

Strategies to increase access to surgical services in resource-constrained settings in sub-Saharan Africa

Bellagio Essential Surgery group

Kampala

July 22nd – 24th, 2008

Background Paper for Session on Strategies to strengthen access to surgery at the district level

The lack of access to surgical care in developing countries has been increasingly recognized as a critical gap in the development of health systems. Since Alma Ata, primary health facilities have been prioritized as the main delivery mechanism for achieving good health outcomes, with an emphasis on immunization services. Increasing resources have also been placed at the hands of individuals and organizations doing work with infectious diseases, particularly HIV, TB, and malaria. Yet even experts in those fields have recognized the paucity of services available for those afflicted with surgical conditions, calling surgery the “neglected stepchild of global public health.”[1]

The first meeting of the Bellagio Essential Surgery Group sought to emphasize the rationale for surgical services, as well as the scope of the problem of surgically-avoidable disease and conditions, most prominently that of road traffic injuries (the leading cause of death in all age groups) as well as emergency obstetric care. The conference drew attention to the scale of the problem and the fact that surgical conditions will inevitably account for a large proportion of a population’s disease burden, regardless of how successful the prevention efforts. Three factors contribute to the surgical burden of disease in these settings: (1) the lack of access to elective or conservative treatment; (2) higher rates of trauma and obstetrical complications; and (3) a backlog of untreated surgical conditions.[2] While some rough estimates have been made regarding the burden of surgical disease, including that 11% of the world’s Disability Adjusted Life Years (DALYs) are comprised of surgical conditions, it is thought that the surgical DALYs in sub-Saharan Africa are even higher than in other regions of the world.[3]

This second meeting of the Bellagio Essential Surgery Group brings together participants from many African countries and provides the opportunity to share experiences and to develop some model approaches to strengthening surgical services at the district level. This paper outlines some of the issues that need to be considered when developing such models.

Incorporating surgical services at all levels of the health care system

While traditionally primary health centers have delivered preventive care (e.g., vaccinations) and hospitals have delivered more labor and cost-intensive curative care, surgical care be integrated at all levels in a tiered way, with early referral from primary health centers to higher levels of care for more complex cases. This is consistent with the overall goal of a health system to improve health, and also to strengthen the system's ability to respond to the needs of its population.

Following the WHO guidelines of 2005 (appendix 1), level 1 health centers should be able to perform minor surgical procedures, including uterine evacuation, wound debridement and dressings, laceration repairs, temporary reduction of fractures (e.g., splinting), and circumcision. They should also act as referral centers for higher level of care and should be equipped with the ability to provide early transport for ill patients. A district level 2 hospital should be able to manage moderate and major (but not tertiary or sub-specialty level) surgery, including caesarian section, amputation, hernia repairs, treatment of open and closed fractures, laparotomy, and emergency ventilation and airway management (e.g., intubation). Finally, the level 3 referral hospital should be able to provide all level 2 procedures, but also perform subspecialist care such as facial, congenital, thoracic, and eye surgeries.[4]

For this to occur, both facility-level needs and health system context must be considered. Key elements of a district surgical service as recommended by the WHO are provided in Appendix 2, but we take the opportunity to detail these facility-level needs, as well as highlight the importance of understanding health system context, in this section.

Consideration of facility-level needs when incorporating surgical services

Human resources: While the ideal method of incorporating surgical services at all levels of health care has been put forth, one of the main challenges faced by sub-Saharan African countries has been the human capital crisis and workforce shortages. Numerous challenges face the workforce issue: not only is there an absolute shortage in surgically-trained personnel due to well-discussed “brain drain” out of the country or continent, there are also few incentives to entice potential physicians to invest in surgical training. Opportunities are few, and come with both real and opportunity costs of longer training and also more perceived risk of infectious disease. Furthermore, in most of sub-Saharan Africa, surgical practice is not more lucrative than non-surgical specialties and, as a result, surgery as a whole is less available to patients in need. While some countries have devised both temporary and

more permanent responses to address this need, it is a challenging one that will require creative solutions from the local and global community.

