Plastic and Reconstructive Surgery in Global Health: Let’s Reconstruct Global Surgery

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Summary: Since the inception of the Lancet Commission in 2013 and consequent prioritization of Global Surgery at the World Health Assembly, international surgical outreach efforts have increased and become more synergistic. Plastic surgeons have been involved in international outreach for decades, and there is now a demand to collaborate and address local need in an innovative way. The aim of this article was to summarize new developments in plastic and reconstructive surgery in global health, to unify our approach to international outreach. Specifically, 5 topics are explored: current models in international outreach, benefits and concerns, the value of research, the value of international surgical outreach education, and the value of technology. A “Let’s Reconstruct Global Surgery” network has been formed using Facebook as a platform to unite plastic and reconstructive surgeons worldwide who are interested in international outreach. The article concludes with actionable recommendations from each topic. (Plast Reconstr Surg Glob Open 2017;5:e1273; doi: 10.1097/GOX.0000000000001273; Published online 25 April 2017.)

Current and future research efforts by the international surgical community are increasing and becoming more synergistic since the 2013 inception of the Lancet Global Surgery Commission and consequent prioritization of global surgery at the 2015 World Health Assembly.1,2

It is time for plastic and reconstructive surgery to publicly join the Lancet Commission to assemble the best evidence, provide cost-effective care, and improve access for low- and middle-income countries (LMICs). It is a surgical specialty founded in World War I, out of a need to provide quality form and function for traumatic injury.3 Plastic and reconstructive surgeons have since been involved in international outreach for decades, with some areas, like burn reconstruction, cleft care, and craniofacial surgery progressing much further than other fields such as graft and flap reconstruction, and hand surgery.4

The aim of this article was to summarize new developments in plastic and reconstructive surgery in global health, to unify our approach to international outreach. Specifically, we discuss 5 topics: current models in international outreach, benefits and concerns, the value of research, the value of international surgical outreach education, and the value of technology.

Part 1: Current Models: Let’s Aim for the Diagonal Approach

There are 4 major models of international outreach5,6: Vertical (1-way), Vertical (2-way), Horizontal, and Diagonal. The first 3 are traditional approaches, with their respective advantages and disadvantages, summarized in Figure 1. The fourth, “Diagonal development is a concept describing the ideal approach to outreach, depicted in Figure 2, reprinted and published in 2012 by Patel et al.6

The diagonal approach finds synergy between the immediate advantages of vertical inputs and the long-term benefits of the horizontal aims. It focuses on a long-term presence, multidisciplinary follow-up, needs-driven patient selection, bilateral exchange between interprofessional staff, enhancing visiting trainee experience in global healthcare delivery and local trainee experience in surgical practice and academic culture, transfer of research skills, and a self-sustainable infrastructure. Successful implementation leads to overflow of qualified local health professionals empowered to provide care to other communities in need.8

This concept has been supported by a number of cleft charities and can be a model for other fields.7-9 Operation Smile is notably a leader in this field, having served over 100,000 patients in over 25 countries.7

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### Table: Traditional Approaches to International Outreach

| Description                                      | Advantages                                      | Disadvantages                                                                 |
|--------------------------------------------------|-------------------------------------------------|-------------------------------------------------------------------------------|
| **VERTICAL (ONE-WAY)**                           | • Disease specific                              | • May not address other diseases/needs/social determinants                    |
|                                                  | • Ready to deliver package of surgical care,    | • May yield redundant and poorly coordinated efforts                          |
|                                                  | teaching faculty, research training, equipment  | • May divert funds from other diseases and other priorities                   |
|                                                  | and supplies, financial support                 | • May increase dependency                                                    |
|                                                  | • Often privately funded                        | • May not be sustainable                                                     |
|                                                  | • Often short-term                               |                                                                               |
| **VERTICAL (TWO-WAY)**                           | • As above                                       | • As above                                                                    |
|                                                  | • Limited to surgeon or patient transfer to a    | • Values the individual                                                       |
|                                                  | higher income country for training, or care      |                                                                               |
| **HORIZONTAL**                                  | • Focuses on healthcare infrastructure, long-term investments | • Strengthens systems as a whole                                             |
|                                                  | • Benefits all patients, because of focus on    | • Long-term interventions may be less attractive to donors and funders        |
|                                                  | primary infrastructure                          | • Require functional state and local governments                              |
|                                                  | • Builds capacity for long-term change           | • More difficult to measure the impact of horizontal interventions           |

### Figures

**Fig. 1.** Traditional approaches to international outreach. Adapted from Patel et al., 2012, with permission from the supervising author, and *Plastic Surgery International*.

