

Emergency Surgical Care Delivery in Post-earthquake Haiti: Partners in Health and Zanmi Lasante Experience

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Abstract

Background The earthquake that struck Haiti on 12 January 2010 caused significant devastation to both the country and the existing healthcare infrastructure in both urban and rural areas. Most hospital and health care facilities in Port-au-Prince and the surrounding areas were significantly damaged or destroyed. Consequently, large

groups of Haitians fled Port-au-Prince for rural areas to seek emergency medical and surgical care. In partnership with the Haitian Ministry of Health, Partners in Health (PIH) and Zanmi Lasante (ZL) have developed and maintained a network of regional and district hospitals in rural Haiti for over twenty-five years. This PIH/ZL system was ideally situated to accommodate the increased need for emergent surgical care in the immediate quake aftermath. The goal of the present study was to provide a cross-sectional assessment of surgical need and care delivery across PIH/ZL facilities after the earthquake in Haiti.

Methods We conducted a retrospective review of hospital case logs and operative records over the course of three weeks immediately following the earthquake.

Results Roughly 3,000 patients were seen at PIH/ZL sites by a combination of Haitian and international surgical teams. During that period 513 emergency surgical cases were logged. Other than wound debridement, the most commonly performed procedure was fixation of long bone fractures, which constituted approximately one third of all surgical procedures.

Conclusions There was a significant demand for emergent surgical care after the earthquake in Haiti. The PIH/ZL hospital system played a critical role in addressing this acutely increased burden of surgical disease, and it allowed for large numbers of Haitians to receive needed surgical services. Our experiences reinforce that access to essential surgery is an essential pillar in public health.

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Introduction

On 12 January 2010, at 4:53 p.m., a 7.0 magnitude earthquake struck the western end of Hispaniola, an island in the Lesser Antilles containing two sovereign nations, the

Dominican Republic to the east and Haiti to the west. The epicenter of the quake was located near the village of Léogâne, Haiti, approximately 25 km (16 miles) west of the capital city of Port-au-Prince. In the subsequent hours and days, more than 59 aftershocks of magnitude greater than 4.0 were reported by The United States Geological Survey [1]. Devastation in Port-au-Prince was widespread and severe, and The International Red Cross estimated that approximately three million people were affected by the quake [2]. According to Haitian Government reports, the quake resulted in over 200,000 deaths, 300,000 injured, and more than 1,000,000 people homeless [3, 4].

The devastation of the Haitian healthcare infrastructure was no less severe. Most major hospitals and clinics in Port-au-Prince were severely damaged or destroyed. Makeshift tent hospitals were immediately erected on the grounds of the International Airport and University Hospital [5], and additional emergency care for the injured was provided in what little infrastructure remained intact in the regional facilities. In the days and weeks following the quake, there was an exodus of people from Port-au-Prince. Based on cell phone records, the Karolinska Institute and Columbia University estimated that 22% of the population (over 570,000 people) left Port-au-Prince by January 31. Approximately 84,000 people fled north to the adjacent Artibonite district, and 39,000 people fled to the Centre district (Central Plateau) [6]. Accordingly, the healthcare facilities outside of the capital faced a rapid and significant increase in demand for acute and essential health services.

For more than 25 years, the Boston-based nonprofit organization Partners in Health (PIH) has collaborated with the Haitian health care organization Zanmi Lasante (ZL) and the Haitian Ministry of Health to improve healthcare delivery and infrastructure in hospitals and clinics throughout the Centre and Artibonite districts [7]. Their facilities stretch from the city of Belladère on the border with the Dominican Republic, across towns and villages in the Central Plateau, through the Artibonite Valley to the city of Saint-Marc on the coast.

Within the PIH/ZL system, there are six healthcare delivery facilities that provide surgical services in the towns of Belladère, Cange, Hinche, Petite-Rivière, Saint-Marc, and Boucan Carré (Fig. 1). Each hospital has one or more fully equipped operating rooms with anesthesia and surgical personnel capable of providing emergency surgery. All of the sites except Belladère and Boucan Carré are staffed with fulltime Haitian general surgeons who provide essential and emergency general surgery.

All of the PIH/ZL facilities began receiving injured Haitians within hours of the earthquake, and many of the arriving patients required emergent surgical interventions [8]. At the time of the earthquake there were no fulltime orthopedic surgeons at any of the sites. Orthopedic surgical care was provided intermittently by local Haitian and international volunteer surgeons.

Once the extent of the devastation of the earthquake was realized, PIH/ZL organized international surgical teams to assist Haitian surgeons in providing specialized care at their facilities throughout the Artibonite and Centre

Fig. 1 Partners in Health/ Zanmi Lasante sites in Haiti, January 2010



districts. As early as 16 January 2010, teams of orthopedic, plastic, and general surgeons from locations across the globe were on the ground operating at ZL sites with the established Haitian staff.

