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ORIGINAL SCIENTIFIC REPORT

Cost-Effectiveness of a Locally Organized Surgical Outreach Mission: Making a Case for Strengthening Local Non-Governmental Organizations

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Abstract

Introduction Many low- and middle-income countries (LMICs) have a high prevalence of unmet surgical need. Provision of operations through surgical outreach missions, mostly led by foreign organizations, offers a way to address the problem. We sought to assess the cost-effectiveness of surgical outreach missions provided by a wholly local organization in Ghana to highlight the role local groups might play in reducing the unmet surgical need of their communities.

Methods We calculated the disability-adjusted life years (DALY) averted by surgical outreach mission activities of ApriDec Medical Outreach Group (AMOG), a Ghanaian non-governmental organization. The total cost of their activities was also calculated. Conclusions about cost-effectiveness were made according to World Health Organization (WHO)-suggested parameters.

Results We analyzed 2008 patients who had been operated upon by AMOG since December 2011. Operations performed included hernia repairs (824 patients, 41%) and excision biopsy of soft tissue masses (364 patients, 18%). More specialized operations included thyroidectomy (103 patients, 5.1%), urological procedures (including prostatectomy) (71 patients, 3.5%), and plastic surgery (26 patients, 1.3%). Total cost of the outreach trips was $283,762, and 2079 DALY were averted; cost per DALY averted was 136.49 USD. The mission trips were "very cost-effective" per WHO parameters. There was a trend toward a lower cost per DALY averted with subsequent outreach trips organized by AMOG.

Conclusion Our findings suggest that providing surgical services through wholly local surgical mission trips to underserved LMIC communities might represent a cost-effective and viable option for countries seeking to reduce the growing unmet surgical needs of their populations.

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Introduction

An estimated five billion people may not have access to essential surgical care [1]. The majority of this disparity occurs in low- and middle-income countries (LMICs), which are least able to provide necessary care due to deficiencies in surgical capacity such as inadequate infrastructure, human, and physical resources [2–4]. Resultantly, LMICs have a high prevalence of unmet surgical needs, even for common conditions like hernias, hydroceles, fractures, and skin and soft tissue masses [5–7]. The high prevalence of unmet surgical needs is the result of several barriers to surgical care that populations of many LMIC communities face [8–10]. While sufficient development of global surgical capacity and care might not occur in the short term [11], one method to address the large unmet need for surgical care in affected communities is the provision of operations through outreach missions [12]. Many surgical missions have successfully provided surgical care to underserved LMIC communities over the years, with a large majority spearheaded by foreign organizations [13]. International travel and logistics of foreign trips add to the cost of such efforts, decreasing the cost-effectiveness overall. Alternatively, local outreach groups may be able to address the large unmet need for surgery in an equally effective and more efficient manner. We sought to assess the cost-effectiveness of surgical outreach missions provided by a wholly local organization in Ghana. By so doing, the impact of such local outreach groups on reducing the large unmet need for surgery might be emphasized.

Methods

Setting

ApriDec Medical Outreach Group (AMOG) is a Ghanaian-based non-governmental organization (NGO) that is committed to providing outreach surgical services to underserved communities in the three northern regions of Ghana [14]. AMOG engages in surgical outreach missions to these communities at least twice a year in collaboration with the regional health directorates and community leaders, who actively mobilize patients to present for surgical care with radio announcements and informative flyers in town centers and other popular areas. Patients are screened by local medical officers and prepared for surgery in consultation with AMOG medical volunteers in advance of scheduled surgical missions. AMOG medical volunteers include various specialized surgeons, surgery residents-in-training, nurse anesthetists/anesthesiologist, theater nurses, pharmacists, and other allied health professionals. This volunteer team allows AMOG to provide a widespread array of surgical services at no financial burden to the patients. Although the primary focus of AMOG's activities is surgical service provision, volunteers also provide supplementary education and training to their host healthcare facilities during the course of each outreach trip.

Data collection

Information on patients' age, sex, principal presenting complaint, clinical diagnosis, and operation performed was extracted from AMOG clinical records. The duration of the outreach mission trip, number, and types of participating volunteers were also recorded.

Cost estimation

To estimate the financial cost of a mission trip, the cost of roundtrip travel to the communities, and the cost of room and board (i.e., accommodation, meals) for the outreach period were calculated. To calculate the worth of time donated by different types of volunteers (surgeons, nurse anesthetists/anesthesiologist, theater nurses, etc.), their daily wages were valued at 1/30 of the corresponding monthly salaries as at December 2016. The cost of hospital operations for patients who received a surgical procedure was estimated from the 2016 approved Ghana National Health Insurance Scheme (NHIS) tariffs. These tariffs are set by the NHIS to cover the hospital's cost of equipment and supplies in the provision of surgical care. We used the exchange rate prevailing in December 2016 (1 GHS = \$0.25 USD) to convert Ghana Cedis to US Dollars and assumed a constant cost in US Dollars for all the outreach trips. The total cost of an outreach trip was the sum of all the above components specific to each trip. All dollar amounts are presented in USD.

Estimation of disability-adjusted life years (DALY) averted

DALY averted were calculated using the method developed by McCord and Chowdhury but with slightly simplified estimates of the risks of death and disability and the effectiveness of treatment as described by Gosselin et al. [15, 16]. Patient data were gathered on all surgical operations performed during each AMOG outreach missions since December 2010. As AMOG started recording more

comprehensive data on surgeries performed during outreaches from December 2011, patients who underwent an operation during outreach trips before this period (December 2010 and April 2011) were excluded. We assigned Global Burden of Disease Study 2015 (GBD 2015) disability weights to each operative indication [17]. When disability weights were not available in GBD 2015 for a particular condition, the authors employed estimates of conditions that were closest in severity. For example, GBD 2015 did not assign a disability weight to gastric perforation due to peptic ulcer disease; the authors assigned to it the disability weight for "severe abdominopelvic problems." Similarly, there was no disability weight for benign soft tissue masses (e.g., lipoma or neurofibroma); these were assigned the disability weight for "symptomatic other skin and subcutaneous diseases, disfigurement level 1″. A disease severity score was assigned to each patient presenting indication, ranging from 0 (less than 5% chance of death without hospital treatment) to 1 (more than 95% fatal without hospital treatment). Likewise, all procedures performed were assigned an effectiveness of treatment score, ranging from 0 (less than 5% chance of permanent cure) to 1 (more than 95% chance of permanent cure), in the treatment of each relevant operative indication [16]. Finally, the life expectancy for each patient was estimated using their age at the time of operation against the life expectancy values listed by age, sex, and calendar year in the WHO life table data for Ghana [18]. No age weighting or discounting was employed. This calculation took the form of:

$$\text{DALY averted} = \text{D} \times \text{Wt} \times \text{DSS} \times \text{ETS} \times \text{LifeEx}$$

where, D × Wt = GBD 2015 disability weight for the particular disease condition, DSS = disease severity score, ETS = effectiveness of treatment score, LifeEx = life expectancy for the individual as per life table for the year of outreach trip.

Appendix 1 shows examples of our estimations of DALY averted. The estimations were made without age weighting or discounting [19].

The total DALY averted for all patients during each outreach trip was then summed, and the cost per DALY averted for each trip was calculated as:

$$\text{Cost per DALY averted} = \frac{\textit{Total cost of outreach trip}}{\textit{Sum of DALYs averted for all patients operated upon during the trip}}$$

For each trip, we reported the number of participating volunteers, duration in days, costs, and DALY averted. Trips were also aggregated to provide the total number of operations performed (by type) and the total number of patients. Assessment of cost-effectiveness was done by comparing the cost per DALY averted to Ghana's gross domestic product (GDP) per capita. The World Health Organization (WHO) suggests that an intervention whose cost per DALY averted is less than the GDP per capita is "very cost-effective," while an intervention whose cost per DALY averted is one to three times the GDP per capita is "cost-effective." An intervention whose cost per DALY averted is greater than three times the GDP per capita is considered "not cost-effective" [20].

Results

AMOG has conducted 12 outreach trips since 2010, lasting 74 days in total and on the average 7.3±2.1 days per trip. For the 10 outreach trips analyzed, 2008 patients underwent an operation representing 94% of 2128 patients who had undergone an operation during all of AMOG mission trips. A total of 1347 (64%) of them were males. Mean age was 44.3±22.0 years (Range: 1 month–99 years).

