

Miami Business School

The Development of a Surgical Mission in The Peruvian Amazon:
Visions, Challenges, and Accomplishments in a 15-Year Odyssey

By

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INTRODUCTION

Inception of an Amazon Medical Foundation

In 2003, Dr. Peter Cole, Chief of Orthopaedic Surgery at the University of Minnesota, was closing a deal on a plot of rainforest situated about twenty potholed kilometers and another seven dirt-road miles from the town “centro” of sprawling Pucallpa, Peru. Pucallpa, an unknown port even to the majority of Peruvian natives, is home to roughly 215,000 inhabitants who by and large live day-to-day as loggers, fishermen, and mototaxi drivers, while neighboring Shipibo-Conibo tribes live off the Amazon terrain in their respective villages.^{1,2} Pucallpa headlines the larger Ucayali Region, home to twice as many citizens, including a lion’s share of Peru’s 13 million indigenous peoples.³

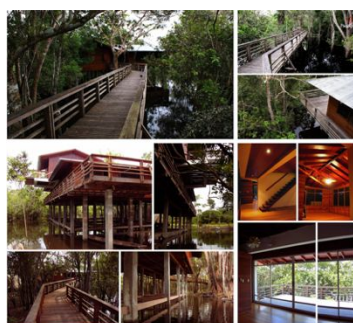
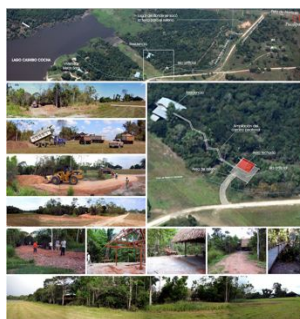
A series of sequentially providential life events invigorated Dr. Cole’s heart for Latin America, equipped him with ached-for skills in the developing world, and situated him in a tributary town known to locals as “End of The Road” before traces of civilization dissolve into the jungle’s cacophony. Now, finally, a seventeen-year dream incepted in medical school, to build an orthopaedic foundation for this underserved cranny of Peru, was budding into fruition.



¹ (Population History, 2015)

² (Porro, et al., 2014)

³ (The Indigenous World, 2006)



A Vision to Ameliorate

The Cole's calling to provide tertiary care in the Amazon had actually been born in the late 1980s when Dr. Cole was in his fourth year of medical school at the University of Miami. He and his wife, Nancy, who ran a clinical psychology practice, had a large South American patient pool and immersed themselves in the Latin customs of America's melting pot. This experience, combined with Dr. Cole's upbringing in Caracas, Venezuela, nurtured a cultural comfort that undoubtedly prepared them for their future ventures. While in South Florida, the Coles met a young, aviation couple who worked for a non-profit (SAMAIR Peru) serving the indigenous people of the Peruvian Amazon. It was this newfound relationship that spurred the Coles to visit Peru and witness the medical depravity that existed in the region.

Oh so much to accomplish in this rundown open air hospital, crowded with wailing patients, rickety wire frame beds, expiring medications, recycled foley tubes... Survival prevails, and a modicum of cure, through the industrious and tidily uniformed workers who show up daily at the crack of dawn, earning a fraction of a living, serving hope to desperation, day in and day out. If only we could...

The Trauma Epidemic

The medical, economic, and societal reverberations that orthopaedic injuries present in the developing world are well documented. Countries of low and middle income (per-capita gross annual income \leq \$1025 and \sum \$1026 - \$12,475 in U.S. dollars) that already suffer from insufficient healthcare resources, claim well over 90% of all injuries—a burden that far outstrips their treatment capacity.^{4,5,6,7} Global health pundits assert that the number of lives claimed each

⁴ (Country and lending groups, 2015)

⁵ (Gosselin, Spiegel, Coughlin, & Zirkle, 2009)

day from injury (five million)⁸ surpass those of malaria, tuberculosis, and HIV/AIDS combined.⁹ All the while, for every trauma-related death, ten to fifty more people suffer permanent disability.^{5,11,12,13} In fact, recent case reports demonstrated that up to half of public hospital beds in a developing-world setting are occupied by trauma patients.¹⁴ The literature indicates that the global burden of musculoskeletal trauma is increasing in dramatic fashion and will exceed that of communicable diseases in the next decade.^{15,16} The consequences of orthopaedic trauma have implications well beyond healthcare. A recent study in Uganda with two year follow up found 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 post-injury; 4) the economic hardships associated with injury forced 39% of patient's dependents to drop out of school.¹⁷ These grim figures personify the austere healthcare condition of the majority world and point to the need for established orthopaedic personnel to recognize their unique skillset as a remedy for this worldwide malady.



GEOGRAPHIC AND SOCIAL CONTEXT

One Country, Two Peru's

Effervescent Lima, Peru, recently characterized by its upscale Miraflores and San Isidro neighborhoods, boasts luxurious shopping centers, world-class gastronomic indulgences, and

⁶ (The World Bank, 2015)

⁷ (Kaya, Ozguc, Tokyay, & Yunuk, 1999)

⁸ (Beveridge & Howard, 2004)

⁹ (Murray & Lopez, 1996)

¹⁰ (Peden, McGee, & Krug, 2002)

¹¹ (World Health Organization, 2004)

¹² (Zirkle, 2008)

¹³ (Beveridge & Howard, The burden of orthopaedic disease in developing countries, 2004)

¹⁴ (Bach, 2004)

¹⁵ (Krug, Sharma, & Lozano, 2000)

¹⁶ (World Health Organization, 2010)

¹⁷ (O'Hara, et al., 2018)

well-preserved historical draws. Rural Peru, meanwhile, remains bogged down by archaic suppressants that stunt upward mobility. Even as the country experiences unprecedented rises in prosperity, its economic growth has been concentrated to its capital city and accompanied by exacerbated discrepancies amongst socioeconomic strata.¹⁸ For instance, in just a six-year span, the poverty rate in Lima dropped from 44.8 percent in 2004 to 15.7 percent in 2011.¹⁵ Meanwhile, the Peruvian outback has continued to languish in depravity. The World Bank reports that Lima citizens earn 21 times more than those living in rural jungle areas, where the poverty rate and extreme poverty rate (\leq \$1,260 U.S. Dollars per year and \leq \$672 U.S. Dollars per year) is a staggering 54 percent and 13 percent respectively.¹⁵ Also recognizable in the literature is a marked racial divide between the Amerindian and non-Amerindian populations with respect to living conditions, access to healthcare, and nutritional status.^{15,18} Barriers such as language, geography, and race are the primary determinants for levels of education, injury, and nutrition.^{15,19} UNICEF and The World Bank report that one-third of rural Peruvian children are malnourished while 78 percent of indigenous Peruvian children are impoverished—twice that of native, Spanish-speaking Peruvian children.^{6,16,20} Comparative analyses are clear that negative indicators of poverty, education, and health are progressively accentuated amongst Peruvian groups, and especially pronounced in the indigenous tribes of the Amazon basin.¹⁷

Ucayali, Peru: Ecological and Social Determinants of Health

Pucallpa, Peru, remained stranded from the rest of society by the Amazon rainforest and Andes Mountain range until the mid 1940s when a highway to Lima was completed.²¹ It has since grown into the bustling capital of the Ucayali Region that represents four provinces composing Mideast Peru. Greater Ucayali has taken baby steps towards economic viability in recent years, although metrics such as illiteracy rate (31% for women; 17% for men) and poverty rate (70%) remain high.²² Research correlates ecological, social, and cultural conditions with health vulnerability of the Ucayali lower class.²³

The local landscape includes distinct sub-regions that drastically change form by the ebb and flow of the dry and rainy seasons. Those located in lowland areas live a largely nomadic lifestyle as their shantytowns become submerged under more than 30 feet of water annually, whereas those dwelling in upland areas face cyclical food shortages during the dry season. In these communities, health service access also takes on a seasonal nature due to either severe flooding or severe need to provide food security.^{24,25} Meanwhile, the seasonal changes and dense rainforest pose lifelong healthcare obstacles to indigenous communities that live in secluded settlements along the Ucayali tributary.^{23,24}