**Fig. 2.** The diagonal approach. Reprinted from Patel et al., 2012, with permission from the supervising author, and *Plastic Surgery International*.

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Focus on the development of sustainable systems and general care

**HORIZONTAL AIMS**

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Local medical professionals became further empowered through self-sufficient programs and the imbued volunteer spirit, replacing their international partners, extending the reach of care. The continuous commitment to support local sustainable foundations with the same organizational ideals has lead to free, local, humanitarian operations throughout Latin America, Africa, and Asia.
Part 2: Benefits, Concerns, and Guidelines

Plastic surgeons have served in international outreach for decades. The concerns and benefits have been well documented with a recent movement toward guidelines that optimize benefits and minimize concerns and sustainable education and collaboration. Table 1 was created to summarize the current literature.\textsuperscript{9–16}

Part 3: The Value of Research

Global health research in plastic surgery is largely opinion-based, epidemiologic, and retrospective in nature, with a significant recommendation for prevention.\textsuperscript{4} There is great potential for innovation. Currently, there are 2 avenues for ethical research.

First, international outreach projects are recognizing that quality evaluation and assessment are essential to monitor and improve program development. In 2009, McQueen et al.\textsuperscript{7} from Operation Smile were the first plastic surgeons to establish an institutional review board and implement an excel electronic medical record to monitor critical indices during surgical missions. This enabled retrospective evaluation of surgical priority, perioperative complications, and program development. A universal consent form included the use of surgical information for research and was signed by the patient’s guardian. Other organizations like Facing the World and Smile Train have also followed suit.\textsuperscript{18,19} Discussion with key members of Operation Smile regarding establishing a reputable Institution Review Board would be a beneficial next step in creating a database for future short-term trips. Academic institutions partnering with charities have also been a source for institutional ethics board approval.\textsuperscript{7}

Second, host institutions within LMICs are using their own institutional ethics board to conduct research. Partnering with host surgeons to address their research needs will direct patient care in a culturally sensitive manner.\textsuperscript{20,21}

Scoping reviews of North American databases in combination with the largest African database, African Journal Online, are recently published, or in progress for all areas of pediatric plastic surgery in global health.\textsuperscript{21–26} Common themes and research gaps are highlighted in tabular form with the goal of visualizing these data on a world map.\textsuperscript{26} Ultimately, the goal is to streamline resources based on local need and to avoid inefficient and redundant work. A framework is in progress to be submitted to guide other such initiatives. A “Let’s Reconstruct Global Surgery” network has been formed using Facebook as a platform to unite all plastic and reconstructive surgeons worldwide interested in global outreach and promote research collaborations.\textsuperscript{27}

Now is the time for high-quality plastic and reconstructive surgical research in global health. Establishing an IRB to create a database and monitor patient outcomes, along with problematic or successful management of perioperative complications in LMICs will boost improvement. Publishing and sharing these data will provide an evidence base for other countries and programs to draw from. Visualizing current research projects on a world map has the potential to accelerate international communication, growth, and collaboration.

Part 4: International Surgical Outreach Education

Since the inception of the Lancet Commission for Global Surgery, there has been rising published interest in resident and fellow surgical education.

Methods

The search terms “Education,” “Global Health,” and “Plastic Surgery” were combined with the Boolean operator “AND” for PubMed and Embase. The term “Global Health” was explored in \textit{Plastic and Reconstructive Surgery, Journal of Plastic, Reconstructive and Aesthetic Surgery, Annals of Plastic Surgery, Journal of Craniofacial Surgery, The Journal of Hand Surgery and Burns}, with a manual screen of title and abstract for articles related to resident education.

Table 1. Risks and Benefits

| Benefits | Concerns | VIP Guidelines |
|----------|----------|----------------|
| Patients | • Millions benefited worldwide\textsuperscript{7,10,14} 
• Operation Smile in 2009, 25 countries, >100,000 patients\textsuperscript{7,14} | • Infamous body count\textsuperscript{4} 
• Ignore informed consent, unqualified operators, inappropriate operative candidates, inattention\textsuperscript{10,11} | Ethics\textsuperscript{9} 
• Informed consent 
• Appropriate follow-up |
| Hosts | • Increase surgical access\textsuperscript{14} 
• Extend reach of care through educating/learning from/empowering local practitioners\textsuperscript{9} 
• Provide resources, funds, or self-sufficient programs\textsuperscript{5,12} 
• Empower those affected and reduce stigma\textsuperscript{5} | • Lack of understanding of local surgeons, anesthetists, and underestimating abilities\textsuperscript{11,12} 
• Overwhelming number of postoperative patients for local practitioners/facilities\textsuperscript{7} 
• Interference leading to dependent relationships | Adequate medical records 
Empower\textsuperscript{9} 
• Plan with local caregivers |
| Volunteers | • Inspires excellent professional, interpersonal, and cultural skills\textsuperscript{15} 
• Personal enrichment\textsuperscript{12,13} 
• Improved clinical skill\textsuperscript{13} | • Lack of preparation, cultural shock | Minimize costs |
| | • Improved cost-conscious practice\textsuperscript{15} | • Burn out 
• Disconnect between site needs and volunteer preference 
• Difficulty adapting limited resources and supplies\textsuperscript{15} | Sustainable through education 
Prepare\textsuperscript{9,16} 
• Minimize health risks for volunteers 
• Ensure competency 
• Appropriate support, debrief\textsuperscript{5} |