Education programs: One aspect related to, but yet deserves its own discussion, is the need for continuous education and skills training for healthcare providers at all levels. Professional development for practitioners is often lacking in most resource-limited settings, yet is crucial to the development of these programs. This can take numerous forms, such as periodic visits from referral hospitals, or visits to these hospitals. Other alternatives exist, such as telemedicine consultations (increasingly common in middle-income countries but less so in low-income countries) or even the mailing or distribution of educational materials. Continuous education is important for not only the safety of patients, but also provides motivation to providers in more rural areas, who often complain of feelings of professional (and social) isolation.

Facilities: Facility capabilities and infrastructure must be taken into consideration when considering making surgery available on a larger scale. Just as in any health initiative, the infrastructure must be put in place before the provision of these services. Even a cursory glance at tuberculosis programs in developing countries reveals that at the very least, a microscope must be available for evaluation of sputum smears, or even the reagents needed to stain the smears. In a similar way, surgery is indeed initially capital-intensive, but often facilities already exist and only need to be modified to adapt to the basic requirements of a surgically-capable facility.

As mentioned in the WHO Safe Surgery initiative, operating theatres must be adequate in size, be adequately lighted, and be sourced with dependable electricity and water.[5] For any facility such as a district hospital that is expected to provide anything more than minor surgery, there should be a back-up electrical generator. In terms of construction of the facility, those providing higher-level surgical services must consider the possibility of how to deliver oxygen, either via cylinders or centrally through pipelines. The facility must also be equipped with the capability to provide safe blood transfusion that has been typed and screened rather than, at last minute, asking family members of patients for blood and not being prepared for the need for blood transfusion. As surgical equipment needs to be sterilized before each patient use, it would be prudent to consider how the facility plans to sterilize its equipment: should an autoclave be built, or will chemicals (e.g., hydrogen peroxide plasma, formaldehyde) be used? In short, the question of “Are we ready to provide surgery at this facility?” requires knowledge and confidence in dependable (and back-up) sources that the following are available at each facility: electricity; water; oxygen; storage of medicines (including those requiring refrigeration); blood; sterilization; waste disposal (contaminated human products and sharps).

Equipment and supplies: Over 230 million operations are done globally each year, with over 1 million deaths and 7 million disabling complications annually, half of which are considered preventable.[6] The WHO has created 10 objectives for safe surgery, including using systems and checklists to prepare for possible complications and recognizing when a patient is in danger.[7] They have created a surgical safety checklist that includes, for example, ensuring that a patient is wearing a functioning pulse oximeter and that the possibility of airway complications and bleeding have been considered. This checklist has been piloted in eight cities, including several low and middle-income countries, including Tanzania, India, and the Philippines. While this checklist requires only a minimal number of resources, it has been shown to increase the provision of basic surgical safety and can be deployed incrementally.

Appendix 1 contains actual recommended equipment and supplies as recommended by the WHO. Importantly, while human error is inevitably a factor in preventable complications, it is clear that having essential equipment (pulse oximetry for airway monitoring, for example) can alert human operators to detect when a patient may be at risk. Systems that are put in place depend on the existence – and dependable existence – of the necessary equipment and supplies. A checklist, for instance, that recommends prophylactic antibiotics during major operations will do little when those antibiotics simply are out of stock.

Ensuring the availability of functioning equipment and supplies relies, therefore, on a planning and procurement process that is essential to proper functioning of a healthcare system and thus must be taken into account. Personnel and budgeting must consider these needs early in the planning phase, and issues such as maintenance engineers, or replacement of parts (e.g., broken capnography machines), should be expected. While each site (e.g., primary health facility, district hospital) will unlikely need to hire its own team of engineers, plans must be made for either periodic visits for equipment maintenance (and routine checks for impending failure/technology updates) from outside teams or a feedback mechanism to more centralized hospitals that can respond quickly to these needs.

Health information system and records: Currently, the state of record-keeping in most sub-Saharan African countries is poor. While surgical logs may be kept, the majority of these logs do not contain follow-up or any information regarding complications. In both administrative and clinical databases, there is often not enough information to provide both timely and accurate reporting. These records and health information systems, in general, are crucial in providing safe surgical care.

Quality assurance: Beyond having the appropriate health information systems and records in place, it is essential that this information be used for quality assurance. Rather than simply having this data available, personnel should be allocated to ensure that these hospital

processes and quality measures are evaluated in a systematic fashion, with a mechanism for feedback to those involved in patient care. For example, it is of little use to collect surgical site infection rates if this information is not monitored in a way to improve patient care. Another example would be the evaluation of airway complications, for example. An analysis of a complicated airway should include review of the processes: Were the co-morbidities and risk factors of the patient known prior to induction? Was the possibility of a complicated airway considered and was the Mallampati score noted? Were plans made for the possibility of a difficult airway, with alternatives such as a bougie or laryngeal mask airway made immediately available? Quality assurance, therefore, is a key component to a successful surgical program.

Consideration of the health system context and the desirability of increasing access to surgical services

Beyond facility-level needs, it is vital to consider the overarching health system context. Are larger health systems in place to provide the most optimal care within these settings? Is the health system addressing the needs of the patients, from their actual medical concerns to larger socioeconomic, geographic, demographic, and cultural issues? This section highlights the most important concerns when considering the health system context and its ability to provide the foundation for high-quality surgical delivery, which encompasses better outcomes.

Population needs, determinants, and access: The WHO's Safe Surgery initiative[7] has championed the importance of having "vital statistics" for surgical efforts in each country, including reporting of the number of:

- operating rooms in each country;
- operations performed in operating rooms in each country;
- trained surgeons and the number of trained anaesthesia professionals
- deaths on the day of surgery; and
- in-hospital deaths following surgery.

While these address issues of access and availability on one level, population needs and health determinants should be considered. What is the basic epidemiology of disease in this area? How well are these needs being addressed? What are the particular health determinants in this area for the population, and which of these factors can be more easily changed? Do patients seek care in the healthcare system as provided by the public health system, or do they seek alternatives to this care (e.g., traditional healers)? What are the barriers to teaching patients about healthcare and its function in their society? Better understanding these larger questions should yield translatable changes in policy and systems to provide more adequately for the needs of the population.

Prevention: Prevention is often considered in discussions of medical disease, such as HIV, tuberculosis, and malaria, and less so in surgical conditions. Yet it is clear that certain surgical conditions, notably trauma, can be largely avoided with the proper prevention. Helmet laws, seatbelts, and speedbumps are only a handful of interventions that have been shown to be cost-effective and significantly decrease the number, and extent, of injury. Some surgical conditions cannot be avoided and thus the need to provide surgery, but consideration of the extent to which public health interventions can impact the need for surgery, should be made on a larger health systems level.

Prehospital care: In most sub-Saharan African countries, prehospital care is grossly inadequate. Because paramedic and emergency medical systems are almost wholly absent, the responsibility of prehospital care falls on the shoulders of non-medical personnel, such as taxi drivers and police officers. These public servants are rarely trained in prehospital care, such as basic life support or hemorrhage control. There are initial inroads being made in these areas in some countries, with good success of these programs.

Referral and transportation: One of the more challenging problems facing resource-limited countries is the ability to refer and transport patients. While in theory, there is a referral system that can direct patients to higher levels of care according to their medical and surgical needs, in practice, these systems rarely exist. Little communication occurs between and among centers of healthcare provision, and transport is severely limited. Because patients in most of these areas have little access to their own transport, inter-facility transfer is almost unheard of, and while often discussed, there are few examples of transport systems that function in ways that address patient needs. Still, lessons can be learned from middle-income countries, and incremental changes, such as ambulance provision at least on a district level, can be made to begin to address these problems.