¹⁸ (Instituto Nacional De Estadísticas Informatica, 2018)

¹⁹ (Díaz, Arana, Vargas-Machuca, & Antiporta, 2015)

²⁰ (UNICEF, 2016)

²¹ (Pino)

²² (Alcock, 2001)

²³ (Goy & Waltner-Toews)

²⁴ (Murray & Packham, 2002)

²⁵ (Murray, Kay, Waltner-Toews, & Ruez-Luna, 2001)

With regard to social determinants, the Shipibo-Conibo and other indigenous groups that occupy areas bookending the Ucayali River face significant hardship. The primary factors that put locals at health risk include isolation from resources or decision-making influence.²² Due to the transitory nature of the group, population metrics are both sparse and misleading, though the monetary income of Shipibo-Conibo and mixed-race inhabitants matches them into the extreme poverty designation.²⁴ Amongst the impoverished, women are particularly at risk due to their societal standing. The majority of them face racial and gender discrimination, and do not have access to land resources, employment, or education; seventy percent of them are married by age seventeen.²² Many villagers of indigenous descent who immigrate to Pucallpa for a better lifestyle, invariably assume living in the city's hazardous slums.^{26,27} In these cases, new exposure to infectious diseases, an erosion of customs and social support systems, and skepticism about contemporary healthcare all propagate health risk throughout their culture.²⁶



²⁶ (Spear, 2002)

²⁷ (Follér & Garrett, 1996)



Health Metrics in Ucayali

Poverty in the Ucayali Region is comorbid with high healthcare need and few healthcare resources. Five small hospitals serve a population estimated above 450,000.²⁸ Sixty-seven percent of Ucayali residents live with at least one basic need unmet.²⁷ The infant mortality rate is 30 per 1,000 (compared to 3.3 per 1,000 for above median GDP countries) and there are .39 physicians per 1,000 people (compared to 3.4 per 1,000 for developed countries).^{27,29} It is likely that these metrics overestimate the Ucayali healthcare status due to selection bias, and represent only those who are documented and live in conditions robust enough to be tracked.

²⁸ (World Data Atlas, 2011)

²⁹ (Peterson-Kaiser Health System Tracker, 2014)



Orthopaedic Need in Ucayali

Pucallpa, Peru, is the prototypical environment wherein a trauma epidemic outpaces the medical, human, and capital resources set in place to combat it. The confluence of high-energy occupations under impoverished conditions harmonized by a paucity of healthcare resources

creates for trauma malady well known to much of Latin America. Due to its accelerated urbanization, there exists a chaotic and dangerous road-scape where drivers, passengers and pedestrians alike fall increasingly victim to accidents. In fact, Pucallpa and the areas that surround it are exemplary of what has been described as “disease conferred by emerging prosperity” where the highest number of mortalities are caused by motor vehicle accidents and other traumatic mechanisms.³⁰



³⁰ (World Health Organization, 2003)



District hospitals providing initial treatment for large volumes of injured patients are not equipped with the funding, resources or expertise necessary to treat severe injuries. In these cases, high energy trauma patients presenting with critical morbidities are referred to larger hospitals, and are then responsible for purchasing the drugs and implants necessary for surgical fixation prior to surgery. The condition of the patient, coupled with the costs of anesthesia and medical implants, often makes treatment unattainable. A recent study in Uganda identified that of patients who were admitted with the intention of operative treatment, only 56% were able to receive it due to resource constraints; we believe that these findings are generalizable to other parts of the world that are similarly under-resourced and over-burdened, and estimate that Ucayali patients suffer a similar fate.¹⁷ Patients with conditions such as open fractures that must be treated immediately are prone to especially drastic outcomes when they are denied treatment. If a patient is able to receive surgery, the systems in place are not ideal—intraoperative imaging is not available, adequate hardware is frequently unavailable, and surgeons are often undertrained to treat these complex cases. For instance, because there are few alternatives, a general surgeon may take on a case that would require years of Residency and Fellowship training to have a functional expected outcome. Therefore, many orthopaedic trauma patients have suboptimal outcomes such as mal-union, non-union, and osteomyelitis. It is important to emphasize that the local medical personnel are diligent, technically skilled, innovative by need, and must rely on tactile sense to insert implants due to most operating rooms lacking radiological technology. However, there are systemic issues with administrative corruption, high turnover, and limited resources that consistently undermine the local medical community, and render them unequipped to treat the volume and complexity of some of the problems with which they are presented.^{31, 32}

HISTORY OF THE MISSION

Scalpel At The Cross Background

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 providing the basis for his patient pool. Today, his family's organization, named Scalpel At The Cross (SATC), has invested 15 years in collaboration with and treatment for the Pucallpa community and the areas that surround it.

³¹ (Los Problemas Médicos Legales, 2018)

³² (Hunt, 2007)

Key Alliances

Since the beginning, SAMAIR Peru was the local connection working side-by-side with SATC and ultimately offering the land and network resources necessary for a seamless mission launch. Though SAMAIR has been used to fly SATC teams into Amazon tribes to set up clinics, their invaluable contribution has been immersing SATC teams into the greater Pucallpa community. Other local ministries such as South American Mission, United Servants Abroad, Living Water International, and the Swiss Mission of Peru, have also played instrumental roles in helping SATC build local credibility.

Unlike most medical organizations which function independently from local hospitals, SATC has embraced partnerships with government regional hospitals as an essential aspect of their model. The first connection took place in 1989 when Dr. Cole introduced himself to the staff at Hospital Regional de Pucallpa. As an active member of the international orthopaedic society (AO Foundation), Dr. Cole would often receive invites to lecture in Lima, and then extend his trips to Pucallpa to cultivate a medical network. The whole family would tag along for these medical “adventures” with their youngest making his first jungle foray at the age of six months. Each trip rooted the Coles deeper into a long-term commitment with Hospital Regional, and that partnership continued well into the SATC years. In 2012, political tensions caused the SATC/Hospital Regional marriage to falter, and SATC entered into a fresh partnership with Hospital Amazónico de Yarinacocha with whom it has operated ever since.





The Mission Model

As will be demonstrated in the “Value” section, the SATC Model provides a blueprint for future practitioners of orthopaedics to take on similar endeavors in the developing world. SATC has a board of directors that meets every three quarters to review budgets, mend challenges, and strategize future initiatives. Four employees are under contract: the Mission Director organizes teams, leads trips, and manages operations; the Mission Coordinator drafts financial reports, handles medical device paperwork, and champions patient informatics; the local healthcare provider in Peru conducts post-surgical follow up treatment for patients and reports data at 2, 6, 16, and 36 weeks after surgery into the SATC outcomes program; the Property Groundskeeper maintains the property and living quarters year round, while hosting teams during their stay.

The SATC model is to take teams of 10-20 members to Pucallpa to evaluate patients with orthopaedic conditions, many of which necessitate surgery. Team makeup typically includes three surgeons, various other medical personnel such as nurses, physician assistants, and surgical technicians, a medical device representative, and other nonmedical volunteers. Though SATC has facilities to evaluate patients and host teams, the surgeries are performed at one of two local government hospitals with which SATC has built relationships.

The conditions are austere, but provide an adequate operating environment. A typical trip includes a couple days on either end traveling in and out of the jungle, a 1-2 days for patient evaluation, and a 3-4 days for operating. Around 75-150 patients are evaluated in clinic per trip, with 20-35 operations performed, and a number of conditions treated with non-surgical interventions like casting, injections, or non-operative recommendations. Operations are generally extensive and technically demanding, even by North American standards. Recent years have included 3 medical trips annually with a goal of one trip per quarter. All team members travel with medical and surgical supplies, keeping treatment needs replete with options. 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 lasting relationships. The model is intentionally not to take over a local hospital, nor to have personal facilities manage all aspects of care. It is through co-laboring that SATC believes the greatest value of medical care is manifested. To remain accountable to its donors and supporters, SATC tracks and regularly reports on metrics such as the value of donated professional hours, dollar value of donated equipment, number of patients evaluated, and number of operations. These

metrics result in a total estimated medical value to the people SATC serves, and a basis for return on dollars spent administratively.

