

THE ORTHOPAEDIC FORUM

The Development of a Surgical Mission in the Peruvian Amazon

A 15-Year Expedition

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Abstract: Musculoskeletal disorders and injuries represent a substantial proportion of the global burden of disease. This burden is particularly prevalent in low and middle-income countries that already have insufficient health-care resources. The purpose of this paper is to highlight the vision, the history, the implementation, and the challenges in establishing an orthopaedic surgical mission in a developing nation to help address the epidemic of musculoskeletal trauma.

Scalpel At The Cross (SATC) is a nonprofit Christian orthopaedic surgical mission organization that sends teams of 10 to 20 members to Pucallpa, Peru, a rural town in the Amazon, to evaluate patients with musculoskeletal conditions, many that require surgery. The organization employs 4 full-time staff members and has included over 400 medical volunteers in 32 surgical campaigns since 2005. SATC has provided approximately 8.1 million U.S. dollars in total medical care, while investing approximately 2.2 million U.S. dollars in implementation and overhead.

Given the projected increase in trauma in low and middle-income countries, the SATC model may be increasingly relevant as a possible blueprint for other medical professionals to take on similar endeavors. This paper also highlights the importance of continued research into the effectiveness of various organizational models to advance surgical services in these countries.

Musculoskeletal disorders and injuries represent a substantial proportion of the global burden of disease, accounting for 11.2% of the total disability-adjusted life years worldwide¹. This burden is particularly prevalent in low and middle-income countries that already have insufficient health-care resources. Low and middle-income countries claim well over 90% of all injuries, a burden that far outstrips their treatment capacity^{2,3}. Many of these countries are experiencing rapid fiscal growth and, with it, there is expansion of their infrastructures. This

rapid growth, accompanied by advances in wealth and technology, has led to a transition from foot or bicycle transport to the use of motor vehicles, without concomitant safety laws or infrastructure^{2,4}. This has led to a substantial increase in the number of injuries from motor-vehicle crashes, accounting for an estimated 1.5 million deaths and 50 million nonfatal injuries per year worldwide⁴, creating a true global orthopaedic trauma epidemic. With about 5.8 million lives claimed each year from injury, the number surpasses deaths due

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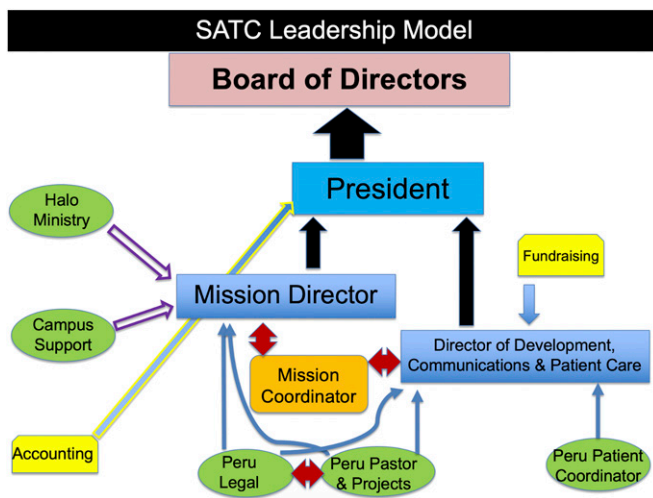


Fig. 1
The SATC leadership model consists of 9 board members, a mission director, a mission coordinator, and a property groundskeeper, as well as various other nonstaff positions.

to malaria, tuberculosis, and human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS) combined^{5,6}. All the while, for every trauma-related death, 10 to 50 more people sustain permanent disability⁷. Consequently, addressing this epidemic is of utmost importance from both medical and public health standpoints, as well as from an economic standpoint.

The traditional view of injuries as “accidental” has resulted in historic neglect of this area in public health. However, as this epidemic has grown, the literature on the subject has expanded. The World Health Organization (WHO) estimates that by 2030, trauma from road traffic accidents alone will be the third most common cause of both mortality and disability worldwide, following only ischemic heart disease and cerebro-

vascular disease². Additionally, the consequences of musculoskeletal trauma have implications well beyond health care. A recent prospective longitudinal study in Uganda to determine the socioeconomic implications of isolated tibial and femoral fractures caused by road traffic accidents with a 2-year follow-up found that (1) the average patient lost 88.4% of their pre-injury income level, (2) only 12% of patients recovered both economically and physically, (3) one-third of patients had not reentered the workforce postinjury, and (4) the economic hardships associated with injury forced 39% of the patients’ dependents to drop out of school^{8–11}. These grim figures personify the austere health-care condition of the majority of the world, and highlight the need for established orthopaedic personnel to recognize their unique skill set as a remedy to help address this growing epidemic.

Although a previously published report has described outcomes in a consecutive series of 104 patients who were treated and followed by our organization¹², the purpose of this paper is to highlight the vision, the history, the implementation, and the challenges in developing an orthopaedic surgical mission in a low and middle-income country setting in order to help address the epidemic of musculoskeletal trauma. In recounting the early history of this project, we hope to present a format that can be replicated; we also hope to share some of what we have learned through our experiences to assuage suffering in low and middle-income countries, where emerging economies collide with poverty in increasingly mechanized societies.

History

Scalpel At The Cross (SATC) is a nonprofit Christian orthopaedic surgical mission organization that was founded in 2004 by the senior author (P.A.C.) and his wife, Mrs. Nancy Cole, a clinical psychologist, after a variety of factors came together to ignite their passion for service in Latin America. The

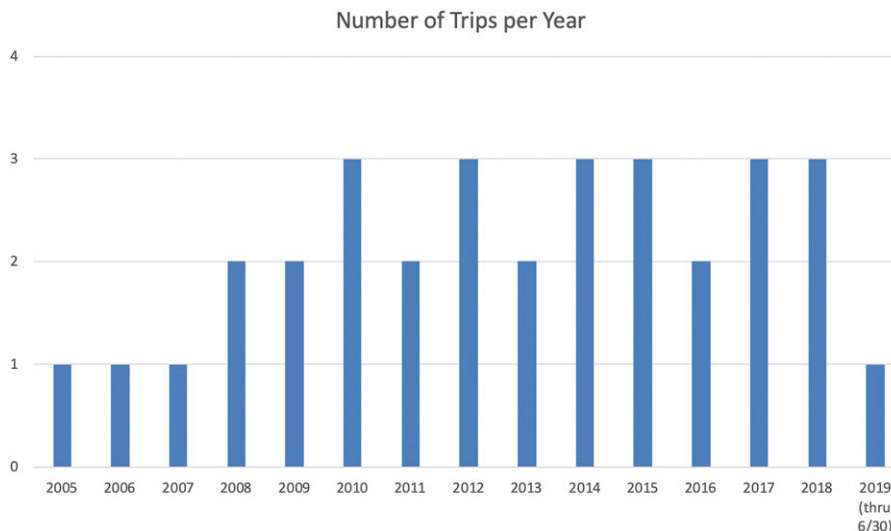


Fig. 2
There have been 32 medical trips conducted by SATC since 2005.

