

Minimum surgical armamentarium for safe operations in remote settings

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Ελάχιστος απαιτούμενος εξοπλισμός για ασφαλείς χειρουργικές παρεμβάσεις σε απομακρυσμένες περιοχές.

Περίληψη

Η έννοια της απομακρυσμένης περιοχής δεν έχει τόσο γεωγραφική σημασία όσο τη σημασία της απόστασης από καλά οργανωμένες υπηρεσίες υγείας. Ως απομακρυσμένη περιοχή για την παρούσα εργασία νοείται η περιοχή αυτή στην οποία οι ανάγκες υγείας ενός πληθυσμού, και ειδικά οι χειρουργικές ανάγκες, αδυνατούν λόγω οικονομικών συνθηκών να καλυφθούν όπως έχουμε συνηθίσει με την έννοια της Δυτικής αστικής Ιατρικής . Για ασφαλείς χειρουργικές επεμβάσεις σε τέτοιες περιοχές, είναι απαραίτητα πολύ περισσότερα από ένα νυστέρι και έναν κλίβανο. Απαιτείται πολιτική βούληση, επαγγελματίες υγείας και ανάπτυξη μιας σχέσης εμπιστοσύνης μεταξύ του τοπικού πληθυσμού και του φορέα παροχής υγείας. Στο παρόν άρθρο εξετάζονται οι παράμετροι που είναι απαραίτητοι για να καταστούν ασφαλείς οι χειρουργικές επεμβάσεις σε απομακρυσμένες περιοχές με σκοπό, τη μείωση των συχνότερων δυνητικά αποτρέψιμων θανάτων και αναπηριών.

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Summary

Remote is not so much a matter of kilometers from a place of care, as one 'far from the desirable availability of quality of care'. The minimum surgical armamentarium needed for safe operations in remote settings has a much wider sense than a couple of surgical instruments. It includes global health policy directives, targeted actions, health care professionals and the development of trust between health care providers and local communities. This article reviews the parameters that compose an environment safe for surgical intervention, in an effort to combine existing knowledge and infrastructure with the pursue of better results and realistic endpoints.

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“Give me a place to stand and I will move the earth”
Archimedes

Introduction

Archimedes advocated he could move even the earth with only a lever. Would it be as pompous for a modern surgeon to believe a scalpel and some ties will do the job every time, even in the most remote of settings? The modern westerly educated surgeon has come to master many life saving techniques and knows most of the tips and tricks of his profession. On the other hand he has come to take for granted things as a safe working place, secure buildings, uninterrupted power supply and running water. Even these facilities, among many others, tend to be scares recourses in some urban areas. The scope of this article is to review the minimum surgical armamentarium necessary, for the maximum impact on easily treatable but potentially fatal surgical conditions among rural dwellers.

Method

The present review aims at defining the problems of surgical health care delivery to rural areas whether in developed or developing countries.

The solutions offered to these problems are also analyzed. Though not intended to be a systematic review, health concerns such as quality health care and limitations, as well as infrastructures, surgical workforce, planning, teaching and training for surgical care in remote and rural areas described in the English medical literature over the last 15 years were searched. Search tools included Medline, PubMed and Google. All retrieved abