emergency surgical team evaluation,¹⁹ and as a contact method among the staff of a plastic and reconstructive surgery team.²⁰ Our study describes the use of WhatsApp between healthcare providers in the United States and healthcare providers in another country for collaborative global health learning and education. WhatsApp was also used to remotely screen surgical candidates, helping to save time and resources from the module's outset.

Over the course of many months, the WhatsApp discussion thread formed an electronic record of this education module in Haiti. From pretrip planning, testing, and patient screening; to capturing the events of each day of module delivery; to postmodule recap, revision, and follow-up, WhatsApp provided continuity and communication. The WhatsApp thread continues to be revisited by participants as they reflect on cases and surgical methods. Recently, follow-up photographs of the operative patients have been circulated to help plan staged procedures.

Participants rated the use of WhatsApp as highly important to their education in the postmodule survey. The resident feedback was exceedingly positive, and the

postmodule survey allowed for both quantitative and qualitative feedback. All residents rated the statement “I enjoyed learning new information through WhatsApp” as a 4 or a 5. Six of the residents rated “I continue to reference the WhatsApp conversation to review concepts I learned during this program” as a 3 or above. All residents found the information stored on WhatsApp to be easy to utilize, and all would like to continue to use WhatsApp to stay connected to the module instructors and participants. Free text feedback was overwhelmingly positive. One resident noted “I found most of the lectures easy to understand but some were really full and at the end I personally felt like I missed a few important things. I also wish I could get the slides to review them at home. Some links to videos or articles could be added to WhatsApp from time to time.” Much of the free text feedback requested more educational time, more discussion, and more resources.

The institutional partnership between our program and a program in a LMIC helped to enrich training of residents and promote technology-driven learning. The success of the program was not only demonstrated by significant multimodal test score improvements, but perhaps more importantly, by the fact that all residents were interested in participating in future teaching modules. Students in LMICs crave exposure to knowledge, competencies, and technology; this program provides a structured model through which much needed surgical capacity building in LMICs could be generated to illustrate a quantitative evaluation of both knowledge and skill acquisition.

This module-based organization can be expanded to other subject areas across head and neck surgery; some additional modules have already been implemented by our department in other countries,⁸ and other modules are in development. Additional mHealth technology, such as video-recording the lectures, simulation sessions, and/or surgeries may prove beneficial to global clinicians who wish to incorporate this surgical module into their practice, although mHealth technologies must take into account patient privacy and confidentiality.¹¹⁻¹⁵

This education module was limited as the group size was small and no control group existed. We believe that WhatsApp contributed to knowledge acquisition, although this is our first time using WhatsApp with a global education module. While participants were assessed at the end of the module, we did not test retention of surgical knowledge and module material beyond our week-long module. In the future, extended recall can be measured to assess long-term knowledge gain. Validation of the testing delivered is also needed. Revisiting the same sites at future dates will lead to a better understanding of current and retained skill sets. While the long-term benefit of this type of program is yet to be determined, this model of training may prove to be a

useful tool in addressing surgical capacity via WhatsApp, surgical simulation, and module-based education.

CONCLUSIONS

A facial plastic and reconstructive surgery education module combining didactics, surgical simulation, and performance of live surgery was implemented in a LMIC. Additionally, the use of the encrypted WhatsApp platform provided continuity and communication. The success of the education module was demonstrated by significant multimodal test score improvements. All residents were eager to continue to learn via education modules, WhatsApp, and mHealth technologies. This module lays out a structured, easily implemented program to generate surgical capacity building in a LMIC and provides a quantitative evaluation of both knowledge and skill acquisition. The ear reconstruction module used in this encounter as well as new, unique surgical modules can be transferred to other LMICs. While further long-term educational studies are warranted, local surgeons report significant benefit, and this ear reconstruction module provides a means of addressing the need for surgical capacity building worldwide.

ACKNOWLEDGMENTS

We would like to thank the Facial Plastic Surgery Mission Fund at Massachusetts Eye and Ear Infirmary and The Kletjian Foundation for providing funding to support this project.

