Wearable Technology for Global Surgical Teleproctoring ☆

Néha Datta, MD,* Ian T. MacQueen, MD,* Alexander D. Schroeder, MD,† Jessica J. Wilson, MD,‡ Juan C. Espinoza, MD,§ Justin P. Wagner, MD,* Charles J. Filipi, MD,† and David C. Chen, MD*

*Department of Surgery, David Geffen School of Medicine, University of California, Los Angeles, California; †Department of Surgery, Creighton University School of Medicine, Omaha, Nebraska; ‡The Medical School for International Health, Ben Gurion University of the Negev, Beer-Sheva, Israel; and §Division of General Pediatrics, Childrens Hospital Los Angeles, Los Angeles, California

OBJECTIVE: In underserved communities around the world, inguinal hernias represent a significant burden of surgically-treatable disease. With traditional models of international surgical assistance limited to mission trips, a standardized framework to strengthen local healthcare systems is lacking. We established a surgical education model using web-based tools and wearable technology to allow for long-term proctoring and assessment in a resource-poor setting. This is a feasibility study examining wearable technology and web-based performance rating tools for long-term proctoring in an international setting.

METHODS: Using the Lichtenstein inguinal hernia repair as the index surgical procedure, local surgeons in Paraguay and Brazil were trained in person by visiting international expert trainers using a formal, standardized teaching protocol. Surgeries were captured in real-time using Google Glass and transmitted wirelessly to an online video stream, permitting real-time observation and proctoring by mentoring surgeon experts in remote locations around the world. A system for ongoing remote evaluation and support by experienced surgeons was established using the Lichtenstein-specific Operative Performance Rating Scale.

RESULTS: Data were collected from 4 sequential training operations for surgeons trained in both Paraguay and Brazil. With continuous internet connectivity, live streaming of the surgeries was successful. The Operative Performance Rating Scale was immediately used after each operation. Both surgeons demonstrated proficiency at the completion of the fourth case.

CONCLUSIONS: A sustainable model for surgical training and proctoring to empower local surgeons in resource-poor locations and "train trainers" is feasible with wearable technology and web-based communication. Capacity building by maximizing use of local resources and expertise offers a long-term solution to reducing the global burden of surgically-treatable disease. (J Surg Ed 72:1290-1295. © 2015 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: wearable technology, internet, Google Glass, telementoring, teleproctoring, global surgery

COMPETENCIES: Practice-Based Learning and Improvement, Systems-Based Practice

INTRODUCTION

The World Health Organization has identified large disparities in the global burden of surgical disease with significant imbalance towards unmet surgical needs in resource-poor countries.[1,2] For these diseases, morbidity owing to inadequate surgical care can be quantified in disability-adjusted life years (DALYs). An estimated 11% of the global burden of disease can be treated with surgery, and most of this disease exists in low- or middle-income countries.[1] There has been a general perception that the delivery of surgical services are cost prohibitive in resource limited countries. Contrary to this belief, basic surgical services can be very cost-effective intervention in these settings; inguinal hernia repair alone can cost as little as $10 per DALY averted.[3] Humanitarian organizations provide intermittent direct surgical care, but the continued prevalence of untreated surgical disease suggests a need for more cost-effective, sustainable models of global surgical outreach. Development of local infrastructure including a network of surgical trainers and regionalized surgical care systems may help meet this need.

☆ Financial support for this study was provided by Covidien, Ltd. and C.R. Bard, Inc.
Correspondence: Inquiries to David C. Chen, MD, Department of Surgery, David Geffen School of Medicine, University of California at Los Angeles, 10833 Le Conte Ave 72-235 CHS, Los Angeles, CA 90095; E-mail: dcchen@mednet.ucla.edu, neha_datta@post.harvard.edu

  1931-7204/$30.00 http://dx.doi.org/10.1016/j.jsurg.2015.07.004

Telemedicine offers promise in improving access to high-quality care. As defined by the American Telemedicine Association, telemedicine is the remote exchange of medical information to improve patient care, to educate patients, or to educate healthcare providers.[4] In the setting of global surgery, the utility of telemedicine has not been described extensively. Teleproctoring is rapidly gaining attention as an effective means of remotely sharing medical expertise.[5] Through this process, experts and specialists can provide educational access and competency-based training to surgeons in a remote location. The benefits of this capability are exponentially greater in resource-poor settings with otherwise limited access to mentorship and evaluation. The feasibility of teleproctoring in surgical education has been demonstrated for surgical residents in the United States.[6] Although several video-capture modalities have been used to review real-time intraoperative images,[7,8] there is currently no broadly-used, cost-effective technology offering hands-free video capture from the surgeon's perspective.

