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Introduction

Caring for another surgeon's complication can be a common, albeit unpleasant, part of any surgical practice in a tertiary care facility. It comes with the territory and can define key differences between academic and community practice. Typically, the patient was cared for in a modern hospital, by a surgeon that was appropriately trained, equipped with modern and sterile equipment, and assisted by competent nursing professionals. In essence, the presenting complication could just as easily have developed in any hospital, and the care plan is understandable and predictable.

As societies broaden their reach, and an individual patient is able to avail themselves of unprecedented opportunities for global travel, the issue of surgical complications takes on a different light. With increasing frequency, patients are presenting to tertiary care medical centers with previously undiagnosed or untreated postoperative complications after either elective surgical care abroad or emergency surgery in an austere environment following a natural or man-made disaster. In either case, the surgeon is left with little written accounting of the surgical procedure, postoperative course, or rehabilitation. Furthermore, the patient's condition may be directly related to the geographic location of the first hospital or the process of travel itself.

Elective Surgery Abroad

Elective surgery abroad, often referred to as "medical tourism," represents a recent development in healthcare economics, involving purposeful travel of patients to a nation other than their own for the expressed purpose of receiving care that is either unavailable, prohibitively expensive, or illegal

in their own country. According to Patients Beyond Borders, a consumer medical tourism resource, around 11 million patients go abroad for medical treatment every year. Although these numbers vary, the organization believes the market size is an estimated US \$38.5–55.0 billion, with the average patient spending \$3500–5000 per visit [1]. Reviewing 2008 data, the cost of individual procedures has been an estimated 20–80% lower in less developed countries compared to a private hospital in the United States [2, 3]. Furthermore, the medical tourism market is only expected to grow, as health-care shortages and costs to patients increase in western countries, and surgical technology costs decrease to an affordable level in less developed countries. Although millions of Americans are now newly enrolled into health insurance under the Affordable Care Act, an estimated 71% of the new insurance arises through Medicaid [4]. And, with 55% of American doctors already refusing new Medicaid patients, according to a 2014 Merritt Hawkins study by Miller and colleagues [5], the American public is still not immune to the pressures of healthcare austerity.

An Unregulated Industry

Marketing of surgical services overseas is regulated at the host nation level, where legal restrictions regarding medical practice and quality of care may differ greatly from the patient's expectations. While no registry or formal means of tracking patients has been established, published studies show a significant percentage of these patients seek bariatric, dental, and cosmetic surgery due to cost savings. Many also have a specific predilection toward transplant surgery, driven by the availability of donor organs. Because quality of care varies greatly by institution, it is difficult to make meaningful generalizations about risks outside the United States [6]. Information asymmetries are particularly pronounced by a lack of comparative quality and safety data, reduced knowledge of infection rates for overseas institutions, and insufficient reporting of adverse events [7]. The World Health Organization issued a

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2014 report on antimicrobial resistance, noting that very high rates of resistance for common bacteria have been recorded in all regions. Overall, surveillance of resistance is neither coordinated nor harmonized [8], but must be considered carefully by the surgeon managing an imported surgical catastrophe.

Just as there is no registry of patients that seek medical care abroad, there are no international standards that tie to outcome measures for hospitals catering to the medical tourism market. Several international organizations are available to accredit hospitals in foreign countries, each with their own methods and standards, but given the migratory nature of the medical tourist, this specific patient population is almost universally lost to follow-up. Overall, little is known about the relative clinical outcomes for particular treatments, institutions, clinicians, and localities associated with medical tourism, partly because follow-up is rare once patients return to their home countries after a procedure [7]. Overall, this lack of information obstructs a patient's ability to make informed, evidence-based judgments about the quality of care and safety in medical travel [8].

Nosocomial and Travel-Related Postoperative Infection

Postoperative infection is an ever-present risk that, in the United States and other highly developed healthcare systems, involves significant investment in broad reaching systems within each hospital. From dedicated personnel for surveillance, materials and supplies at each bedside to reduce transmission, and rigid inspection criteria tied to third-party reimbursements, great effort is paid to reducing the financial burden of postoperative care. Lacking the same focus and resources, the prevalence of healthcare-associated infections in developing countries is substantially higher than in Europe and the United States. Many countries with robust medical tourism programs have high background rates of tuberculosis, antibiotic resistance, hepatitis B, hepatitis C, and human immunodeficiency virus (HIV) [9]. A recent meta-analysis showed that intensive care units in developing nations had infection rates at least three times higher than those reported in the United States. Surgical site infection rates were also comparatively increased (5.6 vs. 1.6–2.9 per 100 surgical procedures) [10]. Many countries with robust medical tourism programs lie in tropical and subtropical regions where malaria, dengue fever, enteric fever, and other endemic infections exist [9]. And, although blood and blood products used in hospitals certified by International Joint Commission (IJC) require screening for common blood-borne pathogens, they do not necessarily require screening for these region-specific agents. As a result, dengue and West Nile viruses, for example, which cause rare infections after transfusion, are not a part of routine screening in most countries and have a higher chance at being transmitted [11].

