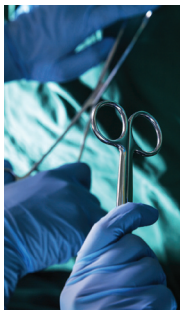

Chapter 13

Specialized Surgical Platforms

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INTRODUCTION

A large fraction of the burden of disease comprises conditions that are potentially amenable to surgical intervention (chapters 1 and 2) (Bickler and others 2015; Mock and others 2015). The proportion is higher in low- and middle-income countries (LMICs) (Shrime, Sleemi, and Ravilla 2014). Because of difficulties in access to surgical care—often due to issues of cost, transportation, infrastructure, and a lack of providers (Chao and others 2012; Ilbawi, Einterz, and Nkusu 2013; Knowlton and others 2013; Linden and others 2012)—this surgical burden is sometimes borne by the international charitable sector.

Historically, first-level hospitals in LMICs have tended primarily to treat conditions associated with a low disability-adjusted life year (DALY) burden. These hospitals have done so with a high loss to follow-up; patients scheduled for surgeries often do not return for their operations (Ilbawi, Einterz, and Nkusu 2013), especially as the complexity and up-front costs of the surgeries increase. Meanwhile, charitable sector involvement has grown rapidly: the charitable sector in the United States, which includes many international charitable surgical organizations, has grown at a pace exceeding the growth of gross domestic product by 20 percent and is currently larger than its counterpart agriculture, construction, transportation, and utilities sectors (Casey 2007). Médecins Sans Frontières (also known as Doctors Without Borders) alone has an annual budget of more than US$700 million, much of which comes from private funders (McCoy, Chand, and Sridhar 2010). This review focuses specifically on the charitable sector's role in the delivery of surgical care in LMICs.

This chapter uses the World Health Organization's (WHO's) six geographical regions: African Region, Region of the Americas, South-East Asia Region, European Region, Eastern Mediterranean Region, and Western Pacific Region.

Challenges to Defining Platforms for Service Delivery

Any attempt to examine the specialized platforms that nongovernmental organizations (NGOs) establish for surgical delivery must necessarily define these platforms. This is a daunting task—an entire galaxy of NGOs provide surgical care, few of which easily fit into any single category, and many of which overlap. Fully 50 percent of international surgical organizations operate in Southeast Asia, with another 46 percent each in Central and South America and 43 percent in Sub-Saharan Africa. Only 20 percent of the organizations provide services in East Asia and the Pacific, the Middle East and North Africa, Europe, or North America (McQueen and others 2010). Organizations vary broadly in surgical scope: 70 percent provide general surgery, 60 percent provide plastic and reconstructive surgery or gynecologic surgery, 50 percent provide ophthalmology services. A minority of surveyed organizations provide other services, including orthopedics; ear, nose, and throat; burns; cardiac; and transplant surgeries (McQueen and others 2010).

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Most of the literature evaluating these organizations focuses on breaking down NGOs by the conditions that each treats. This approach is not, however, informative; it masks salient similarities and differences between platforms, and, in doing so, may actually promote fragmentation in delivery.

New Classification by Delivery Platform

This chapter proposes a novel classification scheme by delivery *platform*. Focusing on the platform of care, rather than on disease-specific organizations themselves, allows for a discussion of the costs and effectiveness of the platforms and for benefit patterns common to the respective platforms to emerge, distinct from the diseases treated and the organizations providing treatment. Using this new framework, nongovernmental surgical platforms are compared along metrics of effectiveness, cost-effectiveness, sustainability, and training.

It should be noted that although the vast majority of providers of specialized surgical care in low- and middle-income countries are NGOs, not all are, and that the concentration of NGOs varies by region. At least one of the organizations discussed—Babbar Ruga Fistula Teaching Hospital—is better described as a public-private (or public-charitable) partnership. Other organizations, such as Médecins Sans Frontières and the International Committee of the Red Cross, provide primarily humanitarian emergency services, although both have been involved in training and capacity building (Chu, Ford, and Trelles 2010, 2011; Chu, Trelles, and Ford 2011). Therefore, although the focus of this chapter is the charitable sector, it is not the only model for delivering surgical care; when other platforms are discussed, they are highlighted as such.

Other methods of delivering surgery by external organizations are not discussed:

- Telemedicine (Bai and others 2007), in which surgeons from high-income countries (HICs) diagnose conditions or guide surgeons in LMICs, is not considered a platform for the actual delivery of surgery.
- Cancer screening (Bailie 1996), despite the surgical nature of many cancers, is not included for similar reasons.