Number of Medical Personnel per Year

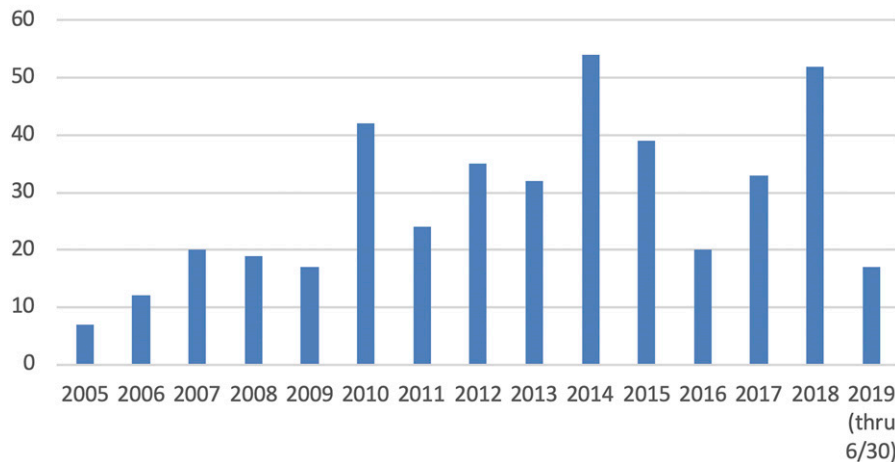


Fig. 3

There have been 423 medical personnel accompanying teams on the 32 trips since 2005.

organization is based in Pucallpa, Peru, a town that lies in the Ucayali region near the western border of Brazil, just outside of the Amazon. Pucallpa is a rapidly growing port town, unknown even to the majority of Peruvian natives, and is now home to >300,000 people¹³. The inhabitants of Pucallpa, by and large, live day by day as loggers, fishermen, and moto-taxi drivers, while neighboring Shipibo-Conibo tribes live off of the Amazon terrain in their respective villages. In contrast to Lima, which has modern colonial areas, Pucallpa is a continuous maze of cramped subsistence housing and dusty open-air markets.

Pucallpa represents the prototypical environment commonly seen in much of Latin America wherein a trauma epidemic outpaces the medical, human, and capital resources that have been set in place to combat it. Because of accelerated urbanization, there exists a chaotic and dangerous roadscape

where drivers, passengers, and pedestrians alike increasingly sustain serious injuries. Pucallpa and the areas that surround it are examples of what has been described as “disease conferred by emerging prosperity,” where the highest number of deaths are caused by motor-vehicle accidents and other traumatic mechanisms¹⁴.

Witnessing the unmet need for orthopaedic specialists, the Coles decided to orchestrate the resources to support a medical foundation with Dr. Cole’s trauma subspecialty.

The Mission Model

Our model takes teams of 10 to 20 members to Pucallpa to evaluate patients with musculoskeletal conditions, many that require surgery. The team typically includes 3 to 4 surgeons; various other medical personnel such as nurses, physician

Value of Medical Personnel

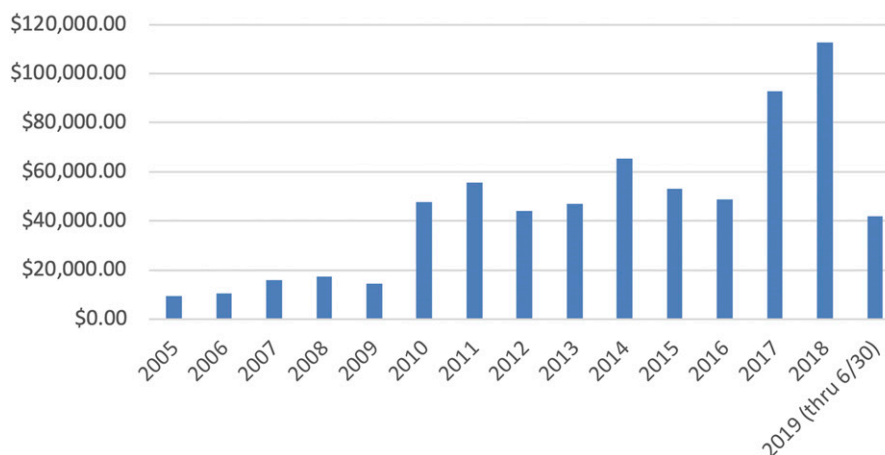


Fig. 4

The total value of medical personnel attending mission trips since 2005 has been \$675,961, which is based on 1 week of compensation per trip over 32 surgical campaigns.