Outcomes; evaluation; policy and dissemination: The inter-relation among all of the aforementioned elements comprise the Donabedian framework of structure, processes, and outcomes of measuring healthcare delivery. Each of these require their own measurements: the WHO, for example, has a facility-level assessment tool to measure the appropriateness of a facility in terms of equipment and human personnel. As emphasized in other literature, surgical structure, processes, and outcomes – as well as how these change with interventions – must be documented so that others can learn from examples. The importance of surgical metrics and some incorporation into a country's vital statistics has been discussed elsewhere, but deserves mention here. Only then can the effectiveness of interventions measured and compared, and only when outcomes are known, can cost-effectiveness analyses be undertaken.

Moving forward

In spite of many challenges, several African countries have undertaken their own initiatives to confront the inadequacy of surgical provision including many of those attending this meeting. Most attempts from governments aware of the need to increase surgical capacity are focused on human resource shortages and task shifting, for example Niger, Tanzania, Malawi, Mozambique, and Burkina Faso have all implemented different approaches to training non-surgeons to perform basic surgical procedures at the district level in order to address the extreme shortage of surgeon in their countries.

While manpower challenges appear to receive most attention from governments, these efforts should be implemented in tandem with attention to systems-level changes, such as investment in facilities, equipment, health information systems, and quality assurance. More work must be done on other facility-level improvements, including facilities, equipment, supplies, health information systems, and quality assurance. Larger population access issues of the health care context, similarly, have at this point not been clearly considered, due to the seemingly insurmountable lack of data. Yet all of these issues are inter-related and depend on each other's existence for success, and should be part of a comprehensive plan from the ministry of health. The health system context should be also addressed by the public health system for both long-term sustainability as well as adaptability to the needs of the population.

Some questions the working groups might like to address include:

- What skills should non-surgeons acquire to perform surgery at the district hospital? What is the minimal and optimal length of training for: (a) physicians; (b) nurses; (c) AMOs? What other types of providers (including that of anesthetists) should be considered?
- How could visiting surgeons be optimally used to support surgery in district hospitals?
- How should surgeons participate in the provision of surgical care by non-surgeons?
- What system should be developed for continuing education and professional development for skill upgrading?
- How should current facilities be evaluated and, eventually, refitted, to become capable of offering surgery?
- What system can be implemented to ensure dependable procurement and maintenance of equipment and supplies?

- How can health information systems be put in place and also ideally contribute to standardized measures of surgically-relevant metrics for the vital statistics of countries?
- What system should be put in place for routine quality assurance?
- How can population needs, utilization, and access to surgical services be better quantified for health policy planning?
- What current initiatives that could decrease the need for surgical conditions (e.g., injury) have been neglected? What are the barriers to their implementation?
- What model is most appropriate for improving prehospital care, referral, and transport in sub-Saharan Africa, where emergency medical systems do not exist?
- What systems for monitoring of outcomes and program evaluation can be established on a larger level to enhance these efforts cross-countries?

Appendix 1: World Health Organization: Guide to Anesthetic Infrastructure and Supplies[4]