METHODOLOGY

A systematic review of the literature was performed to assess the cost, effectiveness, sustainability, and training role of various surgical platforms. The following search strategy was used to query the MEDLINE database, with similar strategies for EMBASE and Google Scholar:

(Surgical Procedures, Operative[MeSH Terms] OR surgery[tiab] OR surgeries[tiab] OR surgical[tiab] OR operative[tiab] OR operating room[tiab] OR operation[tiab] OR cleft lip[tiab] OR cleft palate[tiab] OR eye[tiab] OR congenital[tiab] OR heart[tiab] OR cardiac[tiab] OR vesicovaginal[tiab] OR obstetric fistula[tiab] OR genital fistula[tiab] OR trauma[tiab])

AND

(Medical Missions, Official[MeSH Terms] OR Missions and Missionaries[MeSH Terms] OR Mobile Health Units[MeSH Terms] OR Relief Work[MeSH Terms] OR Voluntary Workers[MeSH Terms] OR humanitarian[tiab] OR surgical mission*[tiab] OR missionary[tiab] OR resource limited[tiab] OR low income countr*[tiab] OR middle income countr*[tiab] OR developing countr*[tiab] OR LMIC[tiab])

NOT "case reports"[publication type]

Bibliographies of the retrieved studies were searched for other relevant publications. Inclusion and exclusion criteria were determined a priori. Only published, peer-reviewed articles were included. The search was not limited to articles in English. Data were extracted using piloted forms and performed by all three authors. Because of a high risk of heterogeneity in studies across multiple disease conditions, countries, and platforms of delivery, no mathematical summary measure was calculated.

Of 8,854 records retrieved, 6,741 were screened by title and abstract; one additional article was found on bibliographic review, and the full texts of 322 were screened. From these, 104 articles were selected for inclusion. The review process, as well as the previously determined inclusion and exclusion criteria, is described in figure 13.1.

CHARITABLE SURGICAL DELIVERY PLATFORMS

Charitable surgical delivery platforms can be divided into two basic types: temporary surgical delivery platforms and specialty surgical hospitals.

Temporary Surgical Delivery Platforms

These platforms are, by definition, temporary, and do not establish hospitals in-country. Although they are almost exclusively run by NGOs, they are different enough to warrant subclassification into short-term surgical trips and self-contained mobile surgical platforms.

Short-Term Surgical Trips. Short-term surgical trips are by far the most common model for surgical delivery

by the charitable sector in LMICs; these platforms send surgeons, anesthesiologists, nurses, and supporting staff—along with, at times, surgical instruments and technology—into hospitals in LMICs for short, time-limited periods. Often, these NGOs perform a restricted set of surgeries, using existing local infrastructure for surgical delivery, and relying on local physicians for follow-up. Operation Smile (Bermudez, Trost, and Ayala 2013; Bermudez and others 2010; Magee 2010; Magee, Vander Burg, and Hatcher 2010; Magee and others 2012), the Kenya Orthopedic Program (Cousins and others 2012), and many others fit this model.

Self-Contained Mobile Surgical Platforms. A significantly rarer model for surgical delivery, NGOs functioning as self-contained mobile surgical platforms spend longer periods (months to years) in-country than the short-term trips and, an important distinction, they carry their entire infrastructure with them. Contained on airplanes, ships, and other modes of transportation, these organizations tend not to leave behind any physical structure. Organizations such as Mercy Ships (Cheng, McColl, and Parker 2012; Harris 2013), CinterAndes, and, in some settings, Médecins Sans Frontières fit this model.

Specialty Surgical Hospitals

Another common model for surgical delivery by the charitable sector, specialty surgical hospitals establish an entire physical plant, either completely new or within an existing structure, dedicated to the treatment of one or a few related surgical conditions. Unlike the temporary platforms, specialized surgical hospitals tend to be a mixture of charitable organizations and government institutions. Organizations such as the Addis Ababa Fistula Hospital and the Aravind Eye Hospital fit this model.

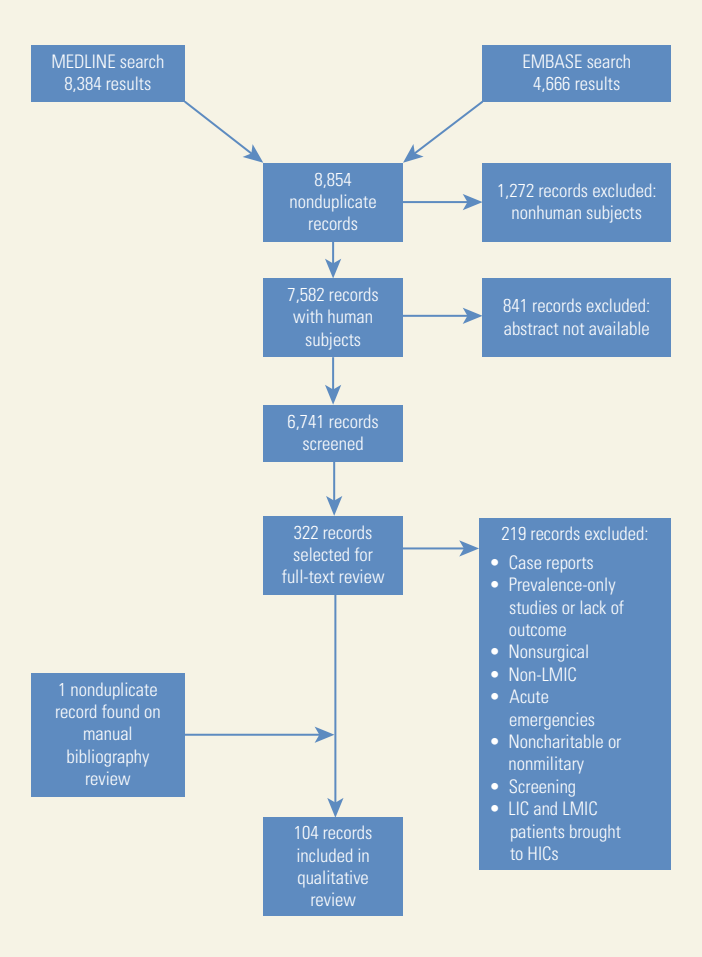
TEMPORARY SURGICAL DELIVERY PLATFORMS

Temporary surgical platforms are legion and span the spectrum from one-week mission trips, through recurring mission trips, to mobile platforms that remain on a near-permanent basis in a region. Short-term surgical trips and self-contained mobile platforms are evaluated separately.