Value of Donated Medical Equipment

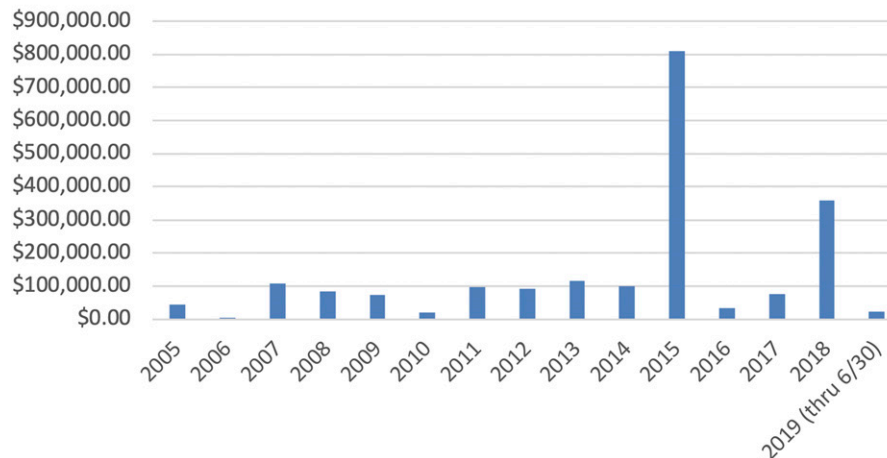


Fig. 5

The total value of donated medical equipment since 2005 has been \$2,047,112.

assistants, and medical students; a medical device representative who is familiar with the operating room; and other nonmedical volunteers. Although SATC has facilities to evaluate patients and host teams, the surgeries are performed at 1 of 2 local government hospitals with which it has built relationships.

The conditions are austere but provide an adequate operating environment. A typical trip includes a couple of days of traveling in and out of the jungle on both ends of the trip, 1 to 2 days for patient evaluation, and 3 to 4 days for operating. Around 75 to 150 patients are evaluated in the clinic per trip; 20 to 35 operations are performed; and a number of additional conditions are treated with nonsurgical interventions such as casting, injections, or other nonoperative means. Operations are generally extensive and technically demanding.

Recent years have included 3 medical trips annually, with a goal of 1 trip per quarter. It is intentional that SATC works with the personnel in the local hospitals, including nurses, anesthesiologists, and surgeons, allowing for socialization, education, and forging of ongoing relationships. The model intentionally is not to take over a local hospital, nor to have personal facilities that are owned and run by the organization itself manage all aspects of care. It is through collaborating that SATC believes the greatest value of medical care becomes manifest.

Regarding governance, SATC has a board of directors with 9 members who meet every 9 months to review budgets, mend challenges, and strategize future initiatives (Fig. 1). Four employees are under contract: the mission director organizes the teams, leads the trips, and manages the operations; the mission coordinator drafts the financial reports,

Value of Patient Care

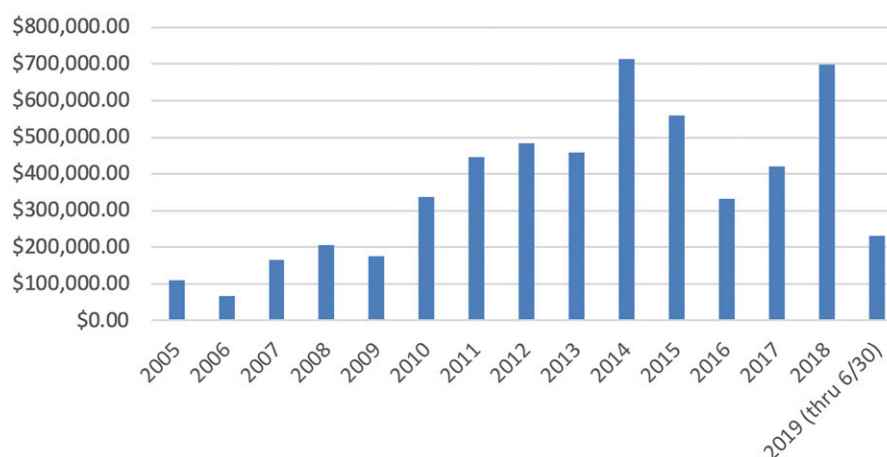


Fig. 6

The value of patient care over 32 surgical campaigns since 2005 has been \$5,405,450.

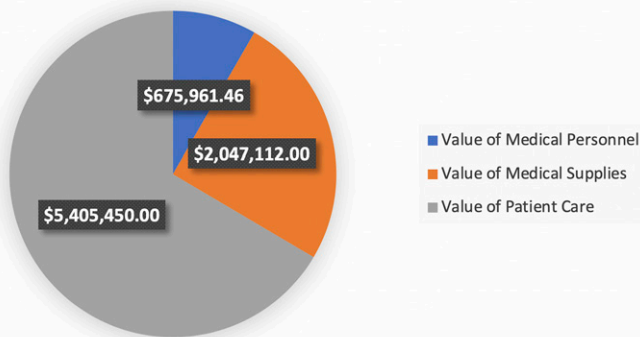
Total Value of Medical Care 2005-2019

Fig. 7

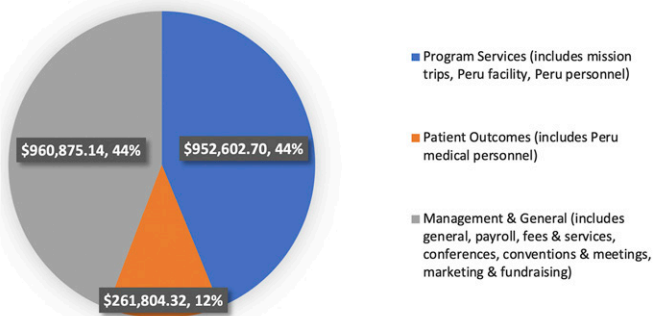
2011-2019 YTD Administrative and Program Expenses

Fig. 8

Fig. 7 In 32 medical trips, SATC has provided approximately \$8.1 million of medical care from 2005 through 2019. **Fig. 8** The total administrative cost since 2011, including program services and patient outcomes, was \$2,175,282 in 22 trips. YTD = year to date.

handles the medical device paperwork, and tracks patient information; the local health liaison professional in Peru conducts postsurgical follow-up for patients and reports

data at 2, 6, 16, and 36 weeks after surgery in the SATC outcomes program (BackPackEMR; Binary Bridge); and the property groundskeeper maintains the property and

TABLE I Challenges and Limitations Common to Short-Term Medical Missions¹⁵ and Solutions

Challenges and Limitations	Solutions in the SATC Model
“Hit-and-run medical care” versus long-term patient engagement through the course of rehabilitation	<ul style="list-style-type: none"> • Robust patient outcomes program prioritizing patient follow-up by employing a full-time medical professional to follow up with patients. • Innovative follow-up incentive for the local medical provider rather than the patient. We hypothesize that this realignment of incentives mitigates the burden of time, effort, and transportation costs incurred by our patient population¹². • Tracking outcomes is fundamental to the mission, recognizing the irresponsibility of performing high-risk interventions in a remote setting without doing so^{15,16}. Approximately 500,000 U.S. dollars have been invested to develop and maintain such an outcomes apparatus.
Cultural and language barriers	<ul style="list-style-type: none"> • Incorporates pretrip reading and discussion materials. • Hires translators and local personnel to assist in the clinical setting on the trip. • 15 years of consistent presence and relationship building in a single location.
Undermining of local medical community	<ul style="list-style-type: none"> • Embraces a core value to equip and empower the local medical community with collaboration and training with Peruvian medical personnel rather than for Peruvian medical personnel. • Employs local medical professional to conduct follow-up work. • Intentional model to partner with the local hospitals and surgeons for training, donations of equipment, and for scholarship opportunities.
Scaling impact	<ul style="list-style-type: none"> • This analysis, representative of an organization in its infancy, captures a patient pool of thousands, many of whom would not have otherwise been treated. Although this may pale in comparison to other organizations with larger capacity, we believe that the medical value of care is manifest. The consistent presence of SATC in Pucallpa has led to opportunities to expand its impact via collaboration with the local community. We are currently in the planning phase of the development of a permanent orthopaedic trauma clinic in Pucallpa, which will provide further sustainable care.
Fundraising challenges	<ul style="list-style-type: none"> • SATC has endeavored to support itself through a variety of traditional means: fundraising dinner events with silent auctions featuring Peruvian wares; outreach to grateful patients stateside who are philanthropically motivated; routine outreach to former donors with notes of thanks, income tax receipts, and newsletters about current happenings; appeals/challenges to board members to raise minimum amounts annually; PowerPoint presentations and literature distribution in settings within circles of influence such as churches, academic institutions, and clubs and fitness centers; utilization of estate planning methods for consideration by the elderly; applications for academic nonsectarian grants or nonprofit grants with international emphases; use of social media in spreading the word about SATC’s impact; and appointment of a subcommittee entitled “Strategic Development.” Despite tremendous effort, however, our funding has not matched the demand of the mission, and the budget is tethered by a sizeable gap between what is needed to operate optimally and what has been collected as endowment. We have considered outsourcing or hiring a development professional for this area, but doing so requires additional funding support.