Postoperative infections are not limited to hospital-acquired pathogens. The transit involved with medical tourism may also put patients at a greater risk of infection because passengers are typically confined to close quarters for many hours when using commercial aircrafts [12]. In an interesting surveillance study from 2010, the extended-spectrum beta-lactamase colonization rate in traveling Australians increased from 7.8% pretravel to 49% posttravel, with resistant *E. coli* isolated from 50 to 79% of travelers to Asia (excluding Japan), South America, the Middle East, and Africa. At 6 months posttravel, 18–24% remained colonized [13]. This demonstrates that at any point in the circular migration of patients traveling for medical care, microbes may also travel from one location where they constitute a harmless bacteria, or at least a known and treatable infection, to another where they are unknown, making diagnosis and treatment much more problematic [12]. Therefore, surgeons treating an imported postoperative infection do well to discuss the case early with infectious disease and pathology colleagues to provide sufficiently broad consideration during the laboratory workup.

Transplant Tourism

Perhaps the most popular and most risky procedures sought by consumers in medical tourism involve solid organ transplants. In 2007, the World Health Organization estimated that 10% of organ transplants worldwide are the result of transplant tourism [14], due in part to the practice of solid organ sales and the relative affordability of the surgery itself. In one study in the Philippines, upward of 3% of the population in a single community had sold a kidney for transplant [15]. However, evidence again suggests increased complication rates. In a 2009 meta-analysis, patients that travel internationally in order to receive their transplant had a lower 1-year graft and patient survival rate compared to those domestic kidney transplant recipients described by United Network for Organ Sharing (UNOS) [16]. In addition, transplant tourists had an increased requirement for postoperative surgical intervention and were more likely than domestic kidney transplant recipients to develop cytomegalovirus (12%), hepatitis B virus (7.1%), HIV (4.1%), and wound infections (8.6%) [17]. A 2006 study of patients evaluated at University of Minnesota Medical Center or Hennepin County Medical Center after undergoing kidney transplantation overseas concluded that there was inadequate communication of information concerning immunosuppressive regimens and preoperative information. In the majority of cases, vital information on induction therapy, immunosuppression, and posttransplant course were missing. In three cases within the study period for this single center, postoperative patients were sent back to the United States in the midst of a crisis (active severe wound infection, seizure, and acute rejection),

and in all of these situations, documentation of the posttransplant course was lacking [18].

Cosmetic Surgery

Based on available data and marketing efforts by international medical tourism “hubs,” elective cosmetic and aesthetic surgery represents the majority of the medical tourist surgical caseload. A 2007 national study conducted by the Australian Society of Plastic Surgeons evaluated female patients returning from Asia after surgery, a majority of which underwent breast enlargements, breast reductions, or facelifts. Of the 68 surgeons surveyed, 40 (59%) reported seeing patients with complications or poor results, and 15 (22%) reported treating more than one patient that had traveled abroad for their cosmetic procedure. The majority of procedures were reportedly performed in Thailand, followed by Malaysia [19, 20]. In an audit of the pan-Thames region of the UK, 60% of National Health Services (NHS) consultants in plastic surgery units had seen complications of returning patients after completed procedures abroad, including abdominoplasty, breast augmentation, and breast reduction. The majority of these cases (66%) were emergencies that required inpatient admission [21]. In a survey of the British Association of Plastic, Reconstructive and Aesthetic Surgeons members, 37% of consultants report having seen patients in the National Health System with complications arising from overseas cosmetic surgery. The most popular procedures included breast augmentation, abdominoplasty, breast reduction, and face/neck lift. The majority (88%) were referred to these plastic surgeons by primary care and emergency department colleagues and required treatment in an outpatient setting (i.e., wound management) or elective surgical revision for cosmetic reasons. Twenty-five percent of patients required emergency surgery [22]. Finally, in a 2011 survey of the American Society of Plastic Surgeons (ASPS), 83.9% of surgeons reported treating patients with complications who had undergone cosmetic procedures abroad by noncore practitioners. A majority of the noncore providers performing procedures abroad were otolaryngologists, but also included general surgeons, oral surgeons, OB-GYNs, and ophthalmologists. The largest percentage of reported complications (31%) in this study were postoperative infections, followed by dehiscence, contour abnormality, and hematoma [23].

Surgical Complications in the Context of Disaster Medicine

In contrast to medical tourism, where procedures are planned and researched by patients in advance, surgical resuscitation following critical injury abroad occurs in the most remote locations, where the untouched beauty of nature is usually

accompanied by an undeveloped or completely absent medical infrastructure. In a retrospective database review of American citizen deaths worldwide from October 2002 through June 2012, authors found the total number of Americans traveling abroad annually was approximately 58.7 million, with the majority traveling to Mexico, Canada, the United Kingdom, France, and Italy. Only one accidental death of an American occurred during the 10-year study period in those highly traveled areas. In travelers visiting less common destinations, however, the story is quite different. There were 7,963 American citizen nonnatural deaths abroad during this study period, and of these 163 (2%) were due to disaster-related deaths. These deaths occurred as a result of 19 disasters in 15 countries, with the only disasters causing greater than 2 deaths being the 2010 earthquake in Haiti (resulting in 121 deaths) and the 2004 tsunami in Thailand (causing 22 fatalities) [24].