Short-Term Surgical Missions

Short-term, disease-specific surgical missions are myriad (McQueen and others 2010), and services rendered, lengths of surgical trips, and resultant efficacy vary.

Figure 13.1 Search Strategy Results, Inclusion Criteria, Exclusion Criteria, and Final Records Included in Qualitative Systematic Review



Note: HICs = high-income countries; LMICs = low- and middle-income countries.

Short-term surgical platforms have been used for the following:

- Eye camps in India (Balent and others 2001; Civerchia and others 1993, 1996; Kapoor and others 1999; van der Hoek 1997; Venkataswamy 1975)
- Ear camps in Namibia (Lehnerdt, van Delden, and Lautermann 2005)
- Surgery for facial clefts (Bermudez, Trost, and Ayala 2013; Bermudez and others 2010; Magee 2010; Magee, Vander Burg, and Hatcher 2010; Magee and others 2012)
- Surgery for hernias in Ghana (Sanders and Kingsnorth 2007)
- Cardiac surgery in Papua New Guinea (Tefuarani and others 2007)
- Surgery on endemic goiter in Burkina Faso (Rumstadt and others 2008)

Underpinning these diverse platforms, however, is a uniting model: surgeons and other specialists are flown into regions with high burdens of specific surgical diseases, where they operate for short periods, often one to two weeks (Gosselin, Gialamas, and Atkin 2011) and often in partnership with in-country physicians, to whom is left all but the most immediate follow-up care. These missions, which have alternately been called surgical safaris (Frampton 1993) or surgical blitzes (Nthumba 2010), not infrequently carry their own equipment to local hospitals in which they work (Gosselin, Gialamas, and Atkin 2011; Hodges and Hodges 2000). Often, they return to the same region in subsequent years (Cousins and others 2012; de Buys Roessingh and others 2012; Haskell and others 2002; Ruiz-Razura, Cronin, and Navarro 2000) and strive toward close partnership with local hospitals and ministries of health (Wright, Walker, and Yacoub 2007; Yeow and others 2002).

Despite the plethora of organizations that adopt the short-term surgical model, evaluations of its effectiveness and cost-effectiveness are few, in part because of the difficulty with follow-up. Of 4,100 operations for cleft lip and palate by one organization in 40 simultaneous sites, for example, only 703 patients returned for a six- to nine-month postoperative visit (Bermudez and others 2010).

Effectiveness of Short-Term Surgical Missions. In a survey of 99 international organizations providing surgeries, nearly two-thirds provided fewer than 500 operative interventions per year (McQueen and others 2010). Strong evidence indicates an association between surgical volume and outcomes in Canada and the United States (Birkmeyer and others 2002). More specifically, evidence also points to a stronger impact on outcomes by *hospital* volume than by *surgeon* volume, especially for more complex procedures (Birkmeyer and others 2003; Eskander and others 2014).

Despite myriad organizations using the short-term model, surgeries performed by these missions tend to suffer from higher mortality and complication rates and to produce mixed results, especially for more complex pathologies. In an evaluation of more than 17,000 operations performed in Sub-Saharan Africa during 114 surgical missions in two decades, overall mortality was 3.3 percent (Poilleux and Lobry 1991). The vast majority of these operations were for hernias, for which a mortality as high as 1 percent was observed—20 times higher than the observed mortality for similar procedures in HICs (Rodgers and others 2000).

Both the success of an operative mission and its complication rates, however, vary by surgical procedure. Simpler procedures, like tonsillectomy, appear safe when performed by short-term surgical missions (Sykes and others 2012). Others are less so: Maine and others (2012) report a rate of fistulization between the mouth and the nose after cleft palate repair more than 20 times higher in surgical missions than in HICs. In this study, operations performed by experienced Ecuadorean and North American cleft surgeons on a mission in Ecuador were compared with cases performed by similar surgeons at a third-level referral hospital in the United States. Notably, all surgeons showed this 20-fold increase in complication rates, and no statistically significant difference was found between surgeries performed by U.S. surgeons on short-term surgical missions and those performed by Ecuadorean surgeons on the same mission. Although patient-level factors obviously confound this increased complication rate, the finding lends further credence to an assertion that mission volume potentially has a greater impact than surgeon experience (Maine and others 2012). De Buys Roessingh and others (2012) similarly report relatively poor functional results in the repair of cleft palates on short-term surgical missions; the lack of a multidisciplinary approach to the repair of these conditions, inherent in short-term surgical blitzes, may contribute to worse outcomes (Furr and others 2011).