REFERENCES

1. Meara JG, Leather AJ, Hagander L, et al. Global surgery 2030: evidence and solutions for achieving health, welfare, and economic development. *Lancet*. 2015;386:569–624.
2. Fuller JC, Shaye DA. Global surgery: current evidence for improving surgical care. *Curr Opin Otolaryngol Head Neck Surg*. 2017;25(4):300–306. <https://doi.org/10.1097/MOO.0000000000000374>. Review. PubMed PMID: 28538021.
3. Bickler SN, Weiser TG, Kassebaum N, et al. Global burden of surgical conditions. In: Debas HT, Donkor P, Gawande A, eds. Third Edition, *Essential Surgery: Disease Control Priorities, Volume 1*, Editor 2015, The International Bank for Reconstruction and Development/The World Bank; 2015 Apr 2. Chapter 2.
4. Chambers KJ, Creighton F, Abdul-Aziz D, et al. Global health-related publications in otolaryngology

- are increasing. *Laryngoscope*. 2015;125:848-851. <https://doi.org/10.1002/lary.24906>. AprEpub 2014 Aug 22. PubMed PMID: 25155277.
5. Patel PB, Hoyler M, Maine R, et al. An opportunity for diagonal development in global surgery: cleft lip and palate care in resource-limited settings. *Plast Surg Int*. 2012;2012:892437.
 6. Okuda Y, Bryson EO, DeMaria S. Jr., et al. The utility of simulation in medical education: what is the evidence? *Mt Sinai J Med*. 2009;76:330-343.
 7. Motola I, Devine LA, Chung HS, et al. Simulation in healthcare education: a best evidence practical guide. AMEE Guide No. 82. *Med Teach*. 2013;35:e1511-e1530.
 8. Fuller JC, Justicz NS, Kim J, Cheney M, Castrillon R, Hadlock T. A facial plastic and reconstructive surgery training module using surgical simulation for capacity building. *J Surg Educ*. 2018. <https://doi.org/10.1016/j.jsurg.2018.06.027>. Aug 6. pii: S1931-7204(18)30152-1[Epub ahead of print] PubMed PMID: 30093333.
 9. Evans CH, Schenarts KD. Evolving educational techniques in surgical training. *Surg Clin North Am*. 2016;96:71-88.
 10. Istepanian RL, Laxminarayan S, Pattichis CS. *M-Health: Emerging Mobile Health Systems*. New York, NY: Springer; 2005.
 11. Siegal G, Dagan E, Wolf M, et al. "Medical information exchange: pattern of global mobile messenger usage among otolaryngologists. *Otolaryngol Head Neck Surg*. 2016;155:753-757.
 12. Leow JJ, Pozo ME, Groen RS, Kushner AL. Social media in low-resource settings: a role for Twitter and Facebook in global surgery? *Surgery*. 2012;151:767-769. <https://doi.org/10.1016/j.surg.2011.12.024>. JunEpub 2012 Feb 4. PubMed PMID: 22306836.
 13. Mars M, Scott RE. WhatsApp in clinical practice: a literature review. *Stud Health Technol Inform*. 2016;231:82-90. Review. PubMed PMID: 27782019.
 14. Chao TE, Riesel JN, Anderson GA, et al. Building a global surgery initiative through evaluation, collaboration, and training: the Massachusetts General Hospital experience. *J Surg Educ*. 2015;72:e21-e28. <https://doi.org/10.1016/j.jsurg.2014.12.018>. Jul-AugEpub 2015 Feb 16. PubMed PMID: 25697510.
 15. Ovaere S, Zimmerman DDE, Brady RR. Social media in surgical training: opportunities and risks. *J Surg Educ*. 2018. <https://doi.org/10.1016/j.jsurg.2018.04.004>. May 2. pii: S1931-7204(17)30866-8[Epub ahead of print] PubMed PMID: 29730180.
 16. Khanna V, Sambandam SN, Gul A, et al. "WhatsApp" ening in orthopedic care: a concise report from a 300-bedded tertiary care teaching center. *Eur J Orthop Surg Traumatol*. 2015;25:821-826.
 17. Dhiliwal SR, Salins N. Smartphone applications in palliative homecare. *Indian J Palliat Care*. 2015;21:88-91.
 18. Giordano V, Koch HA, Mendes CH, et al. WhatsApp Messenger is useful and reproducible in the assessment of tibial plateau fractures: inter- and intraobserver agreement study. *Int J Med Inform*. 2015;84:141-148.
 19. Johnston MJ, King D, Arora S, et al. Smartphones let surgeons know WhatsApp: an analysis of communication in emergency surgical teams. *Am J Surg*. 2015;209:45-51.
 20. Wani SA, Rabah SM, Alfadil S, et al. Efficacy of communication amongst staff members at plastic and reconstructive surgery section using smartphone and mobile WhatsApp. *Indian J Plast Surg*. 2013;46:502-505.

SUPPLEMENTARY DATA

Supplementary data associated with this article can be found in the online version at <https://doi.org/10.1016/j.jsurg.2018.09.015>.