MIXED-METHODS ASSESSMENT OF A PILOT DECENTRALIZED SURGICAL TRAINING PROGRAM FOR HOUSE OFFICERS IN GHANA

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Abstract

Introduction : There is a critical surgical workforce gap in low- and middle-income countries, particularly at first-level referral (i.e. district) hospitals. To address this gap we piloted a decentralized surgical training program for house officers at a district hospital in Ghana.

***Methods* :** Six house officers took part in the pilot program. Trainees participated in : i) didactic, video-based, and practical modules ; ii) intensive surgical immersion at a district hospital with consultant surgeon oversight ; and iii) a 12-month supervised rotation as a surgical care provider at a district hospital. Case mix and volume, complications, and perioperative mortality rate during the program were tracked. Anonymous feedback from the trainees was analysed with a content analysis framework.

***Results* :** In the 12-month pilot training program, 6 trainees were actively involved in carrying out 606 procedures either independently, under supervision or as assistant (mean : 101 procedures/trainee). The most frequent pre-operative diagnoses were hernia and complications of labour (432, 71.3%), followed by acute abdomen requiring laparotomy (85, 14.0%), soft tissue mass (21, 3.5%), hemopneumothorax or plearal effusion (19, 3.1%), hydrocele (16, 2.6%), abscess (12, 2.0%) and other (47, 7.8%). Twenty-three (3.8%) patients experienced complications, with the most common being surgical site infections (superficial : 8, 1.3% ; deep : 3, 0.5%). The perioperative mortality rate was 1.2%. Feedback from trainees was generally positive, but revealed several unmet challenges.

Conclusion : Through the decentralized surgical training program Ghanaian trainees gained useful experience with essential surgical care at a first-level hospital and provided timely surgical care to patients.

Keywords : Medical officers, House officers, Decentralization, Surgical Training

Introduction

Conditions that can be treated by surgery comprise more than 16% of the global disease burden[1]. However, according to current estimates, 5 billion people do not have access to essential surgical care, resulting in significant rates of premature death and disability from preventable causes[2]. Although, nearly 90% of the 87 million disability-adjusted life-years incurred by conditions that require surgical care could be averted by providing timely, safe and effective surgery in low- and middle-income countries (LMICs)[3], LMICs are least equipped to provide surgical care due to lack of physical and human resources[4]. These resources are particularly deficient in district hospitals, which are integral to the provision of timely care in most LMIC health systems[3].

Many national and international efforts have been implemented with the aim of increasing the numbers of trained surgical care providers in LMICs. While programs such as those establishing task-sharing and exchange visitation[5,6] have been successful in a variety of contexts, the importance of teaching local medical students and junior doctors the knowledge and skills required to provide essential surgical care cannot be overlooked[7]. Furthermore, such training should be designed and carried out in a way that exposes trainees to the realities they will likely face as district hospital care providers which are different from those faced at tertiary centres, where the majority of surgical rotations or training are provided. Providers entering the surgical workforce who are already comfortable in district hospital settings might be more likely to work in them after training thereby improving the overall skilled workforce available to provide access to timely surgical care for those most in need currently[7-9].

Ghana is a heavily indebted LMIC in West Africa, with a population of 26 million people and an annual per capita income of USD1,760[11]. Although predominantly urbanized with several densely-populated cities (e.g., Accra, Kumasi, Tamale), 47% of Ghana's population live in rural areas[12]. Thus, the numerous district hospitals around the country are well positioned to provide the majority of timely essential surgical care if they were staffed by skilled providers[4].

District hospitals in Ghana are usually staffed by a medical officer and nurse anaesthetist and have between 50 and 100 beds. Some rural districts do not have a district hospital and rely on other health facilities such as a neighbouring district. Some of the more densely populated districts however, have several district

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hospitals in each of their sub-districts. Some medical officers provide surgical care, although such care is often limited to obstetric emergencies[13,14]. In general, however, all of the district hospitals throughout Ghana are under-resourced to provide essential surgical care[4, 15]. Ghana's total four medical schools graduate around 500 doctors annually. The newly graduated doctors go on to complete 2-year training as house officers in tertiary and/or select large hospitals, where they learn practical aspects of general medical, paediatric, obstetric, gynaecologic and surgical care. Upon completion, the trainee doctors are posted to hospitals around the country for another 2-year training as a medical officer. Postings at a district hospital typically involve only one doctor, who is then solely responsible for the entire facility's essential surgical care. Unfortunately, the current training system in Ghana does not adequately prepare medical officers for the realities they will face while autonomously providing essential surgical care in these low-resource settings[14].

To address this gap in surgical education and follow-up on our previous study of this subject[10], we developed and implemented a decentralized surgical training pilot program for senior house officers. The program consisted of preparatory modules, 2 weeks of intensive surgical training in a district hospital, and 1 month of district hospital work experience. Herein, we describe the clinical exposure of our trainees at a district hospital and evaluate the related rates of complications and perioperative mortality experienced by the treated patients (as proxy measures of safety). These descriptive data provide insights into ways by which this and other decentralized training strategies could be improved and designed for maximal effectiveness.

Methods

Development of the decentralized surgical training program

The concept of the decentralized surgical training program was proposed for house officers by the Ghana Health Service (GHS; the branch of the Ministry of Health charged with organizing and supervising government hospitals, with the exception of teaching hospitals, which are directly under the Ministry of Health). The GHS approached the Department of Surgery at the University for Development Studies (UDS) in Tamale, Ghana to design the training program. The training program had three objectives: i) to educate senior house officers on the knowledge and skills required to provide safe essential surgical care; ii) to promote a career of surgical service at district hospitals; and iii) to reduce the backlog of conditions that require surgery in the community.

After the program was designed, the GHS and UDS sought accreditation from the Ghana Medical and Dental Council for a district hospital in which the training program would be implemented as a pilot. Accreditation was dependent on the hospital's demonstrated ability to select appropriate trainees (i.e. senior house officers who have completed rotations in obstetrics and gynaecology) and to provide adequate supervision of the trainees. The latter was defined as immediate supervision by an experienced principal medical officer who performs surgery (i.e. a medical doctor who performs surgery) and proximate supervision by a surgical consultant if needed (i.e. constant availability for immediate communications and capable of arriving at the hospital within 2 hours if needed). The principal medical officer at Yendi Municipal Hospital (Yendi, Ghana) was found to fit the needs as he actively provided basic surgical care for a population 300,000, operated independently, and declared a desire to work in teaching and mentoring capacities at the district hospital.

The program was designed to be intensive and hands-on, and to allow significant face-to-face time with the surgical consultant; the latter being only available at large teaching hospitals in Ghana otherwise. To accomplish these objectives, all trainees participated in the following three phases of the program prior to receiving their postings: i) training via didactic, video and practical modules; ii) intensive surgical immersion at a district hospital with a consultant; and iii) a supervised rotation as a surgical care provider at a district hospital.

Trainee selection and program

The program was introduced to the entire senior class of house officers in Ghana at a conference, with the background, goals and logistics of program presented in detail and discussed. Eight house officers then voluntarily applied to the pilot training program, and six of the applicants were selected for participation. Three trainees were assigned to one of the two rounds of the 6-month training program.

Each group of three trainees took part in the three-module phase of the program over a 2-week period to ensure that a basic level of surgical knowledge and skill was acquired for immediate application when they presented to the district hospital. First, the trainees were given a series of lectures on the diagnosis, management and potential complications of conditions they will frequently encounter at district hospitals (e.g. inguinal hernias, intestinal obstructions, severe soft tissue infections, soft tissue tumours, breast masses and acute abdomen). Second, the trainees were shown a Basic Surgical Skills Training video produced by the Royal College of Surgeons of England (including skills training on wound debridement, suturing and knotting techniques, laparotomy, soft tissue mass excision, intestinal anastomosis); after each module of the video, the key principles were discussed and the trainees were given the opportunity to practise each skill under supervision. Next, the trainees underwent training for basic life support techniques. Finally, the trainees participated in a 1-week hands-on practical that used discarded animal tissues to demonstrate and practice incisional, suturing and intestinal surgical techniques.