Our purpose here is to present a cross-sectional assessment of surgical care delivered across PIH/ZL facilities after the earthquake in Haiti.

Materials and methods

After the initial surge in both surgical demand and the capacity for delivery of emergency and essential surgical care, we conducted a retrospective review of facility log books and operating room records to obtain a preliminary cross-sectional estimate of the acute burden of surgical disease and operative volume at PIH/ZL hospitals after the earthquake. Although the completeness of the operative logs varied from site to site, this formal record offered the most consistent and standardized way to accurately compare surgical cases between the different PIH/ZL facilities. Combining data from each individual site, we were able to estimate the total met surgical need in the region over the course of three weeks, from 12 January to 5 February 2010.

Surgical cases and procedures were defined as those procedures performed in the operating room under general anesthesia (see Table 3). Additional injuries and disease processes related to earthquake-induced conditions that did not require surgical intervention according to this definition were not included in the analysis. For example, complex dressing changes and wound debridements performed under local anesthesia and outside the operating room were not recorded.

Results

In the post-earthquake efflux from Port-au-Prince, Haitians seeking surgical care were captured by four PIH/ZL hospitals (Fig. 2). Collaborative teams of international volunteers arrived to help Haitian physicians address the escalated need for surgical care. More visiting surgeons were dispatched to Cange and Saint-Marc than to other PIH/ZL sites in the initial days following the earthquake, largely due to those facilities' surgical infrastructure and ability to accommodate higher case loads. As the weeks progressed, however, more international surgeons began to assist in Hinche and Petite-Rivière.

Patients were initially triaged in each hospital's emergency room. Radiographs and laboratory data were obtained and tetanus immunization was delivered. Often, local churches and schools were also used to expand the inpatient wards [8]. Patients needing life-saving surgery



Fig. 2 Clinical flow to PIH/ZL sites post earthquake, January 2010

received care as they were seen. Those patients that needed more complex surgical intervention were stabilized at each hospital and then transferred to the hospital ship *USS Comfort* when possible for definitive treatment. A basic medical record was created for each patient, and that patient's name was then added to a master list for surgical planning. The Haitian staff along with the visiting surgical teams evaluated each patient on a daily basis and established a priority surgical list. Each hospital provided meals for patients, and this feature of patient care was maintained throughout the crisis with the help of community volunteers.

The composition of individual international surgical teams varied. Table 1 depicts the teams' geographic and institutional distribution. The common basic structure of each team included varying numbers of orthopedic, plastic, and general surgeons, as well as anesthesiologists, operating room technicians, and nurses. The average team size was nine people.

Table 2 depicts an estimate of the number of patients seen in the PIH/ZL facilities. A total of 2,950 people were seen and assessed over the 3-week period. Saint-Marc had the highest patient volume initially, with 1,250 patients, while Cange had the lowest, with 300 patients. Nevertheless, 228 of those 300 patients seen in the immediate aftermath in Cange had an operative intervention for their injuries (76%), compared to 125 of the 1,250 seen in Saint-Marc (10%) (Table 3). Figure 3 depicts the temporal trend in the volume of emergency surgical services provided in the days following the earthquake. Because the clinic at Cange was more heavily stocked at baseline and provided a higher volume of surgical care before the earthquake, it was able to respond to the acute surgical need more quickly

Table 1 Surgical teams working at Zanmi Lesante (ZL) sites (1/16 to 1/31, 2010)

| ZL operative sites | Cange | Hinche | Saint-Marc | Petite-Rivière |
|--------------------|---|--|---|---|
| Team | Haitian ZL surgeons CHB Partners (MGH/BWH) Brown University (RIH) Santa Monica, CA University of Pennsylvania Irish Team Private practice | Haitian ZL surgeons Dartmouth University Private practice | Haitian ZL surgeons BIDMC Partners (MGH/BWH) Sutter Health, CA | Haitian ZL surgeons University of Indiana |

Partners Partners Healthcare, *MGH* Massachusetts General Hospital, *BWH* Brigham and Women's Hospital, *CHB* Children's Hospital Boston, *BIDMC* Beth Israel Deaconess Medical Center, *RIH* Rhode Island Hospital

