

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 inter-

national 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 outreach^{5,6}: 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 health-care 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.⁶

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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	DESCRIPTION	ADVANTAGES	DISADVANTAGES
VERTICAL (ONE-WAY) 	<ul style="list-style-type: none"> • Disease specific • Ready to deliver package of surgical care, teaching faculty, research training, equipment and supplies, financial support • Often privately funded • Often short-term 	<ul style="list-style-type: none"> • Fast implementation • Scalable • Donor attractiveness • Efficient delivery • Traditional 	<ul style="list-style-type: none"> • May not address other diseases/needs/ social determinants • May yield redundant and poorly coordinated efforts • May divert funds from other diseases and other priorities • May increase dependency • May not be sustainable
VERTICAL (TWO-WAY) 	<ul style="list-style-type: none"> • As above • Limited to surgeon or patient transfer to a higher income country for training, or care 	<ul style="list-style-type: none"> • As above • Values the individual 	<ul style="list-style-type: none"> • As above • Risk of brain drain • Not sustainable • Limited impact
HORIZONTAL 	<ul style="list-style-type: none"> • Focuses on healthcare infrastructure • Long-term interventions and investments 	<ul style="list-style-type: none"> • Strengthens systems as a whole • Benefits all patients, because of focus on primary infrastructure • Builds capacity for long-term change 	<ul style="list-style-type: none"> • Long-term interventions may be less attractive to donors and funders • Require functional state and local governments • More difficult to measure the impact of horizontal interventions

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

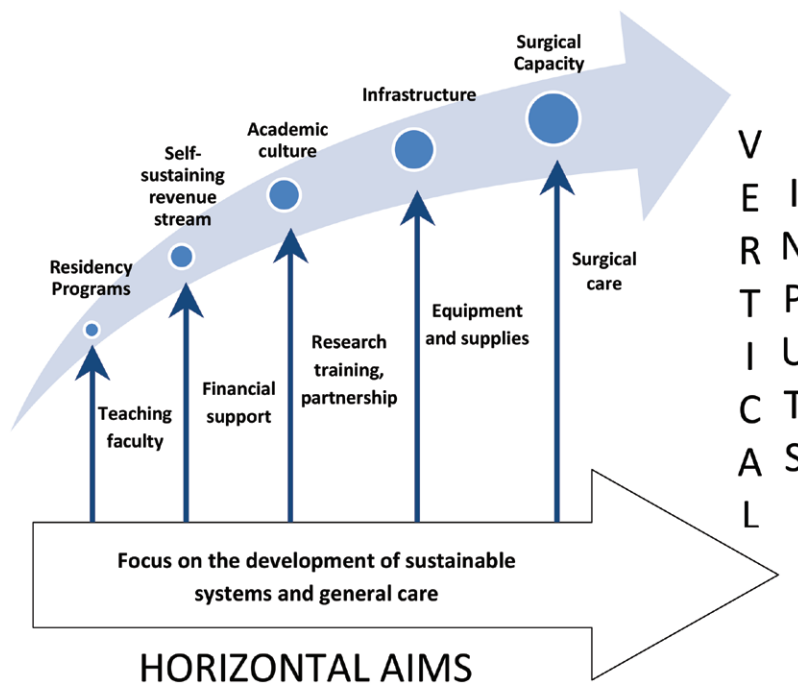


Fig. 2. The diagonal approach. Reprinted from Patel et al., 2012, with permission from the supervising author, and *Plastic Surgery International*.

Local medical professionals became further empowered through self-sufficient programs and the imbued volunteer spirit, replacing their international partners, extending the reach of care.⁷ The continuous com-

mitment to support local sustainable foundations with the same organizational ideals has lead to free, local, humanitarian operations throughout Latin America, Africa, and Asia.⁸

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.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.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.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.^{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.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.^{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.²¹⁻²⁶ Common themes and research gaps are highlighted in tabular form with the goal of visualizing these data on a world map.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.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 *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 ⁹
<p>Patients</p> <ul style="list-style-type: none"> Millions benefited worldwide^{7,10,14} Operation Smile in 2009, 25 countries, >100,000 patients^{7,14} <p>Hosts</p> <ul style="list-style-type: none"> Increase surgical access¹⁴ Extend reach of care through educating/learning from/empowering local practitioners⁵ Provide resources, funds, or self-sufficient programs^{5,12} Empower those affected and reduce stigma⁵ <p>Volunteers</p> <ul style="list-style-type: none"> Inspires excellent professional, interpersonal, and cultural skills¹³ Personal enrichment^{13,15} Improved clinical skill¹³ Improved cost-conscious practice¹³ 	<ul style="list-style-type: none"> Infamous body count⁸ Ignore informed consent, unqualified operators, inappropriate operative candidates, inattention^{10,11} Lack of understanding of local surgeons, anesthetists, and underestimating abilities^{11,12} Overwhelming number of postoperative patients for local practitioner/facilities⁷ Interference leading to dependent relationships Lack of preparation, cultural shock Burn out Disconnect between site needs and volunteer preference Difficulty adapting limited resources and supplies¹⁵ 	<p>Ethics⁹</p> <ul style="list-style-type: none"> Informed consent Appropriate follow-up <p>Adequate medical records Empower⁹</p> <ul style="list-style-type: none"> Plan with local caregivers <ul style="list-style-type: none"> Minimize costs Sustainable through education <p>Prepare^{9,16}</p> <ul style="list-style-type: none"> Minimize health risks for volunteers Ensure competency Appropriate support, debrief¹⁵