Abdominal wall hernia repairs (including groin hernias, umbilical and incisional hernias) were the most common operation performed (824 patients, 41%), followed by excision biopsy of various soft tissue masses (364 patients, 18%) and hydrocelectomy (335 patients, 17%) (Table 1). Other more specialized operations included thyroidectomy (103 patients, 5.1%), urological procedures, such as prostatectomy, urethroplasty, and varicocelectomy (71 patients, 3.5%), and plastic surgical operations including grafting of ulcers and release of contractures (26 patients, 1.3%).

Details of the cost of each outreach trip, the DALY averted per trip, and the corresponding cost per DALY averted for each trip are presented in Table 2. The outreach trips cost between $2636 and $47,157. The total cost of 10 outreach trips analyzed was $283,762. In total, 2079 DALY were averted; thus, the cost per DALY averted was 136.49 (Table 2). Per WHO-suggested parameters, each of the outreach mission trips organized by AMOG was "very cost-effective" as the cost per DALY averted was less than the country's GDP per capita for the year of the mission trip. The number of DALY averted increased with the cost of an outreach trip. However, with increased experience with the outreaches, there was a trend toward a lower cost per DALY averted with subsequent outreach trips organized by AMOG (Fig. 1).

Discussion

This study aimed to estimate the average cost per DALY averted by the activities of a local surgical outreach-oriented NGO in Ghana. On the average, it costs about $136 for every DALY averted by the NGO's activities over 10 mission trips and with increased experience, there was a

Table 1 Surgical procedures performed by AMOG volunteers from 2010 to 2016[a]

Operations	*N*	(%)
Hernia repair (e.g., groin, umbilical, epigastric, incisional, etc.)	824	(41)
Hydrocelectomy	335	(17)
Soft tissue mass excision biopsy (e.g., lipoma, fibroadenoma, ganglion, etc.)	364	(18)
Thyroidectomy	103	(5.1)
Trauma and orthopedic operations (e.g., bone fracture fixation, osteotomy for genu valgum, etc.)	61	(3.0)
Other obgyn operations (e.g., repair of vesicovaginal fistula or pelvic organ prolapse, etc.)	70	(3.5)
Fibroid surgery	54	(2.7)
Other urologic operations (orchidopexy for undescended testis, urethroplasty, varicocelectomy, etc.)	44	(2.2)
Prostatectomy	27	(1.3)
Operations for benign perianal conditions	33	(1.6)
Cesarean section	25	(1.2)
Intra-abdominal operations (e.g., operations for bowel obstruction, cholecystectomy, appendectomy, etc.)	21	(1.0)
Plastic surgery	26	(1.3)
Cataract surgery	11	(0.5)
Head and neck procedures (orofacial cleft repair, foreign body removal, etc.)	7	(0.3)
Mastectomy	3	(0.1)
Total	2008	(100)

AMOG ApriDec Medical Outreach Group

[a] Excludes operations performed during December 2010 trip (55 cases) and April 2011 (65 cases)

trend toward a reduced cost per DALY averted. This suggests that AMOG's surgical mission trips are increasingly becoming more cost-effective, thus presenting an option for reducing the large unmet need for surgery in underserved communities such as those in the three northern regions of Ghana.

The considerably large unmet need for surgical care, especially in LMICs, has been well documented and continues to increase [5–7, 21]. Many physician groups and NGOs have amplified their efforts to respond to this well-established need through the provision of surgical care to LMIC communities via mission trips [12, 21]. However, the financial costs of foreign surgical mission trips to LMICs have been described as substantial, encompassing the total cost for expenditures such as airfare, lodging, and resource utilization as well as forfeited wages of foreign health providers participating in the surgical mission trip. In total, these costs are usually estimated to range from $10,000 to well over $1 million [22–24].

The total cost of 10 mission trips organized by AMOG, a wholly local NGO, providing surgical care for 2008 patients, was under $285,000. This was an average of about $28,500 per trip or $141 per patient. This suggests that with surgical mission trips organized by local NGOs, there is an opportunity to reduce the substantial financial cost associated with these well-intended efforts to reduce the unmet surgical needs of deprived communities. Furthermore, close to two-thirds (63%) of the surgical procedures performed by AMOG were essential procedures (as defined by the third edition of the World Bank's Disease Control Priorities) [1]. This highlights the high impact made on the health of these communities served. A report on the activities of a surgical outreach mission team from the USA to the Dominican Republic showed that, in two trips, 71 essential surgical procedures were performed [25]. The estimated overall cost per DALY averted for their operations was $304.88. It is informative to note that the cost of airfare and hotel accommodation alone for their two trips was $35,550.

The average cost per DALY averted by AMOG activities was $136 which was "very cost-effective" per WHO-suggested parameters [26]. The steady reduction in cost per DALY averted with increasing mission trips may be explained by the experience gained and efficiencies improved by planners and volunteers with each subsequent mission. In addition, increasing awareness in the communities about AMOG mission trips has led to an increasing number of patients presenting for surgical care, allowing AMOG the opportunity to perform more surgeries during a trip. This contributes to a trend of more DALY being averted with subsequent trips.

The relationship an NGO cultivates with the community they are serving is critical to mission success. Many NGOs, especially foreign ones, might not have the capacity or mandate to find, diagnose, and prioritize patients for surgical care [13]. AMOG has continued to organize their

Table 2 Details of outreach mission trips organized by AMOG

Outreach mission trip	Period	Number of volunteers	Duration (days)	Volunteers' wages (USD)	Transportation (USD)	Accommodation and meals (USD)	Cost of surgery provision (USD)	Total cost of trip (USD)	DALY averted	Cost per DALY averted	Ghana's GDP per capita (USD)
Trip3	December 2011	18	11	7147	540	5130	6803	19,620	51	381.04	1587
Trip4	December 2012	32	11	12,902	960	9120	23,115	46,097	233	197.49	1642
Trip5	March 2013	34	4	5483	1020	3145	18,163	27,811	198	140.52	1827
Trip6	April 2014	23	8	8158	690	4658	16,695	30,200	160	188.36	1446
Trip7	August 2014	3	5	921	90	360	1265	2636	17	154.31	1446
Trip8	December 2014	37	6	9293	1110	5458	19,134	34,994	411	85.20	1446
Trip9	February 2015	4	7	1826	120	700	3794	6440	64	99.88	1370
Trip10	March 2015	31	8	10,026	930	6278	16,880	34,113	263	129.85	1370
Trip11	December 2015	28	7	10,861	840	4900	18,092	34,694	364	95.38	1370
Trip12	April 2016	37	7	14,064	1110	6475	25,508	47,157	317	148.70	1370[a]
Total				80,681	7410	46,223	149,449	283,762	2079	136.49	1574

AMOG ApriDec Medical Outreach Group

[a] 2016 GDP per capita for Ghana assumed to be same as for 2015, as exact figure not yet available

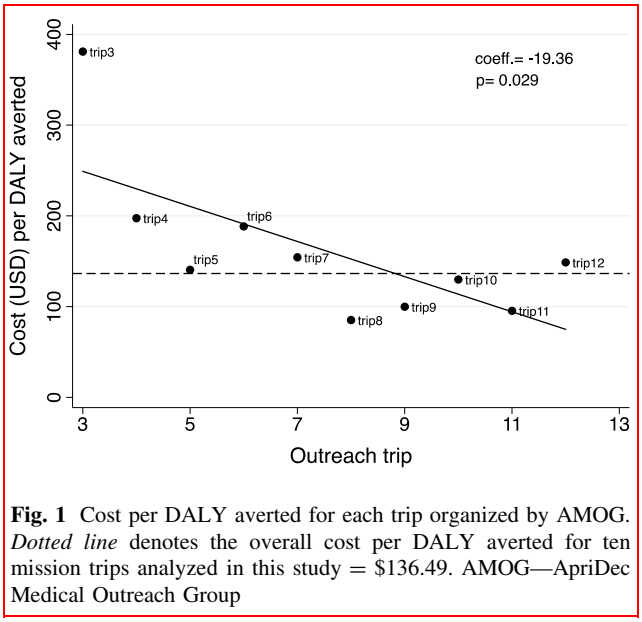

Fig. 1 Cost per DALY averted for each trip organized by AMOG. *Dotted line* denotes the overall cost per DALY averted for ten mission trips analyzed in this study = $136.49. AMOG—ApriDec Medical Outreach Group