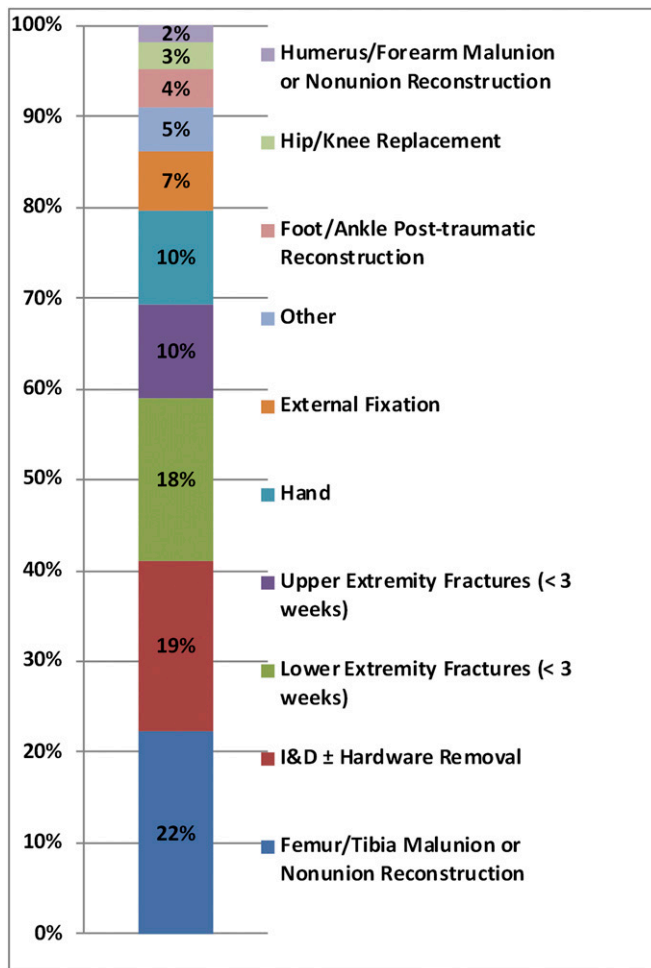


Fig. 9
A bar chart representing the percentage breakdown of the 188 surgical cases performed by SATC in 2.5 years. I&D = incision and drainage.

living quarters year-round while hosting teams during their stay.

Results

Since 2005, SATC has deployed 423 volunteers on 32 surgical campaigns to Pucallpa for 10-day periods to provide orthopaedic treatment (Figs. 2 and 3). Through its history, it has provided approximately 8.1 million U.S. dollars in total medical care, while investing approximately 2.2 million U.S. dollars in implementation and overhead. The organization's primary medical contributions are medical personnel, donated equipment, and patient care, whereas its primary expenses are program services, administrative management, and patient outcomes management. Below is a breakdown of the way that value is tracked for the board members and the donors.