VIP, Volunteers in Plastic Surgery.

Table 2. Resident Education in International Outreach

Authors	Title	Journal	Relevant Points
Yao et al., 2016 ²⁸	The medical mission and modern core competency training: a 10-year follow-up of resident experiences in global plastic surgery	<i>Plastic and Reconstructive Surgery</i>	<ul style="list-style-type: none"> • 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. • 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 Committee/plastic surgery operative log • 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. • 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.
Nayar et al., 2015 ²⁹	The current state of global surgery training in plastic surgery residency	<i>Plastic and Reconstructive Surgery</i>	<ul style="list-style-type: none"> • 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 competencies 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 GC4 surgeons clinical appointments to allow residents and fellows to have ACGME-accredited rotations without having to use extended vacation time. • 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. • 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.
Broer et al., 2016 ³³	The role of plastic surgeons in advancing global development	<i>Annals of Plastic Surgery</i>	
Jones et al., 2016 ³¹	The expanding role of education and research in international healthcare	<i>Annals of Plastic Surgery</i>	
White et al., 2013 ³²	International plastic surgery missions: a framework for resident education using the CanMEDS competencies	<i>Annals of Plastic Surgery</i>	
Yao et al., 2016 ³¹	The Tsao Fellowship in Global Health: a model for international fellowships in surgery residency	<i>Journal of Craniofacial Surgery</i>	

(Continued)

Table 2. (Continued)

Authors	Title	Journal	Relevant Points
Richardson et al., 2016 ³⁴	Facing the world in Vietnam: feedback from trainees on the educational value of surgical missions to help patients with craniofacial deformities	<i>Journal of Craniofacial Surgery</i>	<ul style="list-style-type: none"> • 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. • 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. • Recommendation: build mutual surgical capacity through international partnerships. Surgeons can travel to locations with overwhelming surgical needs permitting 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. • 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. • 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. • Recommendation: application templates for international rotations to comply with ABPS and ACGME/RRC requirements were created to facilitate the participation of interested programs. • 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.
Braun and Hollier, 2016 ³⁷	Review of "Uncovering the hidden curriculum of global health electives"	<i>Journal of Craniofacial Surgery</i>	
Diaz and Caterson, 2015 ³⁵	Shared education and shared innovation in the global health setting	<i>Journal of Craniofacial Surgery</i>	
Dodard and Fournier, 2015 ³⁶	Plastic surgery in global health: the role of primary care infrastructure		
Nayar et al., 2015 ³⁸	The imperative of academia in the globalization of plastic surgery	<i>Journal of Craniofacial Surgery</i>	
Rodriguez et al., 2015 ³⁹	International programs in the education of residents: benefits for the resident and the home program	<i>Journal of Craniofacial Surgery</i>	
Ho et al., 2015 ⁴⁰	The present status of global mission trips in plastic surgery residency programs.	<i>Journal of Craniofacial Surgery</i>	
MacKay ⁴¹	Obtaining ACGME approval for international rotations during plastic surgery residency training	<i>Journal of Craniofacial Surgery</i>	
DeGennaro and DeGennaro, 2013 ⁴²	Linking surgical missions with training of developing-country surgeons	<i>Journal of Craniofacial Surgery</i>	

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.