VIP, Volunteers in Plastic Surgery.
Table 2. Resident Education in International Outreach

| Authors          | Title                                                                 | Journal                                | Relevant Points                                                                                                                                 |
|------------------|----------------------------------------------------------------------|----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| Yao et al., 2016 | The medical mission and modern core competency training: a 10-year follow-up of resident experiences in global plastic surgery | Plastic and Reconstructive Surgery     | • Operation Smile Regan Fellowship/Stryker International Fellowship offers plastic surgery residents 2-week experiences that include a surgical mission with a follow-up debriefing meeting under the mentorship of senior attending surgeons and operations with local surgeons.  
• Research collaborations and sustainable connections are created.  
• This positively impacts all 6 Accreditation Council for Graduate Medical Education core competencies. |
| Nayar et al., 2015 | The current state of global surgery training in plastic surgery residency | Plastic and Reconstructive Surgery     | • Sixty-four of 81 residency programs returned questionnaires, and of these, 26 programs reported a formal global health curriculum, classified by a clinical care experience followed by an educational experience.  
• 23 Programs do not have Residency Review accreditation.  
• Barriers: lack of Residency Review Committee/plastic surgery operative log recognition of cases performed abroad (n = 27 (71%)), difficulty funding for trip expenses (n = 25 (66%)), and salary support (n = 24 (63%)).  
• Common conditions are CLP, thermal injury, and posttraumatic reconstruction. |
| Broer et al., 2016 | The role of plastic surgeons in advancing global development         | Annals of Plastic Surgery              | • Recommendation: collaborative partnerships with local institutions to ensure research and advocacy efforts relevant to local practice will catalyze LMIC access to excellent plastic surgery.  
• Programs can offer similar exchange opportunities to promote to LMIC trainees.  
• Many training programs have implemented protected time during residency training to enable physicians to learn the research, advocacy, and clinical skills required to contribute to global surgery.  
• Other areas for plastic surgery innovation: advocacy, health information management systems, and interdisciplinary research to monitor and optimize global surgical care. |
| Jones et al., 2016 | The expanding role of education and research in international healthcare | Annals of Plastic Surgery              | • The Operation Smile Regan and Stryker Fellowships allow senior residents in plastic surgery, anesthesia, or pediatrics to participate by educational weekend where residents are instructed on multidisciplinary cleft care and provision of care in mission countries.  
• Residents are then sent worldwide with mentors for structured participation in all aspects of team care. This model of education has helped residents grow in each of the 6 core competences outlined by the ACGME.  
• Approved rotations in Guwahati Comprehensive Cleft Care Center (GC4) in the northeast Indian state of Assam, from partnerships with Lurie Children’s Hospital at Northwestern University and Penn State Hershey gave key GC4 surgeons clinical appointments to allow residents and fellows to have ACGME-accredited rotations without having to use extended vacation time. |
| White et al., 2013 | International plastic surgery missions: a framework for resident education using the CanMEDS competencies | Annals of Plastic Surgery              | • International missions can be a useful and significant vehicle to teach all 7 CanMEDS roles: communicator, professional, scholar, advocate, manager, collaborator, and medical expert.  
• Barriers: financial difficulties and scheduling conflicts  
• Recommendation: international plastic surgery missions should be supported and encouraged by local training programs and national specialty societies. |
| Yao et al., 2016   | The Tsao Fellowship in Global Health: a model for international fellowships in surgery residency | Journal of Craniofacial Surgery         | • This fellowship curriculum is completed over 24 months and divided into 3 areas: clinical research, international reconstructive surgery fieldwork, and the completion of a Master of Science in Clinical and Biomedical Investigations.  
• Clinical: 4–7 international missions each cycle and have performed an aggregate total of 684 surgical procedures.  
• Research: 2–6 research projects and authorships in several publications. Fellows continue to assume leadership roles within the field of global reconstructive surgery. |

(Continued)
| Authors | Title | Journal | Relevant Points |
|---------|-------|---------|-----------------|
| Richardson et al., 2016 | Facing the world in Vietnam: feedback from trainees on the educational value of surgical missions to help patients with craniofacial deformities | Journal of Craniofacial Surgery | • Facing The World is a UK-based craniofacial charity that provides facial reconstructive surgery to children with complex, craniofacial anomalies. • All local Vietnamese trainees and 83.3% of UK trainees found the training program to be useful or very useful. • Recommendation: education and training of local healthcare staff is a crucial component of a surgical mission. |
| Braun and Hollier, 2016 | Review of “Uncovering the hidden curriculum of global health electives” | Journal of Craniofacial Surgery | • Recommendation: recognize hidden curriculum, to increase awareness and understanding via self-reflection and role modeling. • An experienced, thoughtful mentor to help sensitize the mentee to the curriculum and provide formal expectations and descriptions of the GHE to ensure the host community's needs is beneficial. |
| Diaz and Caterson, 2015 | Shared education and shared innovation in the global health setting | Journal of Craniofacial Surgery | • Recommendation: build mutual surgical capacity through international partnerships. Surgeons can travel to locations with overwhelming surgical needs permit-ting relationships that can be formalized into training programs as they meet the need for the requirements set by the Accreditation Council for Graduate Medical Education. |
| Dodard and Fournier, 2015 | Plastic surgery in global health: the role of primary care infrastructure | Journal of Craniofacial Surgery | • 79% of 117 US schools offer global health experiences in plastic surgery programs, which can contribute to global health. • Recommendation: a comprehensive approach, that is, a horizontal integration that develops sustainable human resources, physical infrastructure, administrative oversight, and financing mechanisms in the developing world is needed. |
| Nayar et al., 2015 | The imperative of academia in the globalization of plastic surgery | Journal of Craniofacial Surgery | • Recommendation: careful, planned integration of medical mission trips into the residency curriculum will develop and enhance resident education and experience by fulfilling all 6 ACGME core competencies and by benefiting the native program. |
| Rodriguez et al., 2015 | International programs in the education of residents: benefits for the resident and the home program | Journal of Craniofacial Surgery | • Recommendation: application templates for international rotations to comply with ABPS and ACGME/RRC requirements were created to facilitate the participation of interested programs. |
| Ho et al., 2015 | The present status of global mission trips in plastic surgery residency programs. | Journal of Craniofacial Surgery | • The Residency Review Committee has an approved process for recognizing international rotations. The RRC must ensure residents are educated in a safe environment and that the rotation takes place, ideally with a previously established relationship of the home institutions. Competency goals and objectives including outpatient and follow-up is required, as with any rotation, and the program director must explain what is unique about the rotation that would not be provided at the home institution. • Surgeon at the site must be appropriately qualified either with the American Board of Medical Specialties certification or qualifications deemed appropriate by the RRC. Program directors must also be aware that after they have received RRC approval, they still need to get approval from the American Board of Plastic Surgery for these rotations. • Recommendation: The Global Health Committee of the American Council of Academic Plastic Surgeons provides a list of resources. • Benefit: resource-poor settings force young doctors to hone their clinical instincts and practice with fewer resources, which is useful in the US struggle to finance high-resource medical care. |
| DeGennaro and DeGennaro, 2013 | Linking surgical missions with training of developing-country surgeons | Journal of Craniofacial Surgery | • The table summarizes key points from 15 articles in resident education for International Outreach published since 2013. ABPS, American Board of Plastic Surgeons; ACGME, Accreditation Council for Graduate Medical Education; CLP, Cleft Lip/Palate; GHE, Global Health Education; RRC, Residency Review Committee. |