Table 2 Patient volume stratified by care delivery site

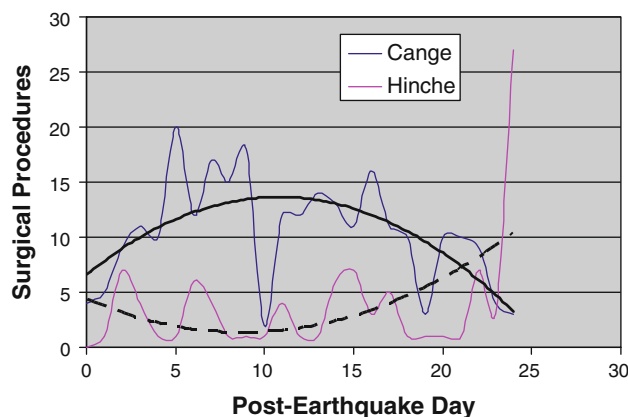
| ZL site | Cange | Hinche | Saint-Marc | Petite-Rivière |
|---|-------|--------|------------|----------------|
| Estimated number of patients seen (1/16/10 to 2/5/10) | 300 | 400 | 1,250 | 1,000 |

than Hinche. There were also more international volunteers at Cange initially. In the days following the quake, as additional visiting teams arrived with supplies, Cange's surgical contribution stabilized, and other facilities like Hinche began to provide an increasing volume of surgical care.

A significant percentage of patients seen at the PIH/ZL facilities required some form of operative intervention. Table 3 depicts the operative volume at each center stratified by procedure type. A total of 513 operations were performed at the four clinical locations. Other than debridements, the most common procedure across all sites was fixation (external or internal) of long bone fractures, constituting 18.5% of all surgical procedures performed. Method of fixation (internal or external) varied between sites based on surgeon comfort level with the procedures

Table 3 Operative procedures by care delivery site

| ZL site | Cange | Hinche | Saint-Marc | Petite-Rivière |
|---|-------|--------|------------|----------------|
| Operations performed (1/12/10–2/5/10) | 232 | 86 | 149 | 46 |
| Amputations | 21 | 9 | 14 | 6 |
| Open reduction and internal fixation (ORIF) | 16 | 14 | 10 | 0 |
| External fixator | 19 | 3 | 20 | 13 |
| Fasciotomies | 9 | 1 | 3 | 0 |
| Debridement and lavage | 81 | 19 | 56 | 11 |
| Reduction | 40 | 9 | 20 | 6 |
| Laceration/repairs | 0 | 5 | 8 | 1 |
| Split-thickness skin graft (STSG) | 19 | 1 | 2 | 3 |
| Revision of amputation | 12 | 0 | 8 | 1 |
| Exploratory laparotomy | 4 | 4 | 4 | 0 |
| Back immobilization | 0 | 0 | 0 | 3 |
| Unknown trauma | 0 | 4 | 0 | 2 |
| Dressing changes | 11 | 17 | 4 | 0 |

**Fig. 3** Trend in surgical volume at PIH/ZL sites in Haiti, post earthquake 2010

and equipment availability. For instance, 82.4% (14 of 17) of fixations performed at Hinche were internal and 100% (13 of 13) of those performed in Petite-Rivière were external. At Cange and Saint-Marc, where more fixations were performed by a variety of surgeons, the fixation types were more varied (45.7 and 33.3% for internal fixation, respectively). The overall amputation rate was 9.7%

(50/513) across all surgical facilities. Interestingly, although the percentage of all emergency surgical cases resulting in amputation was highest in Petite-Rivière (13.0%), rates were roughly equivalent among the four sites (9.1% in Cange, 10.0% in Hinche, and 9.4% in Saint-Marc; Table 3).

Discussion

Surgery has been dubbed the “neglected stepchild” of public health efforts in low- and middle-income countries (LMICs), but an increasing amount of research and attention is being devoted to the subject, to highlight the essential role of surgery in resource-poor settings [9–14]. Recent modeling efforts aimed at estimating the global volume of surgical intervention suggests that between 180 and 280 million major operations are performed worldwide per year [15]. This figure almost certainly underrepresents the total global need for surgical services, especially in resource-poor areas. Nowhere is this need more immediately apparent than in the aftermath of natural disasters, of which the January 2010 earthquake in Haiti continues to provide a vivid reminder.

Haiti is a small Caribbean island nation of roughly 10 million people, 50% of whom lived in urban centers prior to the earthquake [16]. Even before January 2010, Haiti was the poorest country in the Western Hemisphere, with more than 50% of the population living on less than \$1 a day [16]. Estimates regarding the nation’s available medical workforce are incomplete, and Haiti’s capacity for addressing domestic medical and surgical need was significantly underdeveloped [7, 9]. In the days and weeks after the earthquake, a large portion of the population fled Port-au-Prince to outlying rural areas. Social and civil infrastructures in these surrounding regions were stressed with the acute influx of displaced people, and hospitals experienced a sudden increase in demand for medical and surgical care services [8]. In the present report, we document the significant acute surgical need across PIH/ZL hospitals as part of the sequelae of the earthquake.