Results from cataract surgeries performed in eye camps are equally variable. Some (Kapoor and others 1999) report good vision outcomes, while others (Singh, Garner, and Floyd 2000) report poor outcomes. Similar variability is also seen in studies on otologic surgery. In surgical camps in Greenland, Homøe, Siim, and Bretlau (2008) and Homøe and others (2008) find low complication rates and good results in patients with chronic ear disease; mobile surgical units in Thailand have similarly high success rates. Other authors, however, report success rates tied very strongly to either pathologic diagnosis (Horlbeck and others 2009) or the age of the surgical mission, with better results occurring a few years after the mission's establishment (Barrs and others 2000). Finally, in cardiac surgery, Adams and others (2012) find relatively acceptable results in patients operated on for rheumatic, congenital, and ischemic heart disease during two surgical missions to Peru, but these results come from a survey of very few patients.

Overall, a solid pattern emerges in a review of the effectiveness of surgical missions: the more complex the surgery, the more unsatisfactory the results. Both Marck and others (2010) and Huijing and others (2011) find this pattern in complex reconstructions, which, combined with the findings of Maine and others (2012), leads them to recommend against short-term surgical missions for all but the simplest conditions.

Cost-Effectiveness of Short-Term Surgical Missions. With a significant caveat to be discussed below, the few cost-effectiveness analyses that have been performed on surgical missions point, in general, to a beneficial ratio of costs to effectiveness. The cost of a short-term surgical mission is difficult to calculate and very sensitive to assumptions made regarding discounting, analysis perspective, the inclusion of nonmedical patient costs, and the inclusion of opportunity costs for the volunteering staff (Corlew 2013). Cleft missions have been estimated to range from approximately US$40 per case to US$335 per case (Hodges and Hodges 2000; Moon, Perry, and Baek 2012), and up to US$65,500 per mission (Magee, Vander Burg, and Hatcher 2010). Orthopedic missions cost more than US$170,000 each (Gosselin, Gialamas, and Atkin 2011), and short-term cataract camps cost $50 per case (Singh, Garner, and Floyd 2000).

These estimates translate to cost-effectiveness ratios comparable with other global health interventions: Cleft lip and palate repair costs anywhere from US$52/DALY averted (up to US$97 per DALY averted when costs of lost income to the physician are included) (Moon, Perry, and Baek 2012) to US$1,827 per DALY averted (Magee, Vander Burg, and Hatcher 2010). Orthopedic surgeries are slightly more expensive; elective and emergency operative procedures cost between US$340 and US$360 per DALY averted in Haiti (the emergency figures, notably, come from efforts surrounding the 2010 earthquake, and their generalizability may be limited) (Gosselin, Gialamas, and Atkin 2011).

These findings, however, must be interpreted with extreme caution, especially because they do not square with the assessment that surgical results of short-term surgical missions tend toward the unsatisfactory. The apparent cost-effectiveness of surgical missions is, in fact, very likely simply an artifact of the way in which the cost-effectiveness analyses were conducted. All of the cited studies compared intervention with no intervention—as opposed, for example, to surgery by a surgical mission versus surgery by the local infrastructure. This analytic method will frequently result in a misleadingly small cost-effectiveness ratio, which must, in turn, be interpreted very narrowly: only when *no other* platform exists to deliver care for the condition treated by the mission do these results imply that a surgical mission is cost-effective. If the condition can be treated by other platforms, including first-level hospitals, these cost-effectiveness results cannot be applied.

One cost-effectiveness analysis was found that actually compares the surgical mission with other platforms for the delivery of identical surgeries. Singh, Garner, and Floyd (2000) examine the cost-effectiveness of cataract surgeries performed at specialized eye camps, at NGO hospitals, and at the state medical college. Although not the worst value—that distinction fell to the state medical college—cataract surgery performed at short-term eye camps was much less cost-effective than that performed in permanent, nongovernmental hospitals.

Sustainability and Training Role of Short-Term Surgical Missions. Many authors laud the salutary role that short-term surgical missions can have in the education of HIC surgical trainees. Alterman and Goldman (2008); Aziz, Ziccardi, and Chuang (2012); Belyansky and others (2011); Boyd and Cruz (2011); Cameron and others (2010); Campbell, Sherman, and Magee (2010); Campbell and others (2011); Haskell and others (2002); Henry and others (2013); Hughes and others (2010); Jarman, Cogbill, and Kitowski (2009); Lee and Weinstein (2009); and Matar and others (2012) are among many who have written about this beneficial impact on surgical trainees and the surgeons with whom they travel. Although this role is not to be discounted, the benefits to surgical residents in HICs clearly cannot come at the cost of delivery of unsatisfactory care in LMICs (Wall 2011).

No published evidence was found for the role that short-term missions play in training within LMICs themselves. Short-term surgical missions have, however, been put forward as a method to alleviate the disease burden—especially given that these NGOs frequently offer surgery for free. Unfortunately, with higher complication rates and unsatisfactory results in more complex operations, the sustainable role of the surgical mission is unclear. It is not altogether unlikely, for example, that these surgical missions treat the same conditions that would be treated otherwise in first-level hospitals, and that fragmentation in delivery (Butler 2010) contributes to poor coordination and often a frank inability to meet the large burden of unmet need by the short-term mission (Cam and others 2010).