This table summarizes key points from 15 articles in resident education for International Outreach published since 2013. ABPS, American Board of Plastic Surgeons; ACGME, Accreditation Council for Graduate Medical Education; CLP, Cleft Lip/Palate; GHE, Global Health Education; RRC, Residency Review Committee.
| Fellowship (and Web Site) | Global Surgery Focus | Location | Key Summary |
|--------------------------|----------------------|----------|-------------|
| Paul Farmer Global Surgery | Global Surgery Focus | Harvard | Paul Farmer Global Surgery Fellowship (Web Site) http://bit.ly/2geblRc43 leads by John Meara, 1 of the 3 chair commissioners of the Lancet Commission for Global Surgery. The objective is to train and educate leaders who will promote surgical care, education, and research in the field of global surgery. The fellowship will develop academic, clinical, and administrative skills in global public health, surgical systems development, and humanitarian work. Fellows will have the opportunity to develop a skill set necessary to treat conditions common in resource-poor settings. |
| Paul Farmer Global Surgery | Global Surgery Focus | Harvard | King’s Centre for Global Health, London | Andy Leather, Director of the King’s Centre for Global Health, was appointed 1 of the Commission’s 3 cochairs. The Centre for Global Health’s focus on Global Surgery started in 2012 with the aim of contributing to global health. The Centre provides opportunities for clinical attachments and the discovery of new knowledge in the field of global surgery. |
| Academic Global Surgery Fellowship | Global Surgery Focus | Harvard | UT Southwestern Combined program with UT Southwestern Department of Surgery, the UT Southwestern School of Health Professions, and the Dallas Regional Campus of the UT School of Public Health. The program is dedicated to the training of surgical educators and the discovery of new knowledge in the field of global surgery. Fellows will develop academic, clinical, and administrative skills in global public health, surgical systems development, and humanitarian work. |
| Rowan Nicks International Scholarship and Rowan Nicks Pacific Islands Scholarship | Global Surgery Focus | Royal Australasian College of Physicians and Surgeons | The Rowan Nicks Scholarships and Fellowships are directed at surgeons in targeted countries in South East Asia and the Pacific. The scholarships and fellowships provide opportunities for clinical attachments and the discovery of new knowledge in the field of global surgery. Fellows will develop academic, clinical, and administrative skills in global public health, surgical systems development, and humanitarian work. |
| ASSA/SANOFI Travelling Fellowship | Global Surgery Focus | Royal Australasian College of Physicians and Surgeons | The ASSA/SANOFI Travelling Fellowship is a program that provides clinical attachments and the discovery of new knowledge in the field of global surgery. Fellows will develop academic, clinical, and administrative skills in global public health, surgical systems development, and humanitarian work. |
| ASSA/SANOFI Travelling Fellowship | Global Surgery Focus | Royal Australasian College of Physicians and Surgeons | The ASSA/SANOFI Travelling Fellowship is a program that provides clinical attachments and the discovery of new knowledge in the field of global surgery. Fellows will develop academic, clinical, and administrative skills in global public health, surgical systems development, and humanitarian work. |
| ASSA/SANOFI Travelling Fellowship | Global Surgery Focus | Royal Australasian College of Physicians and Surgeons | The ASSA/SANOFI Travelling Fellowship is a program that provides clinical attachments and the discovery of new knowledge in the field of global surgery. Fellows will develop academic, clinical, and administrative skills in global public health, surgical systems development, and humanitarian work. |
| Plastic Surgery Focus in Global Surgery | Plastic Surgery Focus in Global Surgery | Operation Smile | The Regan Fellowship offers recent graduates the opportunity to participate in the life-changing work of Operation Smile. The fellowship is directed at surgeons in targeted countries in South East Asia and the Pacific. The fellowship provides opportunities for clinical attachments and the discovery of new knowledge in the field of global surgery. Fellows will develop academic, clinical, and administrative skills in global public health, surgical systems development, and humanitarian work. |
| Plastic Surgery Focus in Global Surgery | Plastic Surgery Focus in Global Surgery | Operation Smile | The Stryker International Fellows Program seeks to build a global team of internationally trained plastic surgeons in countries with high prevalence of cleft lip and palate. The fellowship provides opportunities for clinical attachments and the discovery of new knowledge in the field of global surgery. Fellows will develop academic, clinical, and administrative skills in global public health, surgical systems development, and humanitarian work. |

(Continued)
Three hundred seventy-six citations were screened, with 17 articles included. Of these, 15 articles were published since 2013. Global health education publications by plastic and reconstructive surgeons has multiplied over 7-fold since the inception of the Lancet Commission in 2013, demonstrating that there is interest and value in global health plastic surgical education and in attending electives that comply with the Accreditation Council for Graduate Medical Education Residency Review Committee requirements. The United States is currently a leader in this field, with their national Residency Review Committee recently creating guidelines and a template to enable all US Plastic and Reconstructive Surgery programs to formally accredit their global health curriculum. Table 2 outlines key points from the 15 publications since 2015. Table 3 summarizes available plastic and reconstructive fellows in international outreach and global surgery.

Conclusion
Resident education in this field is now a priority, with a strong recommendation for accreditation for electives in international outreach. Fellowships in this field can provide further training in this area. Early, ethical, sustainable, collaborative, and guided surgical exposure to global outreach can only be of benefit to all invested parties.

METHODS

The search terms, "innovation, mobile, global health, developing country, technology" were explored for relevant articles in the Journal of Plastic and Reconstructive Surgery and the Journal of Plastic and Reconstructive Surgery Global Open. The search terms "developing country" were explored in Burns, the Cleft Palate-Craniofacial Journal, and the NEJM.