For the next 2 weeks, the trainees were immersed in surgical training with a general surgery consultant at the selected district hospital. In preparation for this intensive study, the resident principal medical officer at the hospital booked elective general surgical cases ahead of time. This served two purposes: i) to improve the timely access to care for patients in the district hospital's catchment area; and ii) to allow teaching opportunities for the immediately supervised trainees.

For the next 12 months, the trainees worked under direct supervision of the resident principal medical officer at the district hospital to care for patients with conditions requiring surgical intervention. The medical officer was constantly available for immediate supervision. The consultant surgeon remained available by telephone and would present if needed. In addition, the consultant would spend 1-2 days per week with the trainee at the district hospital discussing cases encountered during the week and operating together on elective cases and attending to emergency cases if they presented. However, the trainee was positioned and operated as if he or she was the senior surgeon.

Daily communication between the trainees, the medical officer and the consultant surgeon was facilitated by the WhatsApp instant messaging application (WhatsApp Inc., CA, USA). The WhatsApp cross-platform facilitated the instantaneous sharing of text, voice, images and video. Thus, the supervision of the consultant was effectively extended to the district hospital for a significant proportion of the clinical decision-making.

Data collection and analysis

To evaluate the decentralized training program, we performed two analyses: i) descriptive analysis of surgeries performed by the trainees during the program (e.g., case mix and volume, perioperative mortality and complications); and ii) content analysis of anonymous feedback from house officers who participated in the program.

Information on diagnoses made and procedures performed by the trainees were extracted from the surgical logbook at the district hospital and organized to describe the case mix and volume during the training program. To assess program-related patient safety, information on all deaths and all complications that occurred during the training program from date of surgery to hospital discharge were also extracted.

A questionnaire was created to identify the successes and challenges of the training program from each of the trainees' perspective. In the pilot stage, the questionnaire was first administered to surgical residents in order to make improvements based upon their feedback prior to its use with the house officer trainees. The finalized questionnaire was distributed to the trainees via an online survey platform (SurveyMonkey, CA, USA) in a single batch in order to avoid being able to single out the responses of a particular trainee; the surveys were completed privately. The introductory page of the questionnaire stated clearly that all responses would be anonymous and that the findings would in no way affect performance evaluation. Responses to open-ended questions were examined using a content analysis framework[16]; first, responses were grouped into categories based on codes that represented response clusters, then categories were further refined into useful themes and described.

Ethics

The training program and its evaluation received ethical approval from the GHS (#TTH/TN/32), Ghana Medical and Dental Council and Yendi Municipal Hospital administration.

Results

In the total 12 months of the pilot training program, the 6 trainees were involved in 606 procedures (mean: 101 procedures/trainee; Table 1. Each trainee took an active role in procedures either under supervision, independently or as an assistant.

Cases and procedures

The median age of patients who underwent operation during the training program was 32 years (range: 1 – 97 years; interquartile range: 24 – 49 years). The most frequent pre-operative diagnoses were hernia and complications of labour (432, 71.3%), followed by acute abdomen requiring laparotomy (85, 14.0%), soft tissue mass (21, 3.5%), hemopneumothorax or pleural effusion (19, 3.1%), hydrocele (16, 2.6%), abscess (12, 2.0%) and other (47, 7.8%).