Level 1 Small hospital / health centre	Level 2 District/provincial hospital	Level 3 Referral hospital
<ul style="list-style-type: none"> Rural hospital or health centre with a small number of beds and a sparsely equipped operating room (O.R) for minor procedures Provides emergency measures in the treatment of 90–95% of trauma and obstetrics cases (excluding caesarean section) Referral of other patients (for example, obstructed labour, bowel obstruction) for further management at a higher level 	<ul style="list-style-type: none"> District or provincial hospital with 100–300 beds and adequately equipped major and minor operating theatres Short term treatment of 95–99% of the major life threatening conditions 	<ul style="list-style-type: none"> A referral hospital of 300–1000 or more beds with basic intensive care facilities. Treatment aims are the same as for Level 2, with the addition of: <ul style="list-style-type: none"> Ventilation in O.R and ICU Prolonged endotracheal intubation Thoracic trauma care Haemodynamic and inotropic treatment Basic ICU patient management and monitoring for up to 1 week : all types of cases, but with limited or no provision for: <ul style="list-style-type: none"> Multi-organ system failure Haemodialysis Complex neurological and cardiac surgery Prolonged respiratory failure Metabolic care or monitoring
Procedures	Procedures	Procedures
<ul style="list-style-type: none"> Normal delivery Uterine evacuation Circumcision Hydrocele reduction, incision and drainage Wound suturing Control of haemorrhage with pressure dressings Debridement and dressing of wounds Temporary reduction of fractures Cleaning or stabilization of open and closed fractures Chest drainage (possibly) 	Same as Level 1 with the following additions: <ul style="list-style-type: none"> Caesarean section Laparotomy (usually not for bowel obstruction) Amputation Hernia repair Tubal ligation Closed fracture treatment and application of plaster of Paris Eye operations, including cataract extraction Removal of foreign bodies: e.g. in the airway Emergency ventilation and airway management for referred patients such as those with chest and head injuries 	Same as Level 2 with the following additions: <ul style="list-style-type: none"> Facial and intracranial surgery Bowel surgery Paediatric and neonatal surgery Thoracic surgery Major eye surgery Major gynaecological surgery, e.g. vesico-vaginal repair
Personnel	Personnel	Personnel
<ul style="list-style-type: none"> Paramedical staff without formal anaesthesia training Nurse-midwife 	<ul style="list-style-type: none"> One [two] trained anaesthetists District medical officers, senior clinical officers, nurses, midwives Visiting specialists or resident surgeon and/or obstetrician/ gynaecologist 	<ul style="list-style-type: none"> Clinical officers and specialists in an anaesthesia and surgery
Drugs	Drugs	Drugs
<ul style="list-style-type: none"> Ketamine 50 mg/ml injection, 10 ml Lidocaine 1% or 2% [Diazepam 5 mg/ml injection, 2 ml]injection Pethidine 50 mg/ml injection, 2 ml] [Epinephrine (adrenaline)] 1 mg [Atropine 0.6 mg/ml] 	Same as Level 1, but also: <ul style="list-style-type: none"> Thiopental 500 mg/1g powder Suxamethonium bromide 500 mg powder Atropine 0.5 mg injection Epinephrine (adrenaline) 1 mg injection Diazepam 10 mg injection Halothane 250 ml inhalation [Ether 500 ml inhalation] 	Same as Level 2 with the following additions: <ul style="list-style-type: none"> Vecuronium 10 mg powder Pancuronium 4 mg injection] Neostigmine 2.5 mg injection Trichloroethylene 500 ml inhalation] Calcium chloride 10% 10 m injection Potassium chloride 20% 10 ml injection

WHO/EHT/CPR 2005 formatted 2006

Guide anesthesia infrastructure

	<ul style="list-style-type: none"> Lidocaine 5% heavy spinal solution 2 ml Bupivacaine 0.5% heavy or plain, 4 ml] Pethidine 50 mg injection [Hydralazine 20 mg injection] Fruzemide 20 mg injection Dextrose 50% 20 ml injection Aminophylline 250 mg injection Ephedrine 30/50 mg ampoules 	for infusion
Equipment: capital outlay	Equipment: capital outlay	Equipment: capital outlay
<ul style="list-style-type: none"> Adult and paediatric resuscitators Foot sucker [Oxygen concentrator] 	<p>Complete anaesthesia, resuscitation and airway management system consisting of:</p> <ul style="list-style-type: none"> Oxygen source Vaporizer(s) Hoses Valves Bellows or bag to inflate lungs Face masks (sizes 00–5) Work surface and storage Paediatric anaesthesia system Adult and paediatric resuscitator sets Pulse oximeter Laryngoscope Macintosh blades 1-3(4) Oxygen concentrator[s] [cylinder] Foot sucker [electric] IV pressure infusor bag Adult and paediatric resuscitator sets Magills forceps (adult and child), intubation stylet and/or bougie 	<p>Same as Level 2 with the following additions (one of each per O.R or per ICU bed, except where stated):</p> <ul style="list-style-type: none"> Pulse oximeter, spare probes, adult and paediatric* ECG (electrocardiogram) monitor* Anaesthesia ventilator, electric power source with manual override Infusion pumps (2 per bed) Pressure bag for IVI Electric sucker Defibrillator (one per O.R / ICU) [Automatic B.P. machine*] Capnograph*] [Oxygen analyzer*] Thermometer [temperature probe*] Electric warming blanket Electric overhead heater Infant incubator Laryngeal mask airways sizes 2, 3, 4 (3 sets per O.R) intubating bougies, adult and child (1 set per O.R) <p>* It is preferable to buy combined modalities all in one unit</p>
Equipment: disposable	Equipment: disposable	Equipment: disposable
<ul style="list-style-type: none"> IVI equipment Suction catheters size 16 FG Examination gloves 	<ul style="list-style-type: none"> VI equipment (minimum fluids normal saline, Ringer's lactate and dextrose 5%) Suction catheters size 16 FG Examination gloves Sterile gloves sizes 6–8 Nasogastric tubes sizes 10–16 FG Oral airways sizes 000–4 Tracheal tubes sizes 3–8.5 Spinal needles sizes 22 G and 25G Batteries size C 	<p>Same as Level 2 with the following additions:</p> <ul style="list-style-type: none"> ECG dots Ventilator circuits Yankauer suckers Giving sets for IVI pumps Disposables for suction machines Disposables for capnography, oxygen analyzer, in accordance with manufacturers' specifications: <ul style="list-style-type: none"> Sampling lines Water traps Connectors Filters– Fuel cells