Table 3. (Continued)

| Fellowship (Web Site)                        | Organization                                      | Key Points                                                                 |
|----------------------------------------------|--------------------------------------------------|-----------------------------------------------------------------------------|
| Tsao Global Surgery Fellow                   | Children’s Hospital Los Angeles, Operation Smile, and the USC Institute for Global Health | Organized by Children’s Hospital Los Angeles, Operation Smile, and the USC Institute for Global Health. The program’s fellows develop academic, clinical, and administrative skills in global surgery, clinical, and public health research, and humanitarian aid in resource-poor settings. In addition to gaining master’s degrees in clinical and biomedical investigations, they conduct research and travel around the world to where Operation Smile carries out surgical care missions. |
| Sterling-Bunnell Fellowship                  | American Society for Surgery of the Hand          | American Society for Surgery of the Hand for a young hand surgeon to foster national and international relationships. |
| Jerome P Webster Fellowship                  | ReSurge International                              | The Webster Fellowship offers a newly trained, board-eligible plastic surgeon the opportunity to spend a year with Interplast’s medical colleagues in developing countries such as Bangladesh, Bolivia, Brazil, China, Ecuador, Ghana, Myanmar, Nepal, Nicaragua, Peru, Sri Lanka, Vietnam, and Zambia—performing the highest form of medical citizenship through care of those in need. |
| The John D. Constable International Traveling Fellowship | American Association of Plastic Surgeons          | The John D. Constable International Traveling Fellowship has been an integral part of the American Association of Plastic Surgeons since 2006 and has provided an opportunity for international plastic surgeons to work with leaders in American plastic surgery. |

Part 5: Putting Innovative Technology to the Test

Navi Radjou, a fellow at Cambridge Judge Business School, founded the concept of frugal innovation. This concept, published in the Innovation Countdown 2030 report, focuses on delivering more and better with simple, abundant resources and an emphasis on collaboration, co-creation, education, patient care, and follow-up requirements. Since the inception of the Lancet Commission of Global Surgery, focused efforts to improve surgical infrastructure, education, patient care, and follow-up requirements are key points for global surgical programs to formally credit surgical education and training in global health. The United States is currently a leader in this field, with their national Residency Review Committee recently creating guidelines and a template to enable all US Plastic and Reconstructive Surgery programs to formally credit surgical education and training in global health. Table 2 outlines key points from the global surgery programs since 2013, demonstrating that there is interest and value in global health plastic surgical education and training in global health. Table 3 continues from points from the global health programs since 2013. Table 4 outlines available plastic and reconstructive fellows in international outreach and global surgery.
Table 4. Mobile Health (mHealth) Technology Innovations within Plastic Surgery

| Citation          | Title                                                                 | Source     | Key Points                                                                                                                                                                                                 |
|-------------------|-----------------------------------------------------------------------|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Proximie, 2016    | Proximie                                                             | Proximie.com| • Proximie enables remote “assisting” surgery with commentary and onscreen markings and has been used this year to guide a blast injury or a congenital hand anomaly surgery in the Gaza strip with assisting surgeons in Beirut. Currently developing educational uses for medical students or residents. |
| Hughes et al., 2016 | Remote digital preoperative assessments for cleft lip and palate may improve clinical and economic impact in global plastic surgery. | Cleft Palate Craniofac | • Remote digital video evaluations to assess CLP. 27 Patients evaluated in Latacunga, Ecuador. Results: cleft lip 95.7% agreement ($\kappa = 0.78; P < 0.01$), cleft palate 82.8% agreement ($\kappa = 0.55; P = 0.01$), and ASvelar cleft 47.8% agreement ($\kappa = 0.06; P = 0.74$). |
| Sood et al., 2016  | The role of telemedicine in wound care: a review and analysis of a database of 5,795 patients from a mobile wound-healing center in Languedoc-Roussillon, France. | Plast Recon Surg | • The CICAT network data included 5,794 patients between January 2005 and October 2015. Analyzed wounds, which were principally pressure ulcers (44%), leg ulcers (24%), and diabetic foot ulcers (8%).  
• Results: 75% of wounds improved or healed, a 72% reduction in the number of hospitalizations, and 56% reduction in ambulance transfers to wound-healing center.  
• Recommendation: telemedicine may be of benefit in wound care, although legal constraints and credentialing concerns in other countries may make telemedicine extremely complicated. |
| Patel et al. 2016 | Technology and plastic surgery: potential pitfalls for patient confidentiality and proposed solutions. | Plast Recon Surg | • Investigated mHealth applications and HIPAA compliance. SMS, iMessage, FaceTime, cloud-based Dropbox are not HIPAA compliant.  
• Recommendations: Sookasa can make it compliant for a fee. Google Apps can enter a business associate agreement for HIPAA compliance as well, for a fee. Whatsapp offers encrypted services; however, this has not been formally explored yet. |
| Hwang et al., 2012 | Evolution of communication in post-operative free flap monitoring: using a smartphone and mobile messenger application. | Plast Recon Surg | • 125 Free-flaps.  
• Result: the time interval between first notification of flap compromise and start of reexploration was shortened from 4.0 versus 1.4h.  
• Flap survival rate increased from 96.2 to 100% and increased threatened flap salvage rate from 50 to 100%. |
| Hsieh et al., 2004 | Teleconsultation with the mobile camera phone in digital soft-tissue injury: a feasibility study. | Plast Recon Surg | • Teleconsultation with mobile camera phone in digital tissue injury for 81 digits, reviewed by 3 junior plastic surgery residents.  
• Results: 12 digits had discordance (15%), 79% sensitivity, 71% specificity in remote diagnosis of skin defect, 76% sensitivity, 75% specificity remote identification of the bone exposure, 2 cases of transected digital nerve were found. |