Value of Medical Personnel

Donated team-member time is the opportunity cost of medical professionals on the teams, which is calculated by adding the cumulative sum of the daily mean income for the orthopaedic

surgeons, the emergency room physicians, the nurses, the physician assistants, the surgical technicians, and the physical therapists and multiplying it by the number of days spent on each campaign. In total, the value of medical personnel that SATC has provided has been approximately 675,961 U.S. dollars over 15 years (Fig. 4).

Value of Donated Medical Supplies and Equipment

The value of donated medical supplies and equipment is calculated by adding the valuation assessments that are provided by the medical device and surgical supply companies that donate equipment. Typical donations include orthopaedic implants and instrumentation, as well as surgical supplies, such as gowns, gloves, bandages, splints, casts, and crutches. In total, the value of donated medical supplies and equipment that SATC teams have generally carried in checked luggage for each campaign has been approximately 2,047,112 U.S. dollars over 15 years (Fig. 5).

Value of Patient Care

The value of patient care that is provided is calculated by taking all of the surgical and clinical procedures that are performed and valuing each of them in dollars in a procedure category. The values are arbitrary but approximate a conservative measure by U.S. standards. SATC has assigned a modest value to each type of procedure in U.S. dollars relevant to the current average insurance plus out-of-pocket patient cost for such a procedure in the United States. These assigned costs range between \$500 for an incision and drainage and \$20,000 for a total joint replacement or a complex malunion/nonunion reconstruction. In total, the value of patient care provided by our teams has been approximately 5,405,450 U.S. dollars over 15 years (Fig. 6).

Total Value of Medical Care

The summation of value of medical personnel, value of donated medical supplies and equipment, and value of patient care gives the total value of medical care. In total, SATC has provided approximately 8.1 million U.S. dollars in total medical care from 2005 to 2019 over 32 surgical campaigns (Fig. 7).

Value of Expenses

Expenses are calculated by taking all of the expenses and dividing them into 3 groups: program services, patient outcomes, and management and general, per standard annual reporting requirements for 501(c)3 organizations. Program services include but are not limited to medical campaigns, facility costs, and on-site groundskeeper salary. Patient outcomes include local medical coordinator salary and outcomes program technology. The management and general group includes but is not limited to board meetings, mission director salary, mission coordinator salary, and website and marketing programs (Fig. 8).

Challenges and Obstacles

There are several challenges inherent in operating a medical nonprofit organization, many of which are specific to the low and middle-income country setting. Limitations are common



Fig. 10

Figs. 10-A through 10-F Clinical photographs and radiographs. **Fig. 10-A** A patient with a chronic wrist deformity from an industrial lumber accident that occurred 3 years prior to presentation. **Fig. 10-B** A close-up of the volar surface of the wrist and the hand. **Fig. 10-C** A preoperative anteroposterior radiograph of the wrist showing severe bone loss of the distal aspect of the radius and radioulnar dissociation. **Fig. 10-D** An intraoperative image of a local bone harvest for a segmental transfer from the ulna to the metaphyseal defect in the radius. **Fig. 10-E** A postoperative photograph at 3 weeks after surgery showing correction of the deformity and the patient making the “O sign” to demonstrate intact median nerve function, which would have been at risk in this reconstructive procedure. **Fig. 10-F** Postoperative anteroposterior (top) and lateral (bottom) radiographs depicting stable fixation, with restoration of alignment and rotation. Although the length was not completely restored, the patient was very pleased with the difference in function and pain level at 3 months after surgery.

among short-term missions, and, recently, authors have proposed an ethical framework by which such work can be assessed¹⁵. Table I contrasts proposed challenges and limitations with the possible solutions that are embraced by our organization. The following challenges have warranted additional attention as the most important throughout the life span of our organization.