PATIENT POPULATION AND COMMON PATHOLOGY

SATC surgeons treat not only broken bones, but also perform reconstructive surgery involved in correcting skeletal deformity and complex bone mal-alignment, which often involves the cutting and reorientation of bones, lengthening of tendons, release of scar tissue, and expansion of skin.



Pictured on the left, a surgeon applies screws to the bone through the plate first by predrilling with a power drill which was donated by the mission. Shown in the middle, Co-founder, Nancy Cole, applies a dressing to a scalp incision for an abscess which was drained by the surgeon in a primary care clinic setting. Shown on the right is a “home made” external fixator, created by local surgeons to stabilize a compound tibia fracture sustained in a mototaxi accident. The side bars are made with aluminum window siding, and are connected to pins which penetrate the bone, using cement around the pin-sidebar interface.

Outcomes

The last reported SATC patient follow-up rate (81.9% at 11.8 months) published in 2016 compares very favorably with the largest series of follow-up operations in fifty-five low and

middle-income countries (18.1%).³³ The SATC model is innovative in placing the incentive for follow-up on the provider rather than the patient, and we hypothesize that this realignment of incentives mitigates the burden of time, effort, and transportation costs incurred by the SATC patient population. It is difficult to obtain follow-up in the U.S. where transportation is generally seamless, much less in an environment that requires extensive travel by primitive means, such as by foot, mototaxi, or dugout canoe.

Neglected injuries represent the vast majority of SATC patients, who present at a mean time of 35.4 months' post injury.³³ These data are yet another indicator that the orthopaedic surgical pathology of the developing world differs greatly from what is encountered in the U.S. and other developed societies. The broader point that these data portray is that it is possible to achieve a robust outcome program for patients after surgical trips to the developing world, even in an austere medical environment.

Infection Rate	2.0%
Wound Healing	97.1%
Fracture Unions	95.5%
Non-union	3.0%
Mal-union	1.5%
Good or Fair Outcome	96.2%

³³ (Michael T. Torchia, 2016)

Scalpel At The Cross
Follow-up Sheet (Spanish)
Lower Extremity (Extremidad Inferior)

DATE (Fecha): _____ Follow-up (Seguimiento) Weeks (Semanas) ☐ 2 ☐ 4-10 ☐ 11-15 ☐ >20

LAST NAMES (Apellidos): _____ FIRST NAME (Nombre): _____
 TELEPHONE (Teléfono): _____ OCCUPATION (Ocupación): _____
 ADDRESS (Dirección): _____
 ADDRESS AND CONTACT (Dirección y Contacto): _____
 RELIGION (Religión): _____
 SEX (Sexo): ☐ M ☐ F Age (Edad): _____ Date of Surgery (Fecha de Cirugía): _____
 Type of Injury (Tipo de Lesión): _____

X-Rays: ☐ Anterior/Posterior ☐ Medial/Lateral
 Fecha de X-Ray (Date of X-Ray): _____
 Curación de Heridas (Wound Healing):
☐ Buena (Good) ☐ Mala (Poor) ☐ Pobre (Poor)
 Rango de Movimiento (Range of Motion):
☐ Buena (Good) ☐ Mala (Poor) ☐ Pobre (Poor)
 Capacidad Para Caminar (Ability to walk):
☐ Buena (Good) ☐ Mala (Poor) ☐ Pobre (Poor)
 Calentamiento (Warmth):
☐ Buena (Good) ☐ Mala (Poor) ☐ Pobre (Poor)
 Neuropatías (Neuropathies):
☐ Buena (Good) ☐ Mala (Poor) ☐ Pobre (Poor)
 El dolor de nivel (Pain Level):
☐ Alto (High) ☐ Moderado (Moderate) ☐ Bajo (Low)
 Medicamentos que se toman (Medications taken): _____

Función (Function):
☐ Actividad normal (Normal activity)
☐ Limitaciones leves (Slight limitations)
☐ Limitaciones severas (Severe limitations)
 Si necesita la oportunidad de hacerlo de nuevo, se le practica una cirugía más vez? (If he needs the opportunity to do it again, will he have another surgery?)
☐ No ☐ Sí

Strength Grading (Circle appropriate grade):
 1. No strength
 2. Moderate strength
 3. Good strength, but not quite good
 4. Good strength, slight weakness but not full strength
 5. Full strength
 Comentarios (Comments): _____

Indicaciones (Indications):
 (Indications)



Name & Date of Surgery Blinded Surgery)				
	Paper	Anatomy	X-rays	
Clinic				
Surgery				
2-wks				
6-wks				
16-wks				
36+ wks				

On the top left is the patient data form which provides patient history and physical exam information collected by the local Peruvian General Surgeon. This form was sent electronically (scanned) to our database in the US. An anteroposterior view of a Tibia and Fibula reconstruction using plates and screws and bone grafting technique to restore length, alignment and rotation to the bone as well as stability. On the bottom is an example, taken from a SATC article published in *Journal of Bone and Joint Surgery*, of the data collection matrix utilized to monitor follow-up progress via photographs recording wound-healing, clinical examination, and radiographic results across the follow-up visits.

Neglected Injury

Oftentimes, SATC teams treat the manifestations of crooked bones that did not heal in proper alignment, mangled extremities that healed with draining infections, and congenital conditions such as clubfoot and hip dysplasia that go untreated at birth and create lifelong deformity. One such case is the story of German, who fell from a tree while trying to pick its fruit, breaking his tibia and fibula bones. For eight years, he walked on a leg that shifted and cracked with every

step. The opportunity cost and travel expenses to the nearest hospital, much less the necessary implants and treatment for surgery, were far beyond what he could afford as the caretaker for his family of six. One day, he heard on the radio that a medical team of orthopaedists was coming to Pucallpa. He decided to sell his yearly crop of rice in order to pay for his trip. German, together with his wife, Anna, set out to travel to Pucallpa on the Amazon tributary in a small, rented boat with a small motor to help them navigate the large amounts of debris in the river. For three days, there was little to occupy their minds except for the next branch, the occasional canoe, and the Amazon's oppressive heat. Once arriving at a main port, they hopped in a mototaxi and headed to Hospital Amazónico. There he waited in a line of over one-hundred patients wondering if he would be seen, and hopefully, chosen for surgery.

German was one of 15 operative cases that SATC completed during the campaign. He experienced a successful outcome. He is one of many patients with a similar story. SATC has cared for patients coming from hundreds of miles all over the mountainous jungle with treks via foot, dugout canoe, boat, motorcycle, flight, or some combination thereof. Though the medical care provided to them is free, the costs associated with travel as well as the opportunity costs from missing work are significant.



Shown on the left is German's 86.4 kilometer journey from his home to Hospital Amazónico. Pictured on the right is German and his wife post-surgery with the SATC surgeons. It is not uncommon that missionaries from ally organizations notify or fly in patients to clinic, which involves traversing dense terrain and winding tributaries throughout the Amazon basin. It is not rare for someone to travel 2-3 days to see SATC surgeons.

Club Foot



Congenital foot deformities are common and untreated because they are undetected by medical experts in this region of the country. Often, these patients are crippled and marginalized in society. These images demonstrate severe bilateral clubfoot deformity in a three-year-old child. SATC has provided local education to healthcare surrogates who apply the nonoperative, Ponsetti method of manipulation and casting to help correct the deformity early. If the patients are not treated within months of birth by this method, then the deformities become fixed and require surgical intervention.



Above is a severe congenital foot deformity as well with planovalgus feet and variations of polydactyly and brachydactyly, terms applied to too many toes or shortened or missing toes respectively. An intraoperative image of a clubfoot correction involving tendon lengthenings, joint capsular releases, and corrective pinning of the hind foot. Postoperative clinical correction is demonstrated from the images. The foot progression angle is now proper. In the middle is the corresponding radiograph of the pictured foot. On the right, is a photo of the patient and mother postoperative day 1.

Gun-Shot Trap



Shotgun triggers attached to trip-wires throughout the jungle are used to kill animals such as wild boar and jungle vermin. Unfortunately, these unregulated missile-traps are a great danger to native Indians who traverse the rain forest terrain. Invariably, there are lower leg blast injuries which occur frequently and are indeed witnessed on every surgical campaign. Pictured on the left are X-ray images of a tibia and fibula bone broken by missile fragments and stabilized by a makeshift external fixator. The clinical photo is an open wound that has undergone irrigation and debridement and dressing changes to heal the integument. Many techniques related to internal and external stabilization of bones as well as wound care are taught by the surgical teams to local “Traumatologos.”



Pictured above is a locally treated foot wound sustained 15 months earlier from a gunshot. The corresponding radiographs show the massive bone loss of the lateral column of the foot. The patient is weightbearing completely through his first ray, and the condition is very painful. Though patients in the US would undoubtedly opt for amputation in this case, prosthetics are expensive and hard to come by locally, and amputations can be looked down upon societally.

Skeletal Malunion



Shown in these images is a right tibia and fibula nonunion. This leg is flail, has no stability and cannot bear weight. The mobility of the non-union is demonstrated clinically through the deformity which can be manipulated even at the bedside. The patient is under anesthesia and cannot feel pain from the manipulation. The open medial surgical approach shows the hardware, plate and screws, which were used to fix the non-union after it was corrected. On postoperative day 1, the child appears to be pleased. He is casted to protect the fixation from weight bearing for 6 weeks.

Skeletal Deformity



Pictured are the X-rays and the clinical image of a patient with Blount's disease, an acquired deformity which is idiopathic and carries familial traits. Such deformities can also occur with Vitamin C deficiency Ricketts. In this condition, the medial side of the proximal tibia growth

plate grows more slowly than the lateral proximal tibia growth plate. Therefore, lateral growth plate ablation can be done to promote symmetric aligned development of the tibia long bone.

Infection



Open fractures in severe traumatic mechanisms occur frequently in an increasingly mechanized society with few resources to handle the epidemic of orthopaedic trauma. Pictured are exposed and desiccated bone which was never covered properly. Such a patient may be a candidate for an amputation, which is stigmatized societally in Ucayali. The injury on the left occurred from a lumber refining station. The patient in the middle lost a significant portion of his soft tissue and musculature from a venomous snake bite, which progressed into a condition called compartment syndrome. On the right is a similarly severe open chronic wound, which was incompletely treated after sustaining a shotgun injury.

Innovative Procedures



Shown above are two clinical views of a pedicled groin flap to cover an open wound in the arm and provide vascularized coverage for a wound. After 3-4 weeks of maturing, it is taken down to close both wounds at the groin and the arm providing integumentary coverage to prevent infection.



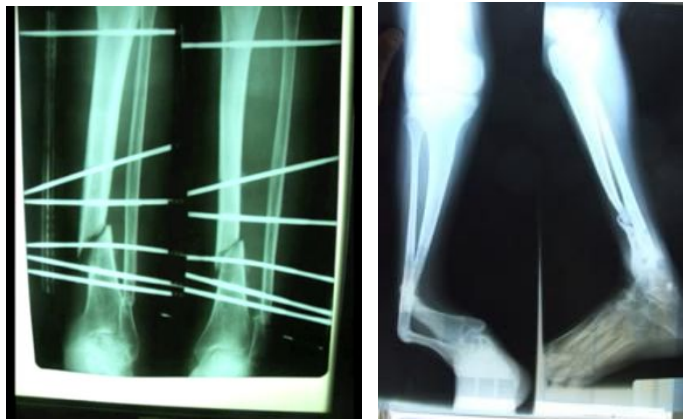


Shown above is a chronic wrist deformity from an industrial lumber accident which occurred three years before presentation to the SATC team. Shown on the top row is a close-up of the wrist and hand, volar surface, with an anteriorposterior view of the wrist preoperatively showing severe distal radius bone loss and radio-ulnar dissociation. Shown on the bottom left is intraoperative image of a local bone harvest for a segmental transfer from the ulna to the metaphyseal defect in the ulna. Illustrated in the bottom middle is a postoperative view at three weeks post surgery showing significant correction of the deformity and the O-sign to demonstrate intact median nerve function which would have been at risk in this reconstructive procedure. Shown on the right are postoperative radiographs of the patient depicting stable fixation with restoration of alignment and rotation, although length was not completely restored. Nevertheless, the patient was very pleased with the difference in function and pain levels.

Skeletal Non-union



Pictured on the top left is a classic valgus deformity of the elbow. An X-ray of the child shown demonstrates an anteriorposterior view and lateral view of a likely lateral condyle nonunion.



Shown on the left are X-rays of a Tibia stabilized with a makeshift external fixator. The tibia is not healed and some intervention will be required when the external fixator is removed. Another example of a Tibia and Fibula nonunion is shown on the right. This likely is a result of a neurofibroma which is a nerve tumor which interferes with proper development of the leg and often manifests in such non-unions.



Pictured is a 60-year-old female patient with genu varus knee deformity, and a left sided tibia and fibula nonunion untreated for 21 years. She actually does attempt weight-bearing through this deformity but this causes pain at the site and associated pain of the ipsilateral knee, hip and the back because of compensatory gait mechanics. SATC performed surgery on the tibia and fibula nonunion and she experienced a successful outcome.

VALUE, BUDGET, AND FUNDRAISING

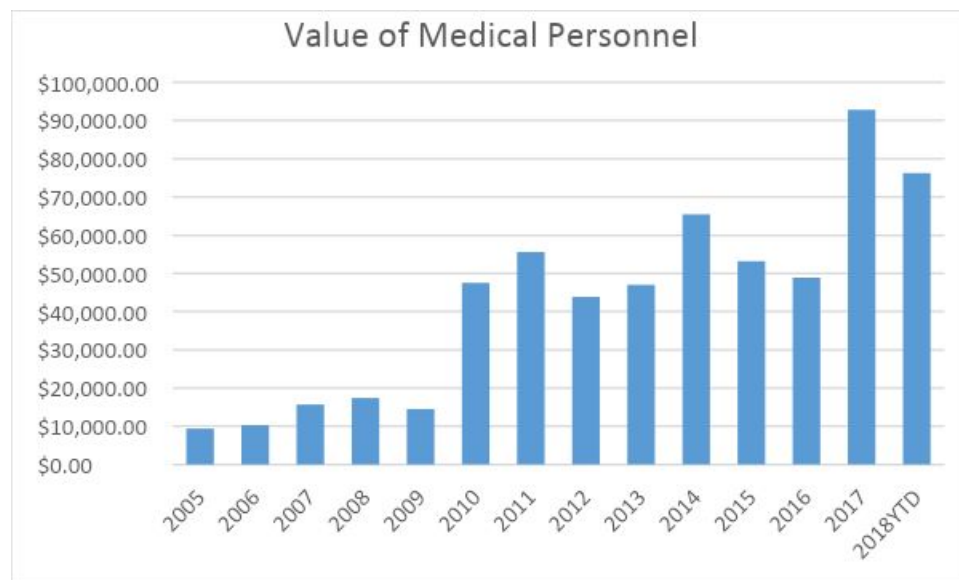
It is important to delineate the medical value that SATC and its campaigns provide. However, in order to fully appreciate the true value of medical mission work, one must understand that these metrics pale in comparison to the intrinsic value of lives changed, relationships developed, and patients returned to livelihood. The following analysis demonstrates the financial undertaking and the value of medical care of SATC's investment over the course of its history.

Valuation Methods

It is difficult to put a quantifiable value on the medical care provided by SATC; our methods do not capture values such as surgical training for local surgeons and its future impact on medical care. SATC has organized orthopaedic conferences at local hospitals, facilitated sponsorships for local medical personnel to be educated in the U.S., and provided U.S. Orthopaedic Residents with scholarships to take their training to Peru. Additionally, our methods do not accommodate the thousands of hours of follow-up care provided by SATC, the hundreds of non-operative assessments provided by SATC, or the hundreds of E-Consults consistently performed by SATC from afar. SATC does have different valuation sources and methods for medical care which will be explained in the following sections.

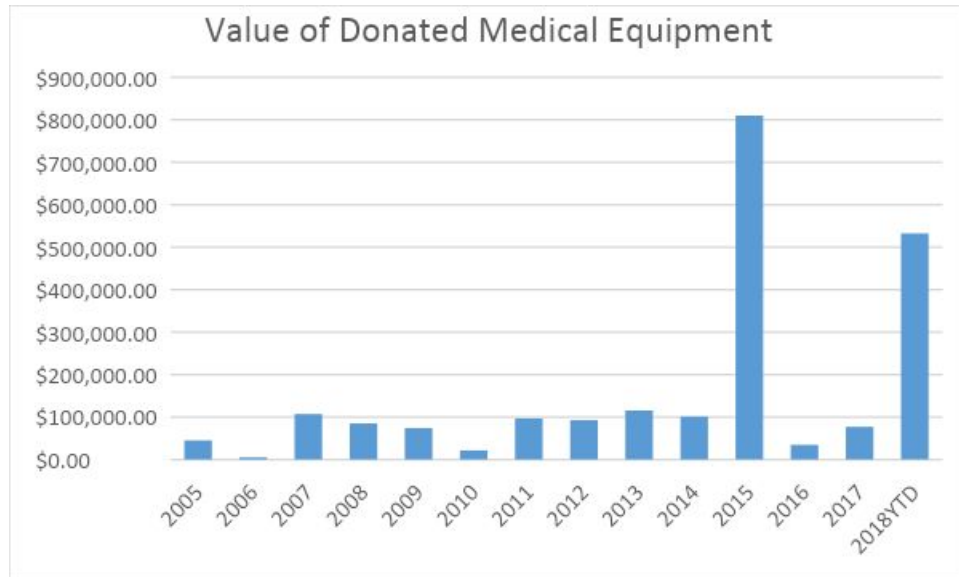
Value of Medical Personnel

Our valuation for “Donated Team Member Time” is calculated by valuing the opportunity cost of medical professionals on SATC teams. In order to obtain these values, we added the cumulative sum of the mean income for the orthopaedists, emergency room doctors, nurses, physician assistants, surgical technicians, physical therapists, and medical device representatives, multiplied by the number of days spent on SATC campaigns. In total, over the course of 30 surgical campaigns, the value of medical personnel that SATC provided is approximately \$597,885 USD.



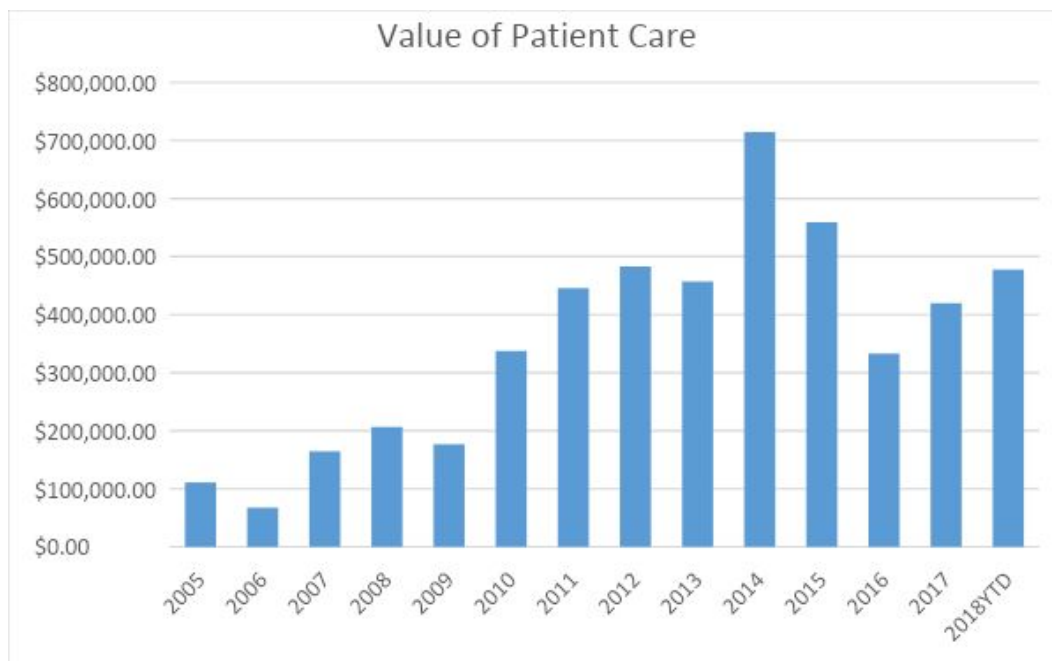
Value of Donated Medical Equipment

Our valuation for “Donated Medical Supplies” is calculated by adding the valuation assessments of the medical device companies that donate equipment for SATC use. In cases where the medical device companies did not provide a valuation for donated supplies—often the case with soft goods—SATC surgeons provided expert assessments of the equipment. In total, over the course of 30 surgical campaigns, the value of donated medical supplies that SATC teams have provided is approximately \$2,197,770 USD.



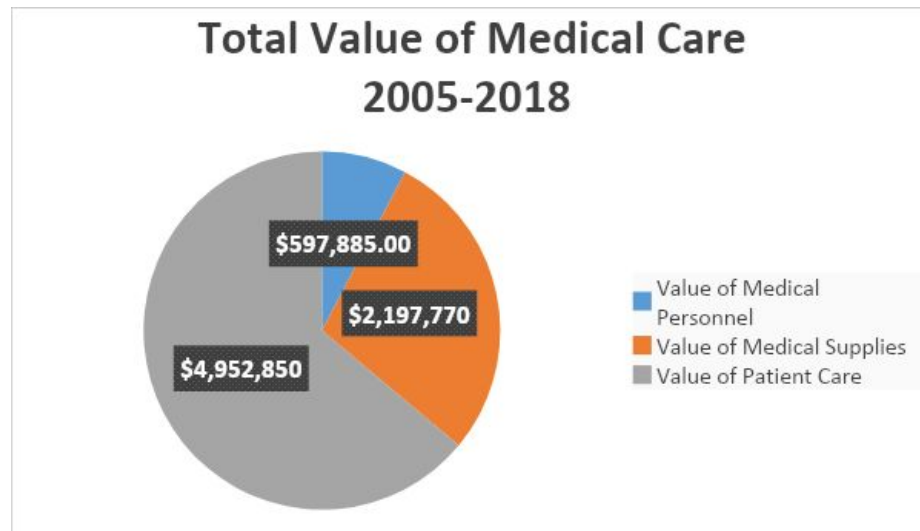
Value of Patient Care

Our valuation for “Patient Care” is calculated by taking all of the surgical and clinical procedures performed by SATC personnel and valuing each of them specific to the Current Terminology Code (CPT Code) maintained by the American Medical Association through the CPT Editorial Panel. In total, over the course of 30 surgical campaigns, the value of patient care provided by SATC teams is approximately \$4,952,850 USD.



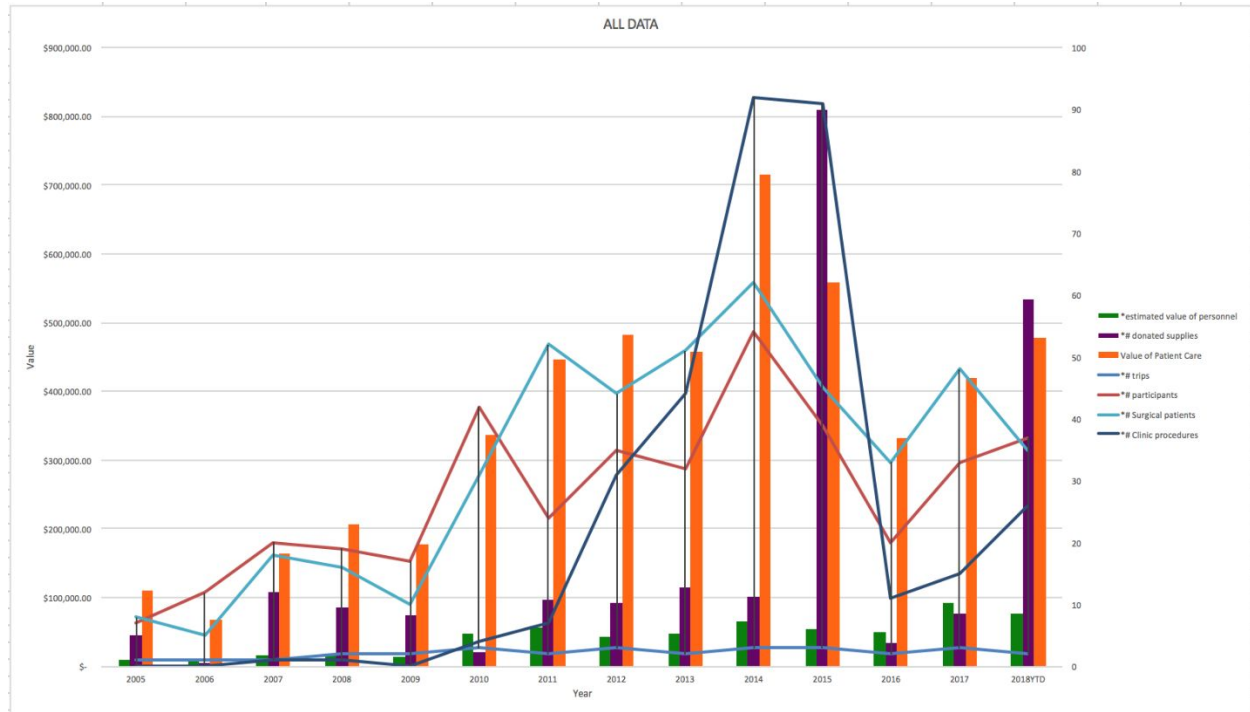
Total Value of Medical Care

Our valuation for “Total Medical Provision” is calculated by taking the cumulative summation for “Value of Medical Personnel,” “Value of Donated Supplies,” and “Value of Patient Care” in one graph denoted as “Total Value of Medical Provision.” In total, SATC has provided approximately \$7.75 million USD from 2005-2018, in which time 30 medical trips were taken.



Scalpel At The Cross Totals

Below are the values for each of the aforementioned methods (Value of Medical Personnel Time, Value of Donated Medical Equipment, Value of Patient Care) in addition to Number of Trips, Number of Participants, and Number of Surgical/Non-surgical patients, in one figure.

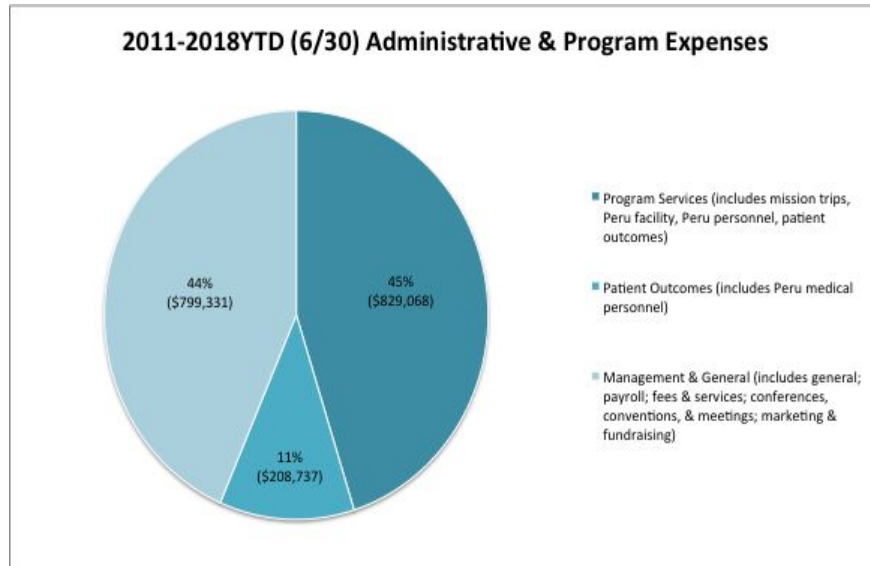


Uncaptured Value of Services

SATC orchestrates a number of endeavors that have not been valued in our metrics and likely represent hundreds of thousands in USD. In its recent history, SATC has led local conferences, sponsored U.S. medical rotations and externships for Peruvian students, and even made available short-term fellowships for Peruvian doctors interested in furthering their training. In addition to this, SATC has provided valuable clinical assessment and follow-up care through the mechanism of email consults.

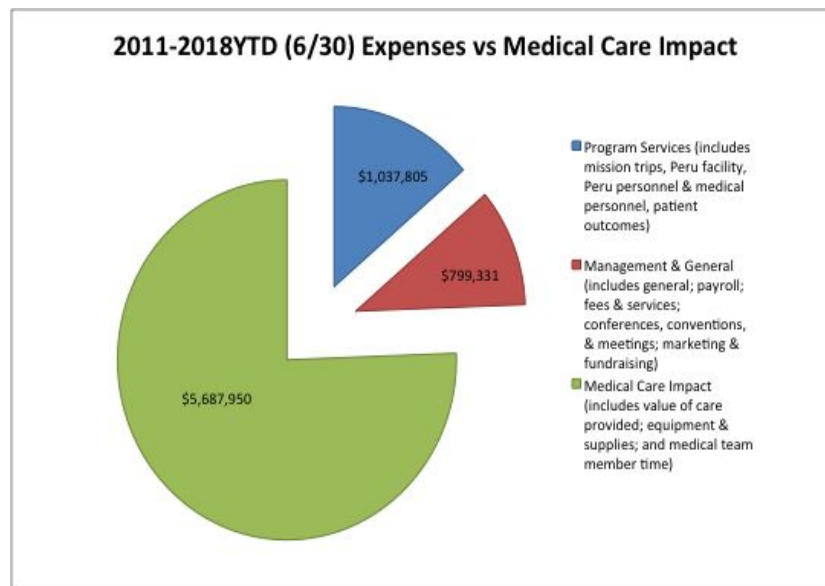
Value of Expenses

Our valuation for “Value of Expenses” is calculated by taking all SATC expenses and dividing them into three groups: Program Services, Patient Outcomes, Management and General. “Program Services” include but are not limited to medical campaigns, and facility costs, and on-site groundskeepers. “Patient Outcomes” include local medical coordinator and outcomes program technology. “Management and General” includes but is not limited to board meetings, mission director, mission coordinator, and website and marketing programs.



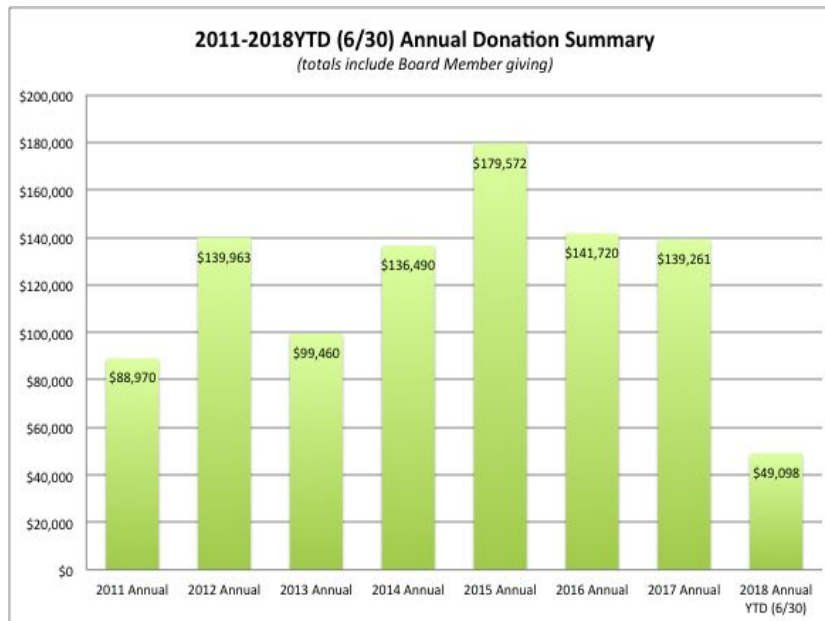
Value of Expenses vs. Value of Medical Care

The “Value of Expenses vs. Value of Medical Care” figure demonstrates the total summation of expenses versus the total summation of medical care impact using the data illustrated in the the aforementioned graphs. It is important to note that these totals are representative of years 2011-2018.



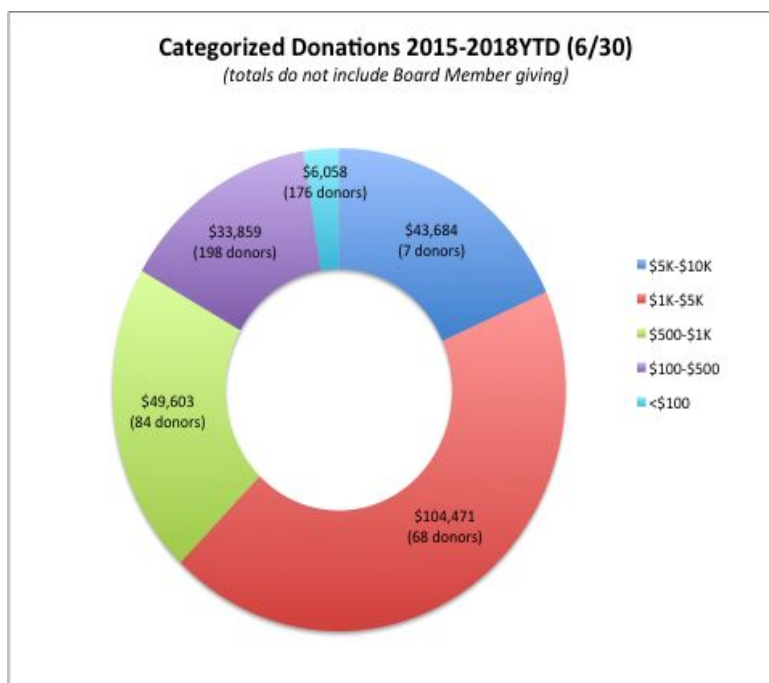
Annual Fundraising

The “Annual Fundraising” table demonstrates the total annual monetary donations to SATC in USD between 2011 and 2018 YTD.



Categorized Donations

The “Categorized Donations” graph demonstrates the breakdown of monetary donations by number of donors to SATC in USD between 2015 and 2018 YTD. It is important to note that these totals do not include board member giving, which accommodates for 40 to 55 percent of SATC donations.



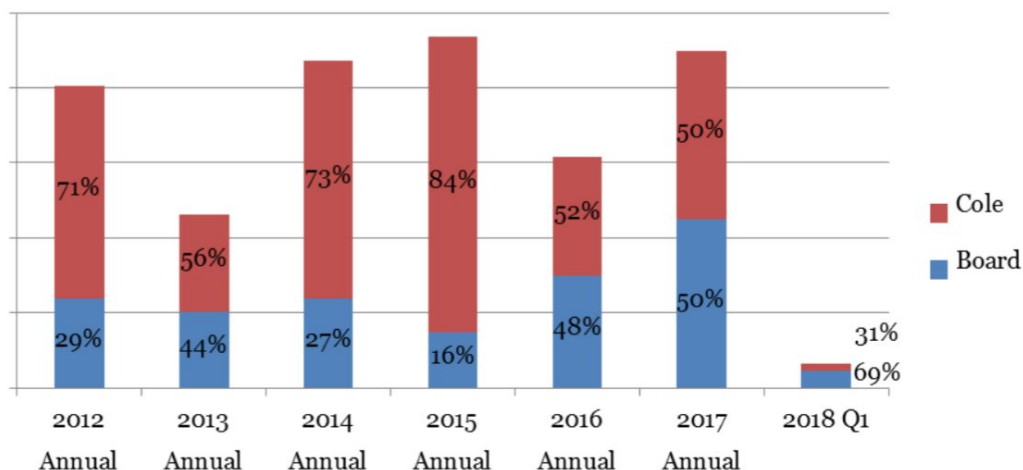
Summary of Results

Since 2005, SATC has deployed 391 volunteers on 30 surgical campaigns to Pucallpa for 10 day periods to provide orthopaedic treatment for the poor. Through its history, SATC has provided approximately \$7.25 million USD in total medical care, while investing approximately \$1.84 million USD in implementation and overhead since 2011. SATC'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.

How to Optimize Impact?

In its near 15-year history, SATC has experienced increased growth, efficiency, and impact. However, SATC constantly asks questions such as: *How can we optimize our value of medical care? How can we organize more medical campaigns? How can we alleviate more suffering? How can we increase the financial sustainability of our model?* The answer to these questions is certainly influenced by fundraising, which has been a limiting factor for SATC. Referencing the pie graph above that excludes board member contributions as well as the Cole's personal giving, SATC has raised \$237,675 USD from 2015-2018 YTD. When including board member contributions and excluding the Cole's personal giving, that number increases to \$509,651 USD from 2015-2018 YTD. Historically, the co-founders have contributed two-thirds to the board's one-third. Running on a budget of approximately \$225,000 per year, SATC is currently in jeopardy, relying too heavily on board contributions and far too heavily on its co-founders' donations to be sustainable without those sources of funding. Though fundraising has been identified as a consistent priority during every board meeting, SATC has not yet been able to successfully solve their fundraising problem. The case study persists on this issue: How can SATC increase its fundraising so that it is sustainable without the Coles?

Annual Summary - Board 2011-2017



MISSION CHALLENGES

There are several challenges inherent to operating a medical non-profit, many of which are specific to the developing-world setting. The following challenges have been highlighted by Dr. Cole as the most significant throughout the SATC lifespan.

Socialization and Politics

Hospital politics and administrative conflict are issues that are felt in any and all healthcare settings. The SATC experience has been no different, and there is cultural baggage that can originate from Americans operating in a developing-world setting. In its first seven years, SATC operated alongside Hospital Regional de Pucallpa and strived to develop several medical allies within the local system. However, consistent administrative turnover created a rotating door of new characters that had varying sentiment about working with medical teams from the U.S. One local surgeon, in particular, made it a goal to create conflict and undermine SATC teams in the hospital. Specifically, he would disrupt operating schedules, cause rifts with the staff that SATC worked alongside, and even went as far as influencing patients to worry that SATC teams were using them as “medical experiments.” After prolonged tension, the Hospital Regional/SATC partnership came to an end and a SATC/Hospital Amazónico partnership was born.

Team Difficulties

There are cultural and physical challenges that often create difficulty for Americans operating in the developing world. It is difficult to successfully provide a clinic, triage patients, and run a rigorous operating room schedule; it is even more difficult to do so in an unfamiliar language and environment, where politics are challenging and team members are under physical and mental duress. SATC trips are demanding, and not uncommonly, team members come down with varying degrees of sickness in the midst of an already difficult schedule. Such morbidity has included sickness and fatigue, tarantula, snake, piranha, and monkey bites, flight cancellations, flooding, motor vehicle accidents, and emotional stress, all of which require SATC resources and medical attention.

Surgical Complexities

There are realities of operating in a cross-cultural, austere environment that surgeons must overcome. Because there are extreme mechanisms of injury, neglected pathology and deformity, different standards of clinical and surgical care, and a paucity of resources delegated to surgery, imaging, and sterilization, SATC surgeons experience never-before seen cases while operating with limited resources at their disposal. They are working with volunteer teams and local hospital personnel that may not understand the stress that comes with being held responsible for patient outcomes. Given the oftentimes 12-16 hour operative day, this can be extremely unnerving and eventuate in challenging a lead surgeon's composure.

Higher occupational risk related to poor protective gear (gloves, shields, x-ray gowns), lack of knowledge of blood-borne diseases patients may carry, or dehydration due to lack of air conditioning and air quality all serve to exacerbate stress levels. Factors which further compound surgical tensions and increase procedural risks for the patient are: poor education of staff on sterility; compromised quality of draping barriers; lack of familiar functioning equipment; and unregulated protocols around reuse of disposable equipment, sterilization methods, and technology audits.

Moreover, there are pressures inherent in operating in a cross-cultural setting which values relationships over results as well. Tardy patients, dropped lab results, endless postponements, and high turnover times do not have the same deleterious effect on local staff as they do on impatient Americans wanting to accomplish procedures within strict confines of time. In sum, these collective stressors must be taken in context where surgeons are operating on: 1) pathology which has unfamiliar complexity due to the natural history of disease-neglect; and 2) patients who have no other answers, given their place in society, for alleviation of pain and dysfunction. The task seems even more daunting given the surgeon's use of unfamiliar language, instrumentation, and assistants to help accomplish the surgical tactics and goals set forth.

Donated Goods and Technology

SATC operates at the mercy of individual and company donors that provide the medical supplies and instrumentation used during clinical and surgical procedures. Because SATC can only provide as much medical care as they have in resources, medical instrumentation is somewhat of a limiting variable for SATC. In the past, SATC has been fortunate enough to have sufficient medical equipment to provide healthcare. However, there are consistent challenges related to bringing medical equipment into the country. Countless times medical equipment has been confiscated and large containers have been held by Peruvian National Customs. SATC has consistently faced red tape and undue monetary requests when bringing surgical supplies into the country.

Theft

It is necessary for those operating in Latin America to be watchful of their belongings. SATC teams have dealt with thefts ranging from trivial amounts to forceful burglary of passports. The most significant theft in SATC history was the theft of hundreds of thousands of USD equipment from the SATC clinic. This presented a challenge for the surgeons on the trip who were unable to perform a lot of the procedures due to the loss of equipment, and put the pressure on SATC to acquire more medical equipment for the future.

It was not even a year later when SATC identified the culprit. During clinic, SATC was examining a patient whose was suffering tibia/fibula mal-union after his operation by a local surgeon. When Dr. Cole reviewed the patient's X-rays, he recognized the medical hardware used in the operation as that which had been stolen. When he asked who performed the surgery, the patient identified the same surgeon who had caused the rift with the previous hospital.

Invasion Threats

“Squatting,” the action of occupying an area of land without permission, has become a dire phenomenon for land owners worldwide and is especially problematic in developing countries. In Peru, squatting is recognized as a civil conflict between the wealthy owners and impoverished squatters; the squatters exercise de facto ownership wherein they possess legal right over the areas that they have squatted by virtue of occupation, rather than ownership. In simple terms, this legal “negligence” puts all private landowners at risk for losing their land to squatters. Squatting has become a major issue in Pucallpa and for SATC and its allies, of whom some have been forced to fight off squatters on a number of different occasions. In several instances, thousands of squatters have built structures on private land overnight and had to be forcefully removed. The squatting situation has become a serious threat to SATC land and safety, and SATC is currently orchestrating strategies to combat it.

Fundraising, Fundraising, Fundraising

To date, SATC has endeavored to support itself through a variety of traditional means: fundraising dinner events held in various cities throughout the U.S. with silent auctions featuring Peruvian wares; outreach to grateful patients stateside who are philanthropically motivated and desire to “give back” for the priceless gift they’ve been given through the surgical expertise of SATC doctors; routine outreach to former donors with notes of thanks, income tax receipts, and newsletters about current SATC happenings; appeals/challenges to board members to raise minimum amounts annually, in part, by examining key connections that might have an interest in healthcare non-profits; brainstorming sessions around what author Shane Snow refers to in his book *Smartcuts* as “lateral thinking,” or applying entrepreneurial/technological concepts to grow our particular business; SATC power point presentations and literature distribution in settings within circles of influence such as churches, academic institutions, and clubs/fitness centers; utilization of estate planning methods for consideration by the elderly; applications for academic, non-sectarian grants or non-profit grants with international emphases; use of social media in spreading the word about SATC’s impact; appointment of a sub-committee entitled, “Strategic Development,” to specifically target this area.

Despite tremendous effort, however, SATC’s funding has not matched the dramatic growth it has undergone in recent years. The budget is tethered by a sizeable gap between what is needed to operate optimally and what has been collected as endowment. SATC has considered outsourcing or hiring a development professional for this area, but requires the funding to support to do so. The vision that has been cast for bringing hope and healing via specialized healthcare to this impoverished jungle town of Pucallpa is prodigious; indeed, the resourcing for such need be even more so.

A CASE FOR THE FUTURE

Building a Multipurpose Hospital

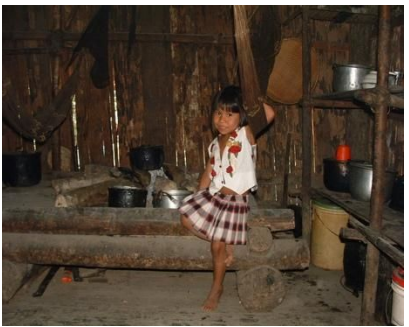
Most recently, SATC has been approached by local allies whose land is at risk of loss to squatters, to solve the issue by constructing healthcare-related facilities, and possibly a hospital. This would serve the immediate need as a structural barrier to the land that resides beyond it, as well as a resource for SATC and other U.S. sponsored teams to come to Pucallpa and utilize existing SATC infrastructure to alleviate the local healthcare burden. This project presents SATC with an opportunity and local support to have a medical impact that far exceeds what SATC teams can currently accomplish in 10-day spurts and follow-up. It also would represent a significant step in working alongside the local medical community for educational purposes, as well as providing a further continuum of care. However, there will be several significant challenges in orchestrating the appropriate resources and working with the right officials to convert this idea into reality. Certainly, as long as the burgeoning frontier of the Amazon continues to develop, the tide wave of orthopaedic need will only swell.

Moving Forward

Over the course of its almost 15-year history, SATC has demonstrated that it is possible to sustain efficacious follow-up results through a philanthropic continuum of orthopaedic care in an austere environment. Delivering responsible patient care requires innovative ways of thinking and methodologies that are custom fit for the local culture and needs. Given the projected increase in trauma in the developing world, the SATC model is increasingly relevant as a blueprint for future practitioners of orthopaedics to take on similar endeavors. Because of this, further research into the effectiveness of various organizational models is a necessary next step in this much-needed new field of studying orthopaedic surgical services in the developing world. It is our opinion, given the excess of surgical specialists in some parts of the U.S., that there should be a paradigm shift from “too many specialists” to deployment of specialists in areas of critical specialty need.









2005-2018YTD SATC MISSION VITALS


30 TRIPS

\$1,697,770
VALUE OF SUPPLIES


391 TEAM
MEMBERS

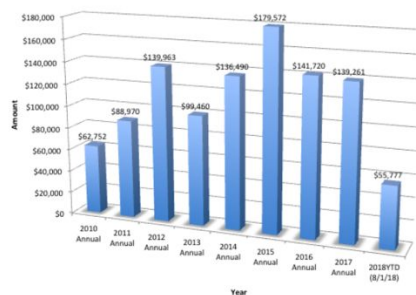
\$597,885
DONATED TIME OF PERSONNEL


458 SURGICAL
PATIENTS

\$4,952,850
ESTIMATED VALUE OF MEDICAL CARE


323 CLINICAL
PROCEDURES

2011-2018YTD Annual Giving Summary
(totals shown thru 8/1/2018 including Board giving)



Scalpel
AT THE CROSS
A Christian Medical Mission
to the Peruvian Amazon

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305-922-4486

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