CLP, Cleft Lip/Palate; CICAT, Home Hospital Wound Healing Network; HIPAA, Health Insurance Portability and Accountability Act; SMS, Short Message Service.
RESULTS

The following trends emerged in 5 key areas: mobile health innovations within plastic surgery (Table 4); mobile health innovations outside of plastic surgery (Table 5),61–65 burns/wounds (Table 6),66–70 and microsurgery. Microsurgery

Despite the high equipment costs and labor-intensive procedures, Merell et al., in 2007, published Operation Smile’s introduction of microsurgery to Vietnam from 1990 to 2005. One hundred three free tissue transfer operations and 15 peripheral nerve procedures were completed. Facial reanimation, flap prefabrication, and perforator flaps were taught to local surgeons. A continuing education program and efficient resource use will build on this foundation. Two examples of cost-effective technologies include the following:

Table 5. Mobile Health (mHealth) Technology Innovations Outside of Plastic Surgery

| Area of Innovation | Explanation | Examples |
|-------------------|-------------|----------|
| Education, behavioral change | Targeted, timely health education and information delivered through SMS, voice, video, and audio clips to ensure the target person/population. | • MAMA  
• BBC World Trust Mobile Kunji project  
• Dimagi CommCare Health Worker Systems |
| Sensor and POC diagnostics | Linking mobile phones to a connected and independent external device. | • Alive Cor: 2-lead ECG approved by FDA  
• MIMOSA for early detection of diabetic ulcers63 |
| Registries and vital events tracking | Uses SMS, voice, digital forms to facilitate identification and enumeration for eligible clients. | • MCTS in India  
• UNICEF birth registration system in Uganda, which uses RapidSMS to maintain a central electronic database of new births |
| Data collection and reporting | Uses platforms like ODK and FrontlineSMS to create Microsoft excel electronic forms for easy data aggregation, sharing, and visualization. | • DHIS2 used in countries for routine health collection and reporting |
| EHR | EHRs allow rural health workers to access and contribute to longitudinal health records in hospital settings. | • OpenMRS: allows frontline health workers to access information from a patient’s health record using a mobile device and to contribute information into the health record  
• RapidSMS, ChildCount+  
• Kobotoooolbox64  
• Google Forms64  
• Pakistan local HER registry65 |
| Electronic decision support: information, protocols, algorithms, checklists | POC decision tools through mobile phones to help ensure quality of care. Mobile phone checklists help reduce clinical errors to ensure care quality at the point of service delivery. | • NGO switchboard: closed user group networks in Ghana, Liberia, Tanzania where members of mobile phone groups can communicate for free or at heavily discounted rates  
• TxtAlert  
• MoTech “Mobile Midwife service” |
| Provider-to-provider communication | Voice communication to coordinate care and provide expert assistance | • eMOCHA  
• Online educational that can be adapted to a mobile phone interface |
| Provider work planning and scheduling | Tools to help keep healthcare workers informed through active reminders of upcoming or due/overdue services and promotes accountability. Alerts healthcare workers about clients who are due or overdue for care to prevent missed appointments and delays in service provision. | • Rwanda’s mUbuzima  
• UNICEF’s RapidSMS in Rwanda |
| Provider training and education | Provide educational videos, informational messages, quizzes, case-based learning, and interactive exercises to reinforce skills provided during in-person training. | • SMS for Life mHealth supply chain system to prevent stockouts of essential malaria drugs |
| Human resource management | To track performance of community health workers through real-time GPS and provide supportive supervision or recognition and reward of exceptional field staff. | • Rwanda’s mUbuzima  
• UNICEF’s RapidSMS in Rwanda |
| Supply chain management | Manage stocks and supplies of essential commodities. Authentication service to reduce risk of purchasing counterfeit drugs. | • Rwanda’s mUbuzima  
• UNICEF’s RapidSMS in Rwanda |
| Financial transactions and incentives | Used to pay for health care, supplies, drugs, or make demand/supply side incentive schemes easier to deploy and scale. Decrease financial barriers to care for clients | • SMS for Life mHealth supply chain system to prevent stockouts of essential malaria drugs  
• African MTN has 7.3 million mobile money clients  
• Pakistan mobile-based cash vouchers |