Table 3. Fellowships in Global Surgery

Global Surgery Focus		
Fellowship (and Web Site)	Location	Key Summary
Paul Farmer Global Surgery http://bit.ly/2gebLRC ⁴³	Harvard	Lead by John Meara, 1 of the 3 chair commissioners of the Lancet Commission for Global Surgery. The objective is to train leaders who will further promote surgical care, education, and research pertinent to global surgery. Fellows will develop academic, clinical, and administrative skills in global surgery, public health, surgical systems development, and humanitarian aid. Throughout the course of the fellowship, there will be a focus on developing a skill set necessary to treat conditions common in resource-poor settings.
King's Centre for Global Health http://bit.ly/2gebLRC ⁴⁴	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 co-chairs. The Centre for Global Health's focus on Global Surgery started in 2012, with the aim of contributing in the following ways: play a leading role internationally in the field of global surgery and global health; provide education and training opportunities in global surgery; build a surgical component into our health partnerships; and conduct research in the area of global surgery.
Academic Global Surgery Fellowship http://bit.ly/2eNYbGK ⁴⁵	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 at the Health Science Center at Houston. It is the first fellowship program of its kind in Texas and one of only a handful throughout the country. Our mission: the training of surgical educators and the discovery of new knowledge to correct the global disparity in access to surgical care.
Rowan Nicks International Scholarship and Rowan Nicks Pacific Islands Scholarship http://bit.ly/2eOIfm2 ⁴⁶	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 Islands who demonstrate potential to become leaders in their communities. The scholarships and fellowships provide opportunities for recipients to develop their management, leadership, teaching, and clinical skills through clinical attachments in selected hospitals in Australia, New Zealand, and South East Asia.
ASSA/SANOFI Travelling Fellowship http://bit.ly/2l7Q2Ir ⁴⁷	Associations of Surgeons in South America	This fellowship aims to enable individuals of exceptional academic, intellectual, and clinical ability to travel to centers of excellence for a period of 4–12 weeks. During this period, the recipients should make contact with leaders in their field or fields of interest.
Academic Global Child Health Fellowship http://bit.ly/2g3rvFx ⁴⁸	The Centre for Global Health at Sick Kids	The Global Child Health Fellowship program is the first in Canada to concentrate on preparing candidates for academic careers in global child health. The goal is to create an exceptional training program that will serve to develop leadership and scholarly skills in working with disadvantaged pediatric populations (from neonates to adolescents), and their families, throughout the world. This interdisciplinary program will be accepting applicants from a variety of clinical, health care, research, and other related professional backgrounds (eg, MDs, nursing, allied health, epidemiology, and so on).
Plastic Surgery Focus in Global Surgery		
Fellowship (Web Site)	Organization	Key Points
Regan Fellowship http://bit.ly/2g6lN4g ⁴⁹	Operation Smile	The Regan Fellowship offers resident physicians the opportunity to participate in the life-changing work of Operation Smile. Made possible by invaluable donor support, residents in plastic surgery, pediatrics, and anesthesiology are invited to attend an international medical mission and work under the supervision and mentorship of veteran Operation Smile physicians. While on the medical mission, residents also participate in our research initiatives that will allow for better treatment and prevention of cleft lip and cleft palate. During this program, residents may network with one another and share their experiences at the annual conference of Regan Fellows.
Stryker International Fellows Program http://bit.ly/2g6lN4g ⁵⁰	Operation Smile	The Stryker International Fellows Program seeks to build a global team of international rising plastic surgeons who have had a unique exposure to the humanitarian programs of Operation Smile and to the surgical management of cleft lip and cleft palate.

(Continued)

Table 3. (Continued)

Plastic Surgery Focus in Global Surgery		Key Points
Fellowship (Web Site)	Organization	
Tsao Global Surgery Fellow http://bit.ly/2g5w0Rw ⁵¹	Children's Hospital Los Angeles, Operation Smile, and the USC Institute of 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 http://www.ash.org/afsh/Grants-Awards-and-Programs/Education/Bunnell-Fellowship-Program ⁵²	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 http://bit.ly/2gnMw1K ⁵³	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 http://bit.ly/2f7X6ES ⁵⁴	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.

Results

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.

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.

Since the inception of the Lancet Commission of Global Surgery, focused efforts to improve surgical infrastructure, education, patient care, and follow-up require cost-effective solutions. It is worthwhile to introduce the scope of solutions currently published.

METHODS

Something New

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*.

Something Borrowed

Abstracts, presentations, and competition winners from the World Health Organization Global Initiative Call for Health Technologies, Partners Advancing Transitions in Health Care and the Innovation Countdown 2030, the Consortium of Affordable Medical Technologies, the Bethune Round Table, and McGill's Centre for Global Surgery were also explored for relevance to plastic surgery in global health.