Appendix 2: World Health Organization: Key elements of a district surgical service[23]

Personnel

Surgery

District surgical practitioners should be able to manage most obstetric, orthopaedic, trauma and abdominal emergencies, including:

- Caesarean section
- Laparotomy
- Amputation
- Surgical treatment of acute infection
- Resuscitation
- Head, chest and abdominal trauma
- Hernia repair
- Acute closed and open fractures
- Management of wounds and burns

Anaesthesia

Anaesthetic practitioners should be able to provide anaesthetic service to 95% of surgical and obstetrical patients including:

- Local, regional and general anaesthesia
- Airway management
- Resuscitation
- Pain relief

Clinical support

The district hospital requires an effective team of trained support staff, including:

- Nurses and midwives
- Operating room personnel
- Laboratory technicians
- Maintenance staff

Education programmes

Continuing professional development at district hospital level is essential to ensure that practitioners maintain the knowledge and skills needed to provide an effective district surgical service. This requires:

- Clinically-based continuing education programmes
- Educational resource materials in district hospitals
- Monitoring and evaluation

Facilities

Surgery

Instruments are needed to cover all common surgical and obstetrical procedures. Several sets of duplicate instruments may be needed to allow continuous provision of services during sterilization.

Anaesthesia

A dedicated set of anaesthetic apparatus is required which provides a source of oxygen, inhalation anaesthesia and the ability to ventilate the lungs.

Resuscitation equipment

A continuous supply of oxygen, is required at key locations, including:

- Casualty
- Operating room
- Labour ward, delivery room and neonatal unit
- Paediatrics

Equipment and instruments

Surgery

Instruments are needed to cover all common surgical and obstetrical procedures. Several sets of duplicate instruments may be needed to allow continuous provision of services during sterilization.

Anaesthesia

A dedicated set of anaesthetic apparatus is required which provides a source of oxygen, inhalation anaesthesia and the ability to ventilate the lungs.

Resuscitation equipment

A continuous supply of oxygen, is required at key locations, including:

- Casualty
- Operating room
- Labour ward, delivery room and neonatal unit
- Paediatrics

Monitoring equipment

Safe surgical care requires the availability in the hospital of simple monitoring equipment, including blood pressure and pulse oximetry.

Supplies system

An effective system at national and regional level is required to ensure the consistent availability in district hospitals of supplies of essential drugs and materials needed for all common surgical and obstetrical emergencies.