As injured people fled Port-au-Prince, the PIH/ZL facilities in the Artibonite district (Saint-Marc and Petite-Rivière) received 2–3 times as many patients as sites in the Centre region. Saint-Marc (population ~ 125,000 people) and Petite-Rivière (population ~ 35,000 people) are larger population centers than Cange and Hinche [17]. All of the sites are connected to the capital by a largely paved highway that remained relatively undamaged after the earthquake [18], which allowed for a large movement of emigrants. The operative numbers in Cange were higher, although fewer earthquake victims were seen. This higher number of surgical patients reflects the more advanced

surgical infrastructure and a regional reputation for providing free, safe, and effective surgical care. As the initial site of PIH/ZL activities in Haiti, Cange has a larger and more developed surgical supply, as well as more Haitian surgeons on staff that were able to assist in the provision of needed surgical care. The clinic sites of Petite-Rivière and Hinche performed fewer earthquake-related procedures, likely because patients with more severe injuries were triaged as they passed through the towns of Saint-Marc and Cange, respectively.

Working in solidarity, multiple groups of international and Haitian health care workers saw approximately 3,000 patients over the course of three weeks as part of a post-disaster efflux of patients in need of medical attention. A total of 513 surgical cases were performed, which represents an estimate of the acute burden of earthquake-related surgical disease within the PIH/ZL catchment areas. As in other studies, these numbers likely underestimate the total burden of surgical disease affecting the Haitian population.

Our study has several limitations that most likely provide an underestimate of the number and severity of surgical injuries after the earthquake. During the first days and weeks following the tragedy, record keeping and data collection were not standardized and often were incomplete. We have produced estimates of patient volume based upon individual staff reports and logs because they represent the most consistent way to compare surgical services between sites. Because of the variety and geographical diversity of the many volunteer teams that arrived in Haiti during this time period, logistical limitations precluded analysis of individual team log books. Furthermore, a review of log and case books only reflects those services rendered, which in turn only reflects that proportion of the population that accessed available resources. Ours is thus a point-of-care estimate, and it is useful as an estimate of the portion of total surgical disease treated, or needs met. What remains unknown, as in many resource-poor areas of the world, is the portion of surgical need that was unmet, whether because of access difficulties, or injury severity, or any number of unstudied potential factors.

This cross-sectional analysis of the burden of surgical disease after the earthquake of January 2010 represents the only estimate of acute surgical need across multiple facilities in Haiti during this time period. As such, we hope that it can provide a framework on which to build additional assessments and interventions, both at the point of care and at the health infrastructural levels. Future studies will provide additional burden of disease estimates at longer follow-up intervals in an effort to provide an evidence-based assessment of surgical efforts in Haiti.

Additionally, we were unable to collect data on post-operative outcomes after the delivery of acute surgical care. Future studies are needed to evaluate outcome

measures and postoperative follow-up to provide an assessment of the quality of essential surgical care delivered in the acute disaster setting. As we are able to collect more data from Haiti, we will be better able to assess the ongoing ability to respond to an even larger increase in surgical demand than normal since the earthquake.

Post-disaster Haiti represents a unique example in the study of the burden of surgical disease in LMICs. Prior to the earthquake, Haiti's healthcare infrastructure was already inadequate to meet volume of needed surgical care. The spike in demand for surgical services in January 2010 added an acute stress to a system that was buckling with the significant and chronic burden of untreated surgical disease. Through a combination of coordinated international efforts and an established network of surgical delivery sites, PIH/ZL was able to provide a significant amount of essential surgical care in the immediate aftermath of the earthquake. Especially as the acute phase of international interest begins to wane, even more diligence will be needed in organizing collaborative efforts to measure the total burden of surgical disease, both met and unmet, within this community.

Conclusions

The existence of a functional surgical system operated by Partners in Health and Zanmi Lasante enabled a large number of severely injured patients to receive essential surgical care in regions adjacent to Port-au-Prince in the immediate aftermath of the January 2010 earthquake. These facilities were successful in meeting a significant portion of acute surgical need in the region. The PIH/ZL response highlights the importance of a functional district hospital system in LMICs in managing natural disasters that result in large-scale trauma requiring emergent surgical care. Future long-term analyses are necessary to study the optimal structure of a district hospital system in LMICs, not only to provide for baseline surgical needs but also to be able to expand to meet the acute need in times of natural disaster. Our experiences following this tragedy have reinforced the growing belief within the global surgery community that access to essential and emergency surgery is a pillar of public health.

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