Complications and perioperative mortality rate

Twenty-three (3.8%) patients experienced complications, with the most common being surgical site infections (superficial: 8, 1.3%, deep: 3, 0.5%; Table 2). The perioperative mortality rate (i.e. death from start of anaesthesia to hospital discharge) was 1.2%. (Table 3). Review of the overall deaths showed that three may have been prevented by better surgical technique; these included: failure of a perforated peptic ulcer repair in a patient with severe malnutrition; failure of intestinal anastomoses in a patient who suffered an abdominal gunshot wound; and death of a 4-year-old male after emergency strangulated umbilical herniorraphy. Two of the total deaths were potentially

Table 1: Level of participation of trainess in procedures performed at a district hospital in rural Ghana

Procedure performed	n	(%)	Level of trainee participation
Inguinal hernia repair	221	(36.5)	Independent
Cesarean section	211	(34.8)	Independent
Bowel resection and anastomosis	27	(4.5)	Supervised/independent
Repair of intestinal typhoid perforation	22	(3.7)	Supervised/independent
Excision of lipoma	21	(2.0)	Independent
Wound debridement	19	(3.6)	Independent
Tube thoracostomy	19	(3.1)	Independent
Salpingectomy for ruptured tubal pregnancy	18	(3.0)	Independent
Amputation	13	(2.1)	Supervised/independent
Hysterectomy	10	(1.7)	Supervised/independent
Hydrocelectomy	8	(1.3)	Independent
Appendectomy	7	(1.2)	Independent
Others	10	(1.7)	Assisted/supervised/independent
Total	606		

Table 2. Complications among patients cared for by trainees at a district hospital in rural Ghana

Complication	*n*	(%)
None	576	(95.0)
Superficial SSI	8	(1.3)
Deep SSI	3	(0.5)
Organ injury	2	(0.3)
Enteroatmospheric fistula	2	(0.3)
Anaesthesia complication	2	(0.3)
Medication reaction	2	(0.3)
Hematoma	1	(0.2)
Missing information	3	(0.5)
Total	599	

Table 3. Deaths among patients cared for by trainees at a district hospital in rural Ghana

Age	Sex	Diagnosis	Procedure	Details	Preventable
4	Male	Umbilical hernia	Umbilical herniorraphy		Yes
22	Male	Gunshot to the abdomen	Laparotomy, bowel resection and anastomosis		Potentially
60	Male	Typhoid perforation	Primary repair of perforation	Anaphylaxis	Yes
84	Male	Peptic ulcer perforation	Graham patch		Potentially
44	Male	Parapneumonic effusions	Tube thoracostomy		Potentially
82	Male	Peptic ulcer perforation	Graham patch	Airway mismanagement	Yes
23	Female	Placental abruption	Caesarean section	Uncontrolled haemorrhage	Potentially

preventable with better anaesthesia management, being cases of anaphylaxis during the procedure and airway mismanagement. The preventability of the final two deaths was not ascribable, due to insufficient information, being cases for which no autopsy was performed and the cause of death was unknown.

Feedback from trainees

As shown in Table 4, the trainees were appreciative of the hands-on skills training, progressive autonomy, use of WhatsApp for real-time decision support, and exposure to broad clinical care (e.g., essential obstetric and urologic surgery, interpretation of radiographs and laboratory results). In addition, trainees praised being introduced to the importance of communicating with patients, other clinical staff and non-clinical staff, as well as the integral role that all staff play in good clinical care. Perhaps most importantly, trainees reported being eager to return to a district hospital setting and provide surgical care after completing their house job.

Conversely, trainees wanted to be exposed to greater breadth of essential surgical care (e.g., essential orthopaedic care) and to have a longer district hospital training experience. Trainees wanted to be remunerated for costs incurred during the rural training (e.g., telephone, internet and transportation). Other feedback included improving the general hospital orientation, increasing the number of trainees or mid-level providers to reduce working hours and allow for studying, and use of morning meetings and regular morbidity and mortality reports for quality improvement purposes.