Hernia Repair for the Underserved (HRFU) is a nonprofit, nongovernmental organization composed of expert hernia surgeons from the American Hernia Society and European Hernia Society with the goal of providing high-quality surgical care to patients under the tenets of the Preferential Option for the Poor. The organization's educational mission has been to train and foster a network of local in-country trainers to augment the reach and impact of this activity. Given the ubiquity of disease, the benefit to the individual patient and society, and the availability of a safe, reliable, operative technique, we selected inguinal hernia to examine the utility of teleproctoring in global surgery. Over 20 million inguinal hernia repairs are performed annually worldwide.[9] In the developing world, late presentation is common among patients with inguinal hernias,[10] and the associated morbidity affects personal and national productivity as well as quality of life.[11-13] The cost-effectiveness of inguinal hernia repair in the developing world has been investigated. A study from Ghana in which hernia repairs were repaired by low-cost techniques found that each repair costs $12.88 per DALY,[13] which is as cost-effective as vaccination initiatives.[14] The Lichtenstein tension-free hernioplasty results in favorable outcomes, low recurrence rates, and low incidence of morbidity.[15] This technique also has the advantage of low-cost and a short learning curve.[16]

In this feasibility study, we hypothesized that a teleproctoring paradigm in resource-poor settings would result in measurable advancement in surgical technique among local surgeons. We used Google Glass to stream live intraoperative video, allowing for remote proctoring by surgeon experts.

METHODS

Setting

Locations and logistics of inguinal hernia repair operations were arranged by HRFU, in conjunction with the Paraguayan Ministry of Health and faculty of the University of Santa Casa in São Paolo, Brazil. Training operations were performed at Luque Regional Hospital in Luque, Paraguay and at Hospital General de Guarulhos in São Paolo, Brazil.

Participants

HRFU surgeon volunteers from Germany, Brazil, and the United States provided training to 1 local surgeon in Luque, Paraguay who was selected by the Paraguayan Ministry of Health, and 1 local surgeon in São Paolo, Brazil who was selected by faculty of the University of Santa Casa. Participant trainees are trained and licensed general surgeons with experience in mesh hernioplasty. The patients participating in this program typically live in rural areas and have more limited access to basic healthcare services than the regional average.[17-19] Underserved patients for the training cases were recruited and selected by local physicians and program coordinators, and then evaluated and approved by HRFU surgeons. In each location, the first Lichtenstein hernioplasty was performed by the HRFU expert trainer with assistance by the local trainee surgeon. In all subsequent cases, the local surgeon performed the Lichtenstein repair with assistance by the HRFU surgeon trainer. The expert offered redirection during the operation if they determined it was necessary. Aside from intraoperative technical assistance, the expert provided no other direct influence on patient care. Subsequent proctoring is continued remotely using wearable technology. Operations were done under monitored anesthesia care and local anesthesia. All services were provided at no cost to the patients.

Assessment Model

At the conclusion of each operation, the local surgeon's performance was evaluated using the Lichtenstein-Specific Operative Performance Rating Scale (OPRS), a validated evaluation system consisting of 13 numerical parameters including several specific to the Lichtenstein inguinal hernia repair. On completing each operation, the expert trainer and the local surgeon reviewed each of the 13 OPRS parameters, and immediate feedback was provided regarding areas of demonstrated proficiency and opportunities for performance improvement. The OPRS ratings were entered into a web-based registry at the time of the discussion. For the parameters evaluating technique, an average score of 3 out of 5 or better represented a rating of technical proficiency. The web-based OPRS form includes a 5-point Likert scale with objective anchors specifically defining each scale score.[20,21] The form was made available in English and Spanish. Trends were noted within each parameter, with improvement being defined as a positive regression slope (t) between scores and case number over the course of the training cases.