surgical mission trips, 2–3 times a year, without interruption since the first mission trip in December 2010. This has been possible because of the strong collaboration with regional health administrators, hospital managers, and local community leaders that has made AMOG well accepted and fondly popular in the communities they provide service. Many communities in the northern regions of Ghana have come to expect AMOG's visit (April and December) and so local hospitals experience a surge in hospital presentation for surgical pre-consultation prior to these periods. Surveyed patients from these communities describe a preference for the surgical services AMOG provides, with some patients waiting up to a year to present for surgical consultation rather than seeking treatment at their local hospital or getting a referral [10]. AMOG aims to strengthen the local healthcare system of its collaborating communities by providing supplementary education and training to host healthcare facilities during outreach trips. Our trips enable medical officers of host facilities to see and learn procedures of all kinds, presenting many opportunities for "on-the-job" training. When sufficiently experienced, they are able to perform these procedures, initially under supervision. Thus, a program of sustained AMOG visits can contribute to training the local workforce to provide surgical care, which can then continue to be supervised and broadened.

Prior to interpreting the results of this study, several limitations require consideration. First, although the DALY is the best composite measure available to quantify effectiveness, the evaluation of disability weights, which represent key components in the calculation of DALY, remains controversial [16, 27]. Some of our patient's diagnoses were not covered by GBD 2015 disability weights. This necessitated our use of the closest possible weights taking into consideration whether the diagnosis represented a mild, moderate, or severe form (where appropriate) of the diagnosis listed in the GBD 2015 database. This process introduces a degree of subjectivity that has the potential to greatly influence the DALY averted calculation. Relatedly, we had to assume that our diagnoses were correct and that the surgical procedures performed were appropriate for each patient's condition. Third, some patients had more than one procedure performed for more than one diagnosis they presented with (e.g., groin hernia and painful ganglion on the wrist). For such patients, only one procedure (the one with a higher disability weight) was used to calculate DALY averted, swaying our estimate of DALY averted as conservative. Finally, since Ghana's 2016 GDP per capita was as yet unavailable, we assumed that it was the same as that for the year 2015. However, an unlikely fall in GDP per capita of as much as 20% would still make our estimated cost per DALY averted for the mission trip in 2016 ($148.70) "very cost-effective." The same could be said for the cost per DALY averted for the total activities of AMOG. Despite these limitations, our results of this study allow reasonable conclusions to be drawn on the impact of local outreach groups, such as AMOG, in reducing the large unmet need for surgery in LIMCs like Ghana.

Conclusion

Our findings suggest that provision of surgical services by locally based surgical mission trips to underserved communities in Ghana, and other LMICs, might represent a cost-effective and viable option for countries seeking to reduce the growing unmet surgical needs of their populations.