This requires policies on:

- Budgeting and procurement
- Transportation and storage
- Prescribing

Drugs and medications

- Blood and blood products
- Intravenous replacement fluids
- Anaesthetics
- Antibiotics
- Analgesics

Surgical materials

- Gloves, gowns, drapes
- Sutures
- Dressings

Consumables

- Disposable equipment and devices

Quality system

A quality system to improve the quality and equity of patient care includes the following elements:

- Standards
- Clinical guidelines
- Standard operating procedures
- Records
- Audit

References

1. Farmer, P.E. and J.Y. Kim, *Surgery and global health: a view from beyond the OR*. World J Surg, 2008. **32**(4): p. 533-6.
2. Murray CJL, L.A., *The global burden of disease: a comprehensive assessment of mortality and disability from diseases, injuries, and risk factors in 1990 and projected to 2020*. 1996, Cambridge, MA: Harvard University Press.
3. Debas, H., et al., *Surgery*, in *Disease Control Priorities in Developing Countries*, J.D.e. al., Editor. 2006, World Bank: Washington DC.
4. *Surgical care at the district level hospital*. 2003, Geneva: World Health Organization.
5. *WHO Guidelines for Safe Surgery*, in *World Alliance for Patient Safety*. 2008, World Health Organization: Geneva.
6. Weiser, T.G., et al., *An estimation of the global volume of surgery: a modelling strategy based on available data*. Lancet, 2008.
7. *Implementation Manual: WHO Surgical Safety Checklist in Safe surgery saves lives*, W.A.f.P. Safety, Editor. 2008, World Health Organization: Geneva.
8. *Atelier: Les strategies d'amelioration de la couverture et de la qualite des soins medicochirurgicaux essentiels et d'urgence*. 2004, République du Niger, Ministère de la Santé Publique et de la Lutte Contre les Endémies et Coopération Technique Belge.
9. *Rapport de mission*. in *Rencontre sous-regional sur les soins medico-chirurgicaux essentiels et d'urgence*. 2004. Ouidah, République du Bénin.
10. *Improving Access to Surgery in sub-Saharan Africa*, in *Bellagio Essential Surgery Group*: Bellagio.
11. Vaz, F., et al., *Training medical assistants for surgery*. Bull World Health Organ, 1999. **77**(8): p. 688-91.
12. Kruk, M.E., et al., *Economic evaluation of surgically trained assistant medical officers in performing major obstetric surgery in Mozambique*. Bjog, 2007. **114**(10): p. 1253-60.
13. Meo, G., et al., *Rural surgery in southern Sudan*. World J Surg, 2006. **30**(4): p. 495-504.
14. Pereira, C., et al., *A comparative study of caesarean deliveries by assistant medical officers and obstetricians in Mozambique*. Br J Obstet Gynaecol, 1996. **103**(6): p. 508-12.
15. Pereira, C., et al., *Meeting the need for emergency obstetric care in Mozambique: work performance and histories of medical doctors and assistant medical officers trained for surgery*. Bjog, 2007. **114**(12): p. 1530-3.
16. Scheffler, R.M., et al., *Forecasting the global shortage of physicians: an economic- and needs-based approach*. Bull World Health Organ, 2008. **86**(7): p. 497-576.
17. WHO, *The world health report*. 2006, World Health Organization: Geneva.
18. *Report of the Africa Working Group of the Joint learning initiative on HRH and Development*, A.W. Group, Editor. 2006, BRAC: Bangladesh.
19. WHO, *Addressing Africa's Health Workforce Crisis: An Avenue for Action the High Level Forum on the Health MDGs*. 2004, World Health Organization: Geneva.

20. Martineau, T., K. Decker, and P. Bundred, *Briefing note on international migration of health professionals: levelling the playing field for developing country health systems*. 2002, Liverpool School of Tropical medicine: Liverpool.
21. Aitken, J.M. and J. Kemp, *HIV/AIDS, equity and health sector personnel in Southern Africa, in Harare: Regional Network for Equity in Health in Southern Africa (EQUINET) in cooperation with Oxfam GB*. 2003.
22. Dovlo, D., *Wastage in the health workforce: some perspectives from African countries*. 2005.
23. *Aide-Memoire: Surgical and Emergency Obstetrical Care at First-Referral Level*, E.s. care, Editor. 2003, World Health Organization: Geneva.