Table 4. Mobile Health (mHealth) Technology Innovations within Plastic Surgery

Citation	Title	Source	Key Points
Proximie, 2016 ⁵⁵	Proximie.	Proximie.com	<ul style="list-style-type: none"> 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 ⁵⁶	Remote digital preoperative assessments for cleft lip and palate may improve clinical and economic impact in global plastic surgery.	Cleft Palate Craniofac	<ul style="list-style-type: none"> 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 82.6% agreement ($\kappa = 0.55$; $P = 0.01$), and ASheolar cleft 47.8% agreement ($\kappa = 0.06$; $P = 0.74$).
Sood et al., 2016 ⁵⁵	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.	<i>Plast Recon Surg</i>	<ul style="list-style-type: none"> The CIGAT 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. ⁵⁸	Technology and plastic surgery: potential pitfalls for patient confidentiality and proposed solutions.	<i>Plast Recon Surg</i>	<ul style="list-style-type: none"> 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 ⁵⁹	Evolution of communication in post-operative free flap monitoring: using a smartphone and mobile messenger application.	<i>Plast Recon Surg</i>	<ul style="list-style-type: none"> 123 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 ⁶⁰	Teleconsultation with the mobile camera-phone in digital soft-tissue injury: a feasibility study.	<i>Plast Recon Surg</i>	<ul style="list-style-type: none"> 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; CIGAT, Home Hospital Wound Healing Network; HIPAA, Health Insurance Portability and Accountability Act; SMS, Short Message Service.

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

Area of Innovation ⁶¹	Explanation	Examples
Education, behavioral change	Targeted, timely health education and information delivered through SMS, voice, video, and audio clips to engage the target person/population.	<ul style="list-style-type: none"> • 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.	<ul style="list-style-type: none"> • Alive Cor: 2-lead ECG approved by FDA • MIMOSA for early detection of diabetic ulcers⁶²
Registries and vital events tracking	Uses SMS, voice, digital forms to facilitate identification and enumeration for eligible clients.	<ul style="list-style-type: none"> • 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.	<ul style="list-style-type: none"> • 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.	<ul style="list-style-type: none"> • 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+ • Kobotoolbox⁶³ • Google Forms⁶⁴ • Pakistan local HER registry⁶⁵ • e-IMCI
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.	
Provider-to-provider communication	Voice communication to coordinate care and provide expert assistance	<ul style="list-style-type: none"> • 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
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.	<ul style="list-style-type: none"> • TxtAlert • MoTech "Mobile Midwife service"
Provider training and education	Provide educational videos, informational messages, quizzes, case-based learning, and interactive exercises to reinforce skills provided during in-person training	<ul style="list-style-type: none"> • eMOCHA • Online educational that can be adapted to a mobile phone interface
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.	<ul style="list-style-type: none"> • Rwanda's mUbuguzima • UNICEF's RapidSMS in Rwanda
Supply chain management	Manage stocks and supplies of essential commodities. Authentication service to reduce risk of purchasing counterfeit drugs.	<ul style="list-style-type: none"> • SMS for Life mHealth supply chain system to prevent stockouts of essential malaria drugs
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	<ul style="list-style-type: none"> • 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; MIMOSA, Multispectral Mobile tissue Assessment device; MCTS, Mother and Child Tracking System; 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;

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 6. Innovative Technology in Burns and Wounds

Citation	Journal/Source	Innovation
Chattopadhyay et al., 2016 ⁶⁶	<i>Plastic and Reconstructive Surgery Global Open</i>	A cost-effective alternative to Xeroform, where 3% bismuth tribromophenate powder was stirred with Vaseline for 3 min, then spread on gauze.
Choudary et al., 2015 ⁶⁷	<i>Eur J Plast Surg</i>	TTS: a simple innovative wound closure device. Recycles sterile suture packs as the attachment plate, applies 2-0 silk sutures, 2-3cm 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.
Janßen et al., 2010 ⁶⁸	World Health Organization	This technology by Hermann Kranzl from Germany uses salt, distilled water, and diaphragmatic electrolysis and states it effectively decontaminates MSSA, MRSA, Pseudomonas, E.coli, <i>Legionella pneumophila</i> , and <i>C. albicans</i> .
Judge, 2009 ⁶⁹	Podiatry Today	Large vessel loops and skin staples used for 2 cases in wound closure.
Ali et al., 2008 ⁷⁰	Burns	Prosthetic arm, foam, and leather successfully simulated escharotomies in a pilot study of 32 surgeons in Pakistan.

MSSA, Methicillin Sensitive Staph Aureus; MRSA, Methicillin Resistant Staph Aureus; TTS, Tension Tile System.

- 1) Low-cost plank microsurgery simulator (\$5): Patel et al.⁷² 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%.⁷³

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.³⁰ The scope of disease requiring plastic surgical skills is even broader and includes the growing burden of diabetes and cancer, as well as trauma.³⁰ 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.”²⁷ This network is currently using Facebook as a platform for all invested in plastic and reconstructive surgery international outreach.²⁷ 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.²⁶

- (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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