DHIS2, District Health Information Software 2; ECG, Electrocardiogram; EHR, electronic health records; e-IMCI, electronic-integrated management of childhood illnesses; FDA, Food and Drug Association; GPS, Global Positioning System; MAMA, Mobile Alliance for Maternal Action; MTN, Mobile Telephone Network; NGO, Nongovernment organization; ODK, Open Data Kit; POC, Point of Care; SMS, Short Message Service; UNICEF, United Nations International Children’s Emergency Fund;.
Table 6. Innovative Technology in Burns and Wounds

| Citation                    | Journal/Source                        | Innovation                                                                 |
|-----------------------------|---------------------------------------|-----------------------------------------------------------------------------|
| Chattopadhyay et al., 2016  | Plastic and Reconstructive Surgery Global Open | A cost-effective alternative to Xeroform, where 3% bismuth tribromophenate powder was stirred with Vaseline for 5 min, then spread on gauze. |
| Choudary et al., 2015       | Ear J Plast Surg                      | TT: A simple innovative wound closure device. Recycles sterile suture packs as the attachment plate, applies 2-0 silk sutures, 2-3 cm away from the edge of the wound margin on top of a sterile foam dressing. Tension sutures and sterile tubing allowed the wound to close by mechanical creep for 5 cases. This technology by Hermann Kranzl from Germany uses salt, distilled water, and diaphragmatic electrolysis and states it effectively decontaminates MSSA, MRSA, Pseudomonas, E coli, Legionella pneumophila, and C albicans. |
| Janßen et al., 2010         | World Health Organization             | Large vessel loops and skin staples used for 2 cases in wound closure. Prosthetic arm, foam, and leather successfully simulated escharotomies in a pilot study of 32 surgeons in Pakistan. |
| Judge, 2009                 | Podiatry Today                        |                                                                 |
| Ali et al., 2008            | Burns                                 |                                                                 |

1) Low-cost plank microsurgery simulator ($5): Patel et al. introduced the idea of a simple cost-effective simulator with a wooden plank, clothespins, and a penrose drain.

2) SilpaRamanitor: Kiranantawat et al., in 2014, developed an android smartphone application to monitor free flap color changes with a sensitivity of 94%, specificity of 98%, and false-negative accuracy of 6%.

CONCLUSIONS

There are some new technologies emerging, with established mHealth innovations in global health that can be applicable to improving access and patient care in plastic surgery and global health. There is a need for well-designed prospective trials to determine whether they can clearly improve outcomes. Collaboration with innovations that are proven to be effective in other fields can accelerate efforts of plastic surgery in global health.

FINAL THOUGHTS

Now is the time to publically join the Lancet Commission in improving the state of evidence in surgery worldwide and increasing access to excellent plastic surgical care. The World Bank’s Disease Control Priorities publication identified 44 procedures that are essential for population health: among these were plastic surgical procedures for the treatment of injuries, burns, and congenital malformations. The scope of disease requiring plastic surgical skills is even broader and includes the growing burden of diabetes and cancer, as well as trauma. Interested individuals in global health can:

1) Aim for the diagonal approach to international outreach.

2) Build on established guidelines, develop sustainable education collaborations, and be mindful of the global health ethics to minimize concerns.

3) Collaborate with nongovernmental organizations and local host institutions to establish a research ethics board and take a united, collaborative approach to research and meeting local need. All are invited to the network “Let’s Reconstruct Global Surgery.” This network is currently using Facebook as a platform for all invested in plastic and reconstructive surgery international outreach. A multilingual database in the form of a world map that visually organizes data based on common research themes and gaps is being piloted, and all are invited to collaborate.

4) Develop a global surgery curriculum within academic institutions that is ethical, collaborative, sustainable, and accredited by recognized education bodies.

5) Create, apply, and partner with innovative technologies to current plastic and reconstructive surgery outreach projects.

So, can we make a difference?

I have a dream, that together, we can.

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