In a 2013 meta-analysis focusing on acute traumatic injuries requiring surgical intervention following earthquakes abroad, Missair and coworkers found that major earthquakes result in the highest casualty rates, between 1 and 8% of the at-risk population [25]. Though many injuries are fatal, 69% of earthquake-related injuries requiring urgent surgical intervention involved survivors with limb trauma and survivable traumatic injuries including bone fractures, soft tissue lacerations, and crush injuries to various parts of the body. In humanitarian disaster and conflict, amputation is often hastily performed as a way of removing significant amounts of damaged tissue and saving a life, without consideration for more conservative techniques. This strategy requires multiple surgical revisions and results in complicated postoperative management and prolonged rehabilitation periods for patients.

The Haitian earthquake of 2010 provides a good example of surgical management following a large-scale disaster that destroys what little medical infrastructure may exist. Many patients received amputations as a primary intervention for complex severe wounds and fractures which could potentially have been salvaged. Amputations as secondary treatment for infected wounds and compartment syndromes were also reported in high numbers even though this is not the standard of care. Significant volumes of guillotine amputations were performed as a “lifesaving intervention” or when technical expertise was limited, subsequently requiring revision at higher levels. These patients’ rehabilitation potential was negatively affected by poor surgical indication, timing, and technique [26]. In the end, Haiti’s earthquake left approximately 1,500 amputation survivors relying on a healthcare system whose baseline, pre-earthquake surgical, anesthesia, rehabilitation, and prosthetic services were already severely limited [27]. Many survivors were evacuated to the United States on humanitarian grounds for continued treatment.

Surgical Infections in Disaster Response

Emergency surgery following a natural or large-scale man-made disaster safely assumes that the deliberate care and processes associated with modern surgical technique break down, if only for the sake of expediency in saving the greatest number of lives. Given unhygienic conditions, gross wound contamination, and delayed presentation of patients following a building collapse, catastrophic bombing, or flood, it is no surprise that surgical infections are common causes for operation in low- and middle-income countries, particularly during a crisis. Infections, in general, require greater than expected surgical resources given the frequent need for serial operations, especially in these areas with limited resources. Because survival and quality of life after severe surgical infection depends on prompt resuscitation, antibiotics, and operative intervention, a large proportion of individuals with surgical infections may be left with disability or not survive. Subsequently, the surgical disease burden, condition for condition, is significantly greater in poorer countries than the rest of the world, and early efforts to evacuate patients to western medical facilities should be expected in an effort to spread the load across a wider and better prepared healthcare base.

In a review of procedures performed in operating rooms managed by *Medecins Sans Frontieres/Doctors Without Borders–Operations Centre Brussels* from July 2008 through June 2014, investigators found that operations for skin and soft tissue infections were the most common surgical infection (64%), followed by intra-abdominal (26%), orthopedic (6%), and tropical infections (3%). Return trips to the operating room for serial washouts, debridement, and “second looks” were more common after procedures for orthopedic (38%) and skin and soft tissue infections (33%) than for intra-abdominal infections. In reviewing resource utilization patterns, it is clear that the pattern of operations for infections is related to nature of the crisis. Resources necessary for the treatment of skin and soft tissue infections (e.g., dressing supplies) are disproportionately higher during natural disasters, while resources necessary for intra-abdominal infections (e.g., closed suction drains, temporary abdominal closure systems) are needed more during hospital support missions. Lastly, resources necessary for the management of orthopedic infections (e.g., surgical sepsis care, ultrasound-guided drainage procedures) are critical during support to areas of armed conflict [28, 29].

Strategies in Patient Management

Assumptions remain the greatest barrier to management of a patient treated abroad that presents with a postoperative complication. When treating patients in one’s own city or

country, it is said that “when you hear hoof beats, think horses.” But, the astute clinician treating an imported postoperative complication must first ask to which ground he has placed his ear before defining the probability of horses versus zebras.

The investigation starts with a carefully obtained history, developing a comprehensive picture of the patient’s preoperative state of health. Then consider the location and setting of the surgical procedure. Early consultation with infectious disease colleagues with specific knowledge of tropical disease is essential, and frank collaboration with laboratory medicine colleagues will yield early benefits in identifying unusual pathogens. Early imaging is critical in identifying deep tissue abscesses and retained instruments or materials as the source of postoperative infection. For the critically ill patient that is unable to provide a detailed history, evaluation of the location and type of surgical wound is critical and must be compared to both modern surgical approaches and outdated approaches that may still be in use in less developed countries.

Perioperative management of the critically ill medical tourist may require a more protracted period of empirical therapy, allowing for offsite testing of samples for unusual or exotic pathogens. Early consideration must be given to fungemia, parasitemia, and viral etiologies that are typically prevented in western surgical practice. Finally, it is important to account for the psychological impact of a debilitating or disfiguring postoperative complication, ranging from regret in having accepted the risk of an elective procedure abroad to frank post-traumatic stress disorder related to the disastrous etiology for their original injury.

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