The structure of the short-term medical mission itself may also be detrimental to sustainability. Patients are usually identified before the surgical team's arrival by local medical staff (Nthumba 2010). While the team is there, a large volume of cases are performed, often overwhelming the local infrastructure during and after the team's visit (Nthumba 2010).

Finally, it should also be noted that, in the communities they serve, these platforms create an awareness of a given surgical condition and the potential to address it surgically. This awareness can often have counterintuitively *detrimental* effects on health care utilization among the population. When outcomes are consistently

good, increased awareness influences positive health-seeking behavior in potential patients. Even the most sporadic of bad outcomes, however, seem to discourage care-seeking outright (Fletcher and others 1999).

Despite its ubiquity, then, the short-term surgical mission appears to have a relatively limited role in the delivery of surgical care. In settings in which surgical conditions cannot otherwise be treated, the short-term mission is cost-effective and appears to have a role in the amelioration of the surgical burden. However, in settings in which other platforms exist for surgical delivery, the short-term mission is unlikely to be either the most effective or the most cost-effective method with which to alleviate the large burden of surgical disease in LMICs. Given potentially unsatisfactory results with complex surgeries, potentially detrimental effects on health-seeking behavior, and stress on the local surgical infrastructure, the short-term stand-alone surgical mission, when other options exist, is likely to be inefficient (Browning and Patel 2004).

Self-Contained Mobile Surgical Platforms

The fact that complex procedures performed by short-term missions yield unsatisfactory results, (Huijing and others 2011; Marck and others 2010), combined with the fact that most first-level hospitals are also unable to provide this care consistently (Hsia and others 2012; Ilbawi, Einterz, and Nkusu 2013; Linden and others 2012), leads to an obvious question. Many LMICs are committed to improving their surgical capacity; while they do so, how can the interim unmet need be best met, if not with short-term missions? Are specialized surgical hospitals the best way to provide adequate complex care that the local health infrastructure cannot yet provide—and to do so cost-effectively? Or can a different temporary model, better structured than the short-term mission, provide this level of care?

Few examples of such an intermediate model for surgical delivery exist, but those that do are promising. Mercy Ships, for example, maintains hospital ships that provide specialized surgical care in West Africa. They carry their entire infrastructure with them, including pathology and radiology (Harris 2013), and they are able to provide ophthalmologic, reconstructive, general, orthopedic, and obstetric fistula surgeries (Cheng, McColl, and Parker 2012; Lewis and de Bernis 2006). The limited studies on the effectiveness of surgical procedures performed using this platform indicate a complication rate that is comparable with complication rates for cases performed in centers in HICs (Cheng, McColl, and Parker 2012). No literature on similar platforms, such as Floating Doctors, was found.

Military organizations adopt a similar model. The United States Navy maintains two hospital ships that report mortality and complication rates that are equivalent to, if not better than, those found in hospitals in HICs (Troup 2007; Walk and others 2011, 2012). There have been, as yet, no cost evaluations and no cost-effectiveness evaluations of these self-contained surgical platforms.

SPECIALTY SURGICAL HOSPITALS

Demand and Supply Constraints

Specialized surgical hospitals are myriad (table 13.1). Many have evolved from temporary surgical platforms. Cataract surgeries in India, for example, were initially performed in makeshift surgical facilities, schools, or community halls, before their care made the transition to specialized hospitals. Technologies were very basic, limited essentially to surgical instruments and the skills of the surgeons. Although this sort of outreach—with improved technology—continues to be common, a population-based study estimates that those accessing these outreach eye camps represent a mere 7 percent of those in need of eye care (Fletcher and others 1998).

Similarly, current global estimates put resource utilization of eye care facilities at 25 percent of incident cases of blindness (WHO 2005). Research by

Table 13.1 Examples of Surgical Specialty Hospitals in LMICs

Cardiac
Salam Centre for Cardiac Surgery, Khartoum, Sudan
Narayana Hrudayalaya Hospitals, Bangalore, India
Innova Children's Heart Hospital, Hyderabad, India
Ophthalmic
ORBIS
Aravind Eye Hospitals, Tamilnadu, India
LRBT Eye Hospitals, Pakistan
Obstetric Fistula
Babbar Ruga Fistula Teaching Hospital, Katsina, Nigeria
Addis Ababa Fistula Hospital, Addis Ababa, Ethiopia
Danja Fistula Center, Danja, Niger
Maternity Services
Life Spring Hospitals, India
Cancer
Adayar Cancer Institute, Chennai, India
Tata Memorial Hospital, Mumbai, India

Note: LMICs = low- and middle-income countries.

Browning and Patel (2004, 321) in the obstetric fistula setting indicates that "at the world's current capacity to repair fistula, it would take at least 400 years to clear the backlog of patients, provided that there are no more new cases." At present, less than 1 percent of the surgical need for fistula repair is met (Browning and Patel 2004). In Ethiopia alone, it is estimated that of the 2.9 million women who give birth annually, almost 9,000 will develop an obstetric fistula (Hamlin, Muleta, and Kennedy 2002; Muleta, Rasmussen, and Kiserud 2010). Similar statements can be made about the unmet need for cardiac surgery, maternity services, and cancer care.

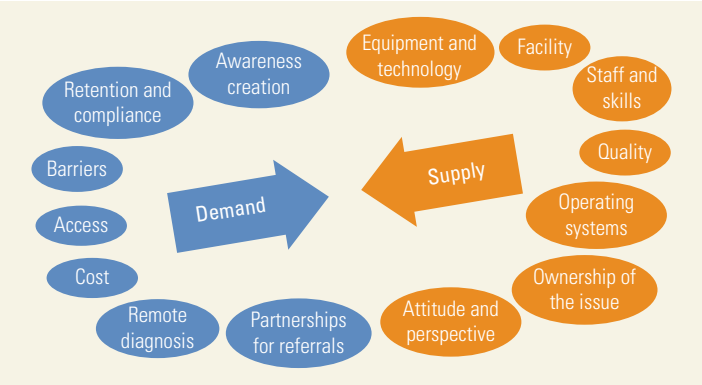
In addition to constituting a large unmet need, many surgical conditions—especially those treated by specialized hospitals—are chronic, allowing (with notable exceptions) these surgeries to be performed electively. Because at least some of these conditions (cataracts, hernias, and cardiac conditions, for example) also tend to be age related, and because these interventions can dramatically enhance activities of daily living and the quality of life (Fletcher and others 1998), an aging population will make it crucial that such services are provided in a sustainable manner.

Demand is, however, constrained by a number of factors: a large, underserved, and dispersed population; scarce capital and human resources; poor in-country logistics; and patient-level characteristics—barriers to market entry, fluctuating incomes with little disposable surplus, unfamiliarity with surgical procedures, and multiple domestic necessities (figure 13.2) (Prahalad 2009). Finally, many complex conditions cannot be treated by a single surgical procedure and require treatment of specialized preoperative and postoperative needs—including physiotherapy, economic rehabilitation, preoperative nourishment, social counseling, and physical environments that are geared toward specific surgical conditions—for which the specialized hospital may be well suited.

Effectiveness of Specialty Surgical Hospitals

The challenge for specialized surgical hospitals is not one of discovering novel clinical solutions to these conditions—time-tested surgical interventions for many of the conditions treated by long-term surgical platforms exist (Ruit and others 2007)—but of effective long-term implementation in permanent centers located in resource-limited settings. Effectiveness data for specialized surgical hospitals are, however, limited and come primarily from ophthalmologic and fistula centers. We found no evidence from specialty hospitals treating other conditions.

Figure 13.2 Demand and Supply Levers in Delivering Surgical Care in LMICs



Note: LMICs = low- and middle-income countries.

Evidence for the effectiveness of ophthalmologic centers has already been presented: specialized NGO hospitals are more cost-effective than other platforms in the provision of cataract surgery (Singh, Garner, and Floyd 2000).

Repair of obstetric fistula is complex. Fistula surgeons are not considered expert until they have performed at least 300 cases (FIGO and Partners 2011); even expert surgeons deliver, on average, closure and continence to only 85 percent of patients. The volume of surgeries required to qualify as an expert and competent fistula surgeon may not be met in short-term missions, or at a first-level hospital, for years (FIGO and Partners 2011). Published studies, however, document good results for specialized fistula hospitals: the Addis Ababa Fistula Hospital (a charitable organization) and Babbar Ruga Fistula Teaching Hospital (an initiative sponsored by the Nigerian government with reliance on external funding) do well, reporting rates of successful fistula closure and return to continence of greater than 90 percent (Muleta 1997; Waaldijk 2008).

In addition to issues of volume and success rates, complex surgical conditions, such as obstetric fistula and cleft palate, place specific demands on the design of the physical facility, often not feasible on a short-term mission. For instance, Hamlin, Muleta, and Kennedy (2002) highlight needs unique to the vulnerable fistula population: traditional multistoried hospitals are not in sympathy with the poor communities from which these women come, while grassy areas can absorb leaking urine, and wide, open walkways and corridors allow the "pervasive smell of urine … to escape more readily" (Hamlin, Muleta, and Kennedy 2002, 51), both of which improve morale. Finally, specialized long-term platforms can provide physical therapy services and rehabilitation and reintegration services, all deemed to be important

to an effective fistula program. Similar rehabilitative considerations—including speech and swallowing therapy—are required for the repair of cleft palate.

Temporary surgical platforms—especially those espousing a short-term model—are unlikely to be able to meet these needs; and while first-level hospitals may meet some of them, they often cannot prioritize such additional services and facilities over more life-threatening surgical conditions, further preventing the delivery of complex surgery (Wall 2007). In keeping with these findings, an expert elicitation study also concludes that outcomes for complicated obstetric fistula cases are most likely best at the high-volume, specialized surgical hospitals as opposed to first-level hospitals (Colson and others 2013).

Cost-Effectiveness of Specialty Surgical Hospitals

The single comparison of cataract care across platforms demonstrates the superior cost-effectiveness of permanent NGO hospitals (Singh, Garner, and Floyd 2000). Compared with US$50 per case at short-term cataract hospitals, NGO hospitals treat cataracts at US$46 per case, with nearly double the patient satisfaction (Singh, Garner, and Floyd 2000). No adequate data, unfortunately, exist to assess the cost-effectiveness of fistula repair centers, cardiac centers, or other specialized surgical hospitals.

Sustainability and Training Role of Specialty Surgical Hospitals

Whether a hospital is run for profit or as a nonprofit, it must be sustainable across the several dimensions of financial stability, clinical services, leadership, and community support. Financial stability is addressed by developing sustainable sources of income, as well as by ensuring high efficiency, appropriate pricing, and effective cost control measures that do not adversely affect quality or productivity. Standard protocols, processes for continuous improvement, and succession planning also contribute to stability and sustainability. The ability to continue to provide clinical services once they have departed is difficult for short-term surgical platforms—most teams take the technical skills, support, and equipment with them when they leave.

The high volume of specialized centers, however, allows for sustainable surgical training programs. The Babbar Ruga Fistula Teaching Hospital has trained more than 315 fistula surgeons and 320 nurses worldwide (Waaldijk 2008); to meet ophthalmic training needs, internal training programs at the Aravind Eye Hospital now graduate about 400 mid-level ophthalmic personnel and 33 ophthalmologists each year. Consistent with Browning and Patel's 2004 estimates, the experience of one of this review's authors (A. Sleemi) with short-term surgical missions for obstetric fistula demonstrates the level of sustainability required for education: the training of two Eritrean fistula surgeons required at least five years before competency levels and adequate case numbers were met.

Finally, from an academic standpoint, the bulk of the literature comes from such specialized training centers: both Addis Ababa and Babbar Ruga Fistula Hospitals have provided key data and landmark papers on the management of obstetric fistula. Specialized surgical centers, because of their high volumes, may have a role in filling the void of an evidence base in global surgery.

DISCUSSION

Surgical conditions constitute up to 26 percent of the global burden of disease, and the current surgical infrastructure in many LMICs meets very little of that need. Access to surgical care is low (Brilliant and others 1985; Browning and Patel 2004; WHO 2005), and most hospitals in LMICs are themselves unable to meet the demand of high-DALY surgical conditions (Ilbawi, Einterz, and Nkusu 2013). Simultaneously, a rich, rapidly growing, and often fragmented charitable sector has stepped in to meet surgical need—a sector that, despite its growth, has not been systematically evaluated (Butler 2010). This review summarizes the known evidence on the impact of the charitable sector in delivering surgical care in LMICs.

Unfortunately, what evaluations have been done may actually promote fragmentation—examining surgical missions in isolation, as most studies have, prevents informative similarities and differences among these missions from becoming explicit. We propose, instead, to structure evaluations around *platforms* for the delivery of care, rather than around disease types or individual missions. Doing so highlights the relative effectiveness or ineffectiveness of models that underpin charitable surgical delivery.

Accordingly, we have broken down the galaxy of surgical NGOs into two types: temporary surgical platforms—including short-term, surgical missions and self-contained mobile surgical programs—and free-standing specialized surgical centers. The overall findings from this systematic review are presented in table 13.2.

Short-Term Surgical Missions

The available evidence suggests that, despite its ubiquity and benefit to HIC medical resident training, the role

Table 13.2 Summary of Results

	Platform		
Domain	**Temporary, short-term mission**	**Temporary, self-contained[a]**	**Surgical specialty hospital**
Effectiveness	Poor results for complex procedures; effective for simple procedures	Potentially equivalent to outcomes in HICs	Equivalent to outcomes in HICs
Cost-effectiveness	Yes if serving as the only platform for surgery; unlikely otherwise	No data available	Most cost-effective of the competing choices
Sustainability	Unlikely; may have a detrimental impact on health-seeking behavior	No data available	Platform suitable for sustainability
Training	Effective for HIC surgeons; limited data on surgeons in LMICs	Available for training	Definite role in LMICs

Note: HICs = high-income countries; LMICs = low- and middle-income countries.
a. Sparse data on this platform limit the certainty of these conclusions.

of short-term temporary surgical missions should be limited to areas and conditions for which no other surgical delivery platform is available. In these settings, this platform delivers care very cost-effectively.

In settings in which alternative delivery systems exist, the short-term mission appears to be an inefficient way to meet the global burden of high-DALY surgical disease (Cam and others 2010). These missions may not be effective at reaching the patients with unmet need, given that they treat conditions that first-level hospitals may already be treating (Browning and Patel 2004; Butler 2010) and may risk delivering unsatisfactory results, especially for complex reconstructions (Huijing and others 2011; Maine and others 2012; Marck and others 2010). Although some conditions are amenable to surgical blitzes (Sykes and others 2012), the blitzes themselves often stress the underlying local surgical infrastructure (Nthumba 2010) and may discourage health-seeking behavior (Fletcher and others 1999), which undermines this platform's sustainability.

For conditions for which cost-effectiveness evidence exists (facial clefting and orthopedic care), these surgical missions provide cost-effective service—but they do so only, again, in comparison with settings that do not provide *any* surgery (Gosselin, Gialamas, and Atkin 2011; Hodges and Hodges 2000; Magee, Vander Burg, and Hatcher 2010; Moon, Perry, and Baek 2012). In analyses in which they are compared with other platforms in delivering identical services, surgical missions become less cost-effective (Singh, Garner, and Floyd 2000).

Self-Contained Mobile Surgical Platforms

Self-contained mobile platforms are rare, but they fit in the negative space between the surgical mission and the specialty hospital. They offer services, such as radiology, that are usually not found in the short-term mission (Harris 2013) and are able to deliver care comparable to that found in HICs (Cheng, McColl, and Parker 2012). Studies on this platform are few, and cost-effectiveness studies are nonexistent; in the interim, while surgical infrastructure develops, a scale-up of this model should be considered, given that it might meet the burden of surgical disease in a more effective and efficient way than its short-term counterpart.

Specialty Surgical Hospitals

Finally, the literature suggests that specialized surgical centers might be effective in providing a high volume of care with good outcomes (Muleta 1997; Waaldijk 2008). These long-term platforms are also able to provide for some of the unique needs faced by patients with more complex conditions (Hamlin, Muleta, and Kennedy 2002; Wall 2007; Wall and others 2006). One cost-effectiveness analysis that makes comparisons across platforms does demonstrate the superiority of these specialized surgical hospitals to short-term missions (Singh, Garner, and Floyd 2000), but further analyses are necessary.

This review is the first to attempt a broad, systematic evaluation of charitable surgical delivery in LMICs, distinct from the conditions treated and the individual organizations that treat them. As such, it has certain limitations. It should be noted, for example, that any taxonomy is leaky. Some organizations that establish hospitals also send short-term missions to other countries; some of the self-contained organizations have themselves established hospitals. That no classification system can adequately characterize any NGO does not, however, mean that research into

these organizations must remain fragmented. This taxonomy, incomplete though it may be, proposes a structure for future research into a large sector of the health system.

The peer-reviewed literature in this area is small, all outcomes studies are case series, and nearly all the cost-effectiveness studies are predicated on heroic assumptions. In addition, although some studies do show less-than-optimal results, publication bias very likely exists. More important, a lack of evidence does not imply evidence of a lack. Many surgeons in LMICs, in addition to surgeons who work with these charitable organizations, have little time to devote to producing peer-reviewed publications. As such, a dearth of evidence exists as to the comparative effectiveness of NGO platforms and first-level hospitals within the same setting. This evidence void highlights the need for further investigation into the effectiveness of surgery as delivered in these settings, as well as the potential role for other research methods—such as realist synthesis—in the study of surgical delivery by charities in LMICs.

Finally, of the domains along which delivery platforms were evaluated (cost-effectiveness, effectiveness, sustainability, and training role), the first is especially controversial, especially given the various platforms used. Some organizations, for example, work entirely with volunteer staff; others pay. Therefore, cost-effectiveness claims must be interpreted with caution.

CONCLUSIONS AND RECOMMENDATIONS

Limitations in the literature highlight the clear need for more, and larger, evaluations of the effectiveness and cost-effectiveness of the charitable sector's role in the delivery of surgical care in LMICs. This sector is large and spends a significant amount of donor money (Casey 2007). Determining the most effective platform for the delivery of care stands to benefit patients, for whom this is often the only affordable avenue of care; determining the most cost-effective platform stands also to align donor interests with those of the patients they seek to help.

The available literature allows the following recommendations to be made:

- Evaluations of charitable surgery should be undertaken from the perspective of the care-delivery platform—short-term surgical trips, self-contained mobile platforms, and specialty hospitals—instead of by the disease condition addressed by individual organizations.
- Short-term surgical missions are useful when access to surgical services is nonexistent. This recommendation must, however, be made with caution because, although any surgical access is better than none, poor outcomes may have a chilling effect on health-seeking behavior.
- Consideration should be given to expansion of self-contained mobile platforms instead of short-term surgical trips to meet the unmet surgical need in countries developing their surgical infrastructure.
- Rigorous evaluations of the cost-effectiveness and sustainability of various charitable delivery platforms should be undertaken.
- Because training already occurs within the confines of some NGOs, further evaluations of the effectiveness of this training should be undertaken—with respect to the retention of surgical skills, to improvements in outcomes, and to the retention of in-country providers.

Although the paucity of data implies a measure of uncertainty in these recommendations, this literature review suggests that following them may help in decreasing the fragmentation found in the nongovernmental sector, to the ultimate benefit of surgical patients (Ilbawi, Einterz, and Nkusu 2013).

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NOTES

This chapter uses the World Health Organization's (WHO's) six geographical regions: African Region, Region of the Americas, South-East Asia Region, European Region, Eastern Mediterranean Region, and Western Pacific Region.

The World Bank classifies countries according to four income groupings. Income is measured using gross national income (GNI) per capita, in U.S. dollars, converted from local currency using the *World Bank Atlas* method. Classifications as of July 2014 are as follows:

- Low-income countries (LICs) = US$1,045 or less in 2013
- Middle-income countries (MICs) are subdivided:
  - lower-middle-income = US$1,046 to US$4,125
  - upper-middle-income (UMICs) = US$4,126 to US$12,745
- High-income countries (HICs) = US$12,746 or more

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