Hospital Politics

Hospital politics and administrative conflicts are issues that are felt in any and all health-care settings. The SATC experience has been no different, and there is cultural baggage that can originate from Americans operating in a low and middle-income country setting. In its first 7 years, our teams operated alongside Hospital Regional de Pucallpa and strived to build relationships within the local system. However, frequent senior administrative turnover created a revolving door of new hospital directors who had varying approaches to working with medical teams from the United States. Some of them even wanted to charge us for using resources (e.g., purchasing services from the hospital anesthesia service). One local surgeon created great conflict and undermined our teams in the hospital. After a period of prolonged tension, the partnership with

the regional hospital came to an end, but, soon, a new strong partnership with Hospital Amazónico was born out of this dilemma. SATC has worked hard to continue promoting positive relationships at the former hospital in hopes of reestablishing this important historic relationship one day.

Mission Team Members

There are cultural and physical challenges that often create difficulty for Americans operating in a low and middle-income country setting. It is challenging to successfully staff a clinic, triage hundreds of patients, and run a rigorous operating room schedule; it is even more difficult to do so in an unfamiliar language and in an environment where team members are under physical and mental duress. Mission trips are demanding and, not uncommonly, team members experience varying degrees of illness or inconvenience in the midst of an already difficult schedule. Such problems have included fatigue; tarantula, snake, piranha, and monkey bites; flight cancellations; flooding; and motor-vehicle accidents. These all require resources to resolve, but they also provide outstanding opportunities for participants to develop and demonstrate leadership skills.

More Complex Surgery in a Simpler Setting

There are challenging realities of operating in a cross-cultural and austere environment that surgeons must overcome. Because of the paucity of resources that are provided for surgery, imaging, and sterilization, surgeons may experience “one-of-a-kind” cases while operating with limited resources at their disposal. Additionally, the pathology of disease often is very advanced, and cases frequently represent the end of the natural history of untreated conditions that are not typically encountered in more advanced societies. In fact, approximately 30% of all operations that we have performed have been for the reconstruction of ununited and/or malunited fractures (Fig. 9). The surgeons work with volunteer teams and local hospital personnel who may not understand the stress that comes with being held responsible for patient outcomes. Factors that further create tension and increase procedural risks for the patient are the poor education of staff regarding sterile technique, the lack of familiar functioning equipment, and the unregulated protocols around the reuse of disposable equipment and sterilization methods. Such variables superimposed on 12 to 16-hour operating days can be extremely unnerving and provide challenges for leadership and team members alike. These circumstances are wonderful opportunities to experience, for the first time, a sense of gratitude for the technology, efficiency, education, and competence of our work settings at home, which we often take for granted.

Donated Goods and Technology

SATC operates at the mercy of individual and corporate donors who provide the medical supplies and the instrumentation that are used during clinical and surgical procedures. The availability of medical instrumentation and implants is a limiting factor for surgical teams. We have fostered key relationships with industry partners to help reduce barriers to meaningful donations. However, there are consistent challenges in getting medical equipment into Peru. Countless times, medical equipment has been confiscated, and large containers of equipment have been held by the Peruvian National Customs Department. We have encountered much “red tape” and undue monetary requests when bringing surgical supplies into the country, even after providing substantial documentation and obtaining pre-clearance with various governmental agencies. This requires substantial lead time and man-hours many months in advance of each campaign.

Summary

Over the course of its 15-year history, SATC has demonstrated that it is possible to sustain and grow a program to help relieve musculoskeletal trauma in an austere environment in a low and middle-income country setting (Fig. 10). It is essential that the leadership be strong and remain centered on a purpose and vision that is executed through a clear staffing model with results-oriented accountability. A rigorous fundraising strategy is paramount for sustainability. In addition, a plan for leadership transition and an intentional vector of organizational shift from a relief organization to one that promotes development inside the environment in which it serves is essential. Given the projected increase in trauma in low and middle-income countries, the SATC model may be increasingly relevant as a blueprint for other medical professionals to take on similar endeavors. There has been much learned, some of which we have conveyed, but, certainly, additional research into the effectiveness of various organizational models is necessary to advance surgical services in low and middle-income countries. ■

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