AMOG volunteers

Abass Abdullah
Abdulai Abdul-Samed
Abeeku Hammond
Abel Tunni
Abiboye Yifieyeh
Adam Gyedu
Addai Arhin Appiah
Adjei Darko
Alexis Buunaim
Alice Ziyaaba
Amoako Assirifi
Angelina Abbey
Angelina Ampong
Anita Esi Botchway
Anthony A. Ayambire
Anthony Amalba
Anthony Davor
Anthony O. Amanfo
Aubrey Tigwii
Baga Abdul-Latif
Barclay Stewart
Bernard Ziem
Betty Anane-Fenin
Boniface Adigah
Callistus Kuubiere
Charles Appiah
Charles Dally
Christiana Amalba
Clement Akulaa
Comfort Asoogo
Dan Awindor
Dan Mbabila
David Asah-Kissiedu
David Karikari
Dominic Awariyah
Douglas Arthur
Edgard Afour
Edward Boateng
Edwin Yenli
Emile Tano
Emmanuel Adu
Emmanuel K. Asante
Emmanuel Nimoh
Erasmus Agongo
Eseenam Agbeko
Eunice O. Ampofo
Fareeda Agyei
Fiifi Yankson
Francis A. Abantanga
Frank Gyamfi
Frank Nketia-Boakye
Freda Saka
Gifty Nora Abeka
Gloria Gyamera
Godfred Boakye
Hectoria A. Awekeya
Henry Fosu
Imoro M. Amin
Isaac Adabere
Isaac Boamah
Isaac Opoku Anto
Ishmael Kyei
Issah Sabahudeen
Jabir Abdul-Rahman
Jacqueline Asibey
James Ankomah
Jeffrey Peters
Jocelyn Asibey
Joseph Akpaloo
Joseph Yorke
Juliana Agandaa
Juliana Appiah
Juliana Atindana
K. Nsiah-Siawu
Ken Amoah
Ken E. K. Aboah
Kofi Evans Agbenu
Kojo Brew Wiredu
Kwabena Agbedinu
Kwabena Lartey
Kwadwo Adae
Kwadwo Tuffour
K. Boakye-Yiadom
Kwaku Otu-Boateng
K Twumasi-Baah Jr
Lawrence Nsoh
Linus Beyuo
Louisa B. Bosompem
Majeed M. Alhassan
Martin Kyereh
Mary Agyapong
Mercy Issifu
Michael Adjepong
Michael Amoah
Michael Nortey
Michael Osei-Sarfo
Mohammed Duah
Mohammed Mouhajer
Nana Adoma Fokuo
Nana Yaa Darkwa
Nsiire Agana
Nsoh Azaare
Nurudeen Ismail
Osman Salia
P. K. Hoyte-Williams
Patricia Amoshie
Patrick Mason
Paul Aseeph
Prince Adu-Boateng
Prince Asenso
Prince O. Agyarko
Richard Ametih
Rex Djokoto
Richard Wuda Seme
Rita Boateng
Robert Amesiya
Robert Sagoe
Roland Azorliade
Romeo Hussey
Sabbash Issah
Samuel Boadi
Samuel Mensah
Sarah Kwakye
Scholastica Amomba
Sena Kumordzi
Soale Issah
Stephen Tabiri
Steve Kpankpari
Tawiah Ohemeng
Utman Abeo
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William Anaba
Wisdom Azanu

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Author's contributions Gyedu and Abantanga were involved in the study concept and design; Gyedu, Gaskill, Boakye, Abantanga, and AMOG were involved in the acquisition, analysis, and interpretation of data; Gyedu, Gaskill, and Boakye were involved in drafting of the manuscript; All authors were involved in the critical revision of the manuscript for important intellectual content; All authors provided administrative, technical, or material support.

Compliance with ethical standards

Conflict of interest The authors declare no competing interest of any form related directly or indirectly to the subject of this article.

Appendix 1: examples of DALY averted estimation

A 12-year-old male with acute appendicitis (GBD 2015 disability weight = 0.324) has more than 95% chance of being fatal or disabling without surgery (i.e., a disease severity score = 1), more than 95% chance of being cured after surgery (i.e., effectiveness of treatment score = 1), and a life expectancy of 56.1 years in 2015. A successful appendectomy will avert $56.1 \times 1 \times 1 \times 0.324 = 18.18$ DALY.

A 26-year-old female with placental abruption (GBD 2015 disability weight = 0.324) has more than 95% chance of being fatal or disabling without surgery (i.e., a disease severity score = 1), more than 95% chance of being cured after surgery (i.e., effectiveness of treatment score = 1), and a life expectancy of 44.9 years in 2013. A successful cesarean section will avert $44.9 \times 1 \times 1 \times 0.324 = 14.55$ DALY.

A 34-year-old male with femoral fracture (GBD 2015 disability weight = 0.111) has a limited ability to perform most recreational, occupational, educational and procreation activities (i.e., a disability severity score = 0.6), more than 95% chance of being cured after surgery (i.e., effectiveness of treatment score = 1), and a life expectancy of 38.8 years in 2012. A successful open reduction and internal fixation will avert $38.8 \times 0.6 \times 1 \times 0.111 = 2.58$ DALY.

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