Table 4. Feedback from trainees at a district hospital in rural Ghana

	Pros	**Cons**
Anticipated	Hands-on training, progressing from models to animal tissues to patients	Lack of training in sub-specialty surgical care (e.g., ENT, ophthalmology, orthopaedics, urology)
	Targeted skill and procedure training specific for care at a first-level hospital	Skills and clinical training periods were too short
	Progressive autonomy for decision-making and operating	Lack of remuneration for costs of phone/internet and transport (given the rural location)
	Use of WhatsApp platform to facilitate continuous decision support from a surgical consultant	
	Exposure to obstetric emergency surgery in addition to general surgery	
	Improving interpretation of radiology and laboratory results in the context of surgical management	
	One-on-one mentorship and surgical supervision, greatly improving decision-making capabilities and technical skill	
	Eager to provide district hospital care after completing training	
Unanticipated	Learned importance of pre-operative patient counselling	Inadequate general orientation by the hospital administration
	Recognition of value of good communication between patients and staff, and between staff	Significant time demand for non-operative care compared to operative care
	Better appreciation of integral role that all clinical and non-clinical staff play in achieving good clinical care	Insufficient use of morning meeting and morbidity and mortality reports for quality improvement purposes
		Inability to read and study given clinical workload

Discussion

This study aimed to describe a pilot decentralized surgical training program for house officers at a district hospital in rural Ghana. The findings suggest that the trainees received adequate training in general, obstetric and urologic essential surgical care in the district hospital setting, as evidenced by the trainees abilities to operate with acceptably low complications and mortalities (i.e. safely). Benefits beyond skill obtainment were that the trainees were more eager to return to the district hospital setting after completing their house job, and the patients treated in the district hospital received timely care, as opposed to otherwise having to navigate the healthcare and referral system to a regional or tertiary facility. These findings suggest that this and similar programs might be developed and/or expanded elsewhere in Ghana, as well as other LMICs, as a potential method for improving access to safe and timely surgical care at the district hospital level.

Such a program is not novel in medical sciences training in LMICs. In Kenya, the University of Nairobi has piloted a decentralized training program for fourth-year medical students[16], whereby 29 students were posted to district and referral hospitals around the country. Analysis of the focus group discussions afterward revealed that the Kenyan students felt much more engaged in patient care, had gained important clinical skills, and had learned to navigate certain sociocultural challenges that they had not been exposed to during their medical education. Importantly, as in our program, the students' responses suggested that they wished to return to non-tertiary hospitals after their post-graduate training. Additionally, the consultants with whom they were paired reported that they had new-found motivation to teach and mentor students and acknowledged that the academic interaction positively impacted patient care.

Other successful examples of decentralized education for medical students exist[17]. However, the formal training of house officers at district hospitals has not been reported in Ghana. Given that recently graduated medical officers are typically the most senior clinicians at district hospitals in Ghana, teaching essential surgical care to this cadre is a promising approach for improving access to essential surgery nationwide. Thus, the model described herein might be useful for other teaching institutions that hope to grow the surgical workforce of district hospitals in their area.

When considering decentralized training programs with graduated autonomy and only mid-level provider supervision, patient safety concerns are obvious. Although we did not collect the incidence of complications and perioperative mortality data from prior to the training program, we observed relatively low rates of the safety indictors during the program and which are consistent with reports from elsewhere in Africa[18-23]. The complication and mortality rates from the present study may have been underestimated due to our inability to follow-up for 30 days postoperatively, as a result of insufficient logistics and infrastructure to support such an endeavour.

Pre-program surgical orientation, a 2-week period of surgical immersion with immediate supervision, and 3 months of proximate supervision by an experienced medical officer and a consultant if needed should not be considered extensive surgical training experience. However, it may represent the bare minimum amount of training and supervision necessary to provide safe surgical care for the conditions often encountered in a district hospital. We would recommend erring on the side of providing too much training, rather than too little, when developing such a program in order to avoid creating a dangerous situation for patients and discouraging house officers from pursuing a career in surgical care.

Given the critical shortage of surgical care providers in LMICs, an important consideration in developing and evaluating a decentralized training program is retention of surgical care providers after they complete their training and national service experience (i.e. placement as a medical officer for 2 years in a non-tertiary hospital). Implementation of task-sharing of surgical care with non-surgeon phisicians and non-doctors to meet the surgical demand at district hospitals has yielded good retention of these providers at target facilities[22]. However, there has not been a report that describes the impact of decentralized training programs on retention of non-surgeons (i.e. medical officers) with surgical capabilities in Ghana. This will be an important outcome during assessment of this and similar programs in the future. In addition to such programs, healthcare systems must ensure concessions are made to incentivize and adequately remunerate surgical care providers who travel to and/or practice in district hospitals, particularly those who choose to provide district hospital care immediately after completion of training.

There are several limitations worth consideration while interpreting the findings from our pilot program. First, this was an evaluation of a small pilot program and the few complications observed and favourable feedback from the six total trainees might not mirror the situation if the program were expanded. As this and similar programs expand, patient safety must be the primary concern and be closely monitored with structured feedback to the trainees. Second, the pre-program surgical orientation lacked surgical simulation equipment and exercises. These tools have been demonstrated to improve the performance, learning curve and safety of trainees in the operating theatre and when working in teams during emergencies[24]. The patient outcomes in our program might have been better if simulation equipment and exercises were incorporated into the training; such resources should be considered when planning future decentralized training programs. Third, the six trainees who volunteered for the program after it was made available represent a small cohort for systematic analysis. Given their interest in a pilot study,

they might not represent the overall house officers population; thus, these results might be biased toward those achieved by interested participants. However, these trainees might also be the individuals that, with steady recruitment, might be the most likely to continue to work in district hospitals after their training. Lastly, we did not assess the impact of the training program on the staff of the district hospital or the costs of care. These issues will require closer examination as we continue to develop and expand the program.

Despite these limitations, these findings allow reasonable conclusions to be made about the potential value of decentralized surgical training programs towards improving both the surgical care training of house officers in the district hospital setting and timely access to safe essential surgical care for patients who might have otherwise not been able to receive surgical care at all. This successful pilot study of a decentralized surgical training program at a rural district hospital in Ghana shows that trainees gained useful experience with essential surgical care at a district hospital, patients were able to receive needed surgical care, and patient safety did not seem to be compromised.

Conclusion

Decentralized surgical training programs have the potential to dramatically improve the surgical workforce at district hospitals in Ghana.

Recommendations

1. Decentralized surgical training program must be developed and expanded cautiously and evaluated systematically and continuously to ensure patient safety is not jeopardized.
2. Going forward, this and similar training programs might benefit from several initiatives: i) institutions might appropriate funds for surgical and team simulation equipment and exercises prior to placing trainees in the district hospitals; ii) comparative assessments might include direct examination of surgical knowledge and skills before and after the program; and iii) long term follow-up should be planned to determine if the program improved recruitment of surgical care providers to district hospitals.
3. Comprehensive feedback from trainees specific to the training program should be elicited and incorporated into the program as it develops.
4. Long-term impact of such programs on the surgical workforce at district hospitals and on population-level access to surgical care should bemonitored, evaluated and reported on in the international literature.

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References

1. GBD_Collaborators, Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013 *Lancet* 2015; 385: 117-171
2. John G. Meara, Sarah L.M. Greenberg . The Lancet Commission on Global Surgery Global surgery 2030: Evidence and solutions for achieving health, welfare and economic development. *Lancet* 2015; 157: 834-835. DOI: http://dx.doi.org/10.1016/j.surg.2015.02.009
3. Mock CN, Donkor P, Gawande A, et al. Essential surgery: key messages from Disease Control Priorities, 3rd edition . *TheLancet* 2015
4. Stewart BT, Quansah R, Gyedu A, Ankomah J, Donkor P, Mock C. (2015) Strategic Assessment of Trauma Care Capacity in Ghana. *World J Surg* 2015; :2428-2440. doi: 10.1007/s00268-015-3132-3.
5. Fulton BD, Scheffler RM, Sparkes SP, Auh EY, Vujicic M and Soucat A. Health workforce skill mix and task shifting in low income countries: a review of recent evidence Human resources for health 2011; 9(1) DOI: 10.1186/1478-4491-9-1
6. Vaz F, Bergstrom S, Vaz Mda L, Langa J, Bugalho A.Training medical assistants for surgery. *Bulletin of the World Health Organization*. 1999; 688-691
7. Ozgediz D, Kijjambu S, Galukande M, Dubowitz G, Mabweijano J, Mijumbi C, Cherian M, Kaggwa S, Luboga S.Africa's neglected surgical workforce crisis. *Lancet* 2008; 371: 627-628
8. Mock CN, Quansah R, Addae-Mensah L, Addae-Mensah L Donkor P The development of continuing education for trauma care in an African nation. *Injury*. 2005; 36:725-732
9. Ozgediz D, Jamison D, Cherian M, McQueen K, (2008) The burden of surgical conditions and access to surgical care in low- and middle-income countries. *Bulletin of the World Health Organization.* 2008;86: 646-647
10. Tabiri S., Nicks Brets A., Hildredt A., Dykstra R, Hiestand B. Assessing Trauma Care Capabilities of the Health Centers in Northern Ghana, *World J Surg.* 2005; 39: 2422-2427. DOI 10.1007/s00268-015-3124-3
11. http://www.ciaworldfactbook.us/africa/ghana.html 2015 April 12th
12. http://data.worldbank.org/country/ghana 2015 Jan 14
13. Choo S, Perry H, Hesse AA, Abantanga F, Sory E, Osen H, Fleischer-Djoleto C, Moresky R, McCord CW, Cherian M, Abdullah F,

Assessment of capacity for surgery, obstetrics and anaesthesia in 17 Ghanaian hospitals using a WHO assessment tool. *Tropical medicine & international health*. 2010;15: 1109-1115

14. Choo S, Perry H, Hesse AA, et al. (2011) Surgical training and experience of medical officers in Ghana's district hospitals Academic medicine. *Journal of the Association of American Medical Colleges*. 2011;86: 529-533
15. Ankomah J, Stewart B, Oppong-Nketia V, et al.Strategic assessment of the availability of pediatric trauma care equipment, technology and supplies in Ghana. *J. of Pediatr Surg*. 2015; 50: 1922-1927
16. Bradley EH, Curry LA, Devers KJ (2007) Qualitative data analysis for health services research: developing taxonomy, themes, and theory. *Health services research*. 2001; 42: 1758-1772
17. Kibore MW, Daniels JA, Child MJ, et al.Kenyan medical student and consultant experiences in a pilot decentralized training program at the University of Nairobi. *Educ Health (Abingdon)*. 2014;27: 170-176
18. Parry J, Mathers J, Al-Fares A, et al. Hostile teaching hospitals and friendly district general hospitals: final year students' views on clinical attachment locations *Med Educ*. 2002;36: 1131-1141
19. Davies JF, Lenglet A, van Wijhe M, et al (2016) Perioperative mortality: Analysis of 3 years of of operative data across 7 general surgical projects operative data across 7 general surgical projects Medecins Sans Frontieres in Democratic Republic of Congo, Central African Republic, and South Sudan. *Surgery 2016*; 159:1269-1278
20. Lofgren J, Kadobera D, Forsberg BC, et al.District-level surgery in Uganda: Indications, interventions and perioperative mortality. *Surgery* 2015; 158: 7-16
21. Uribe-Leitz T, Jaramillo J, Maurer L, et al (2016) Variability in mortality following caesarean delivery, appendectomy, and groin hernia repair in low-income and middle-income countries: a systematic review and analysis of published data. *Lancet Global health* 2016; 4: e165-174
22. Lanktree E, Corluka A, Cohen M, et al.Addressing the human resources for health crisis through task-shifting and retention: results from the Africa Health Systems Initiative Support to African Research Partnerships program Human resources for health. 2014; 12: S1-SI2
23. Michael Ohene-Yeboah. Acute surgical admissions for abdominal pain in adults in Kuasi, *Ghana. ANZ J. of Surgery*. 2006; 10: 898-903.
24. Sevdalis N., Hull L., Birnbach D.J., Improving patient safety in the operating theatre and perioperative care: obstacles, interventions, and priorities for accelerating progress. *Br. J. Anaesth.* 2012 109 (1): i3-i16. Doi:10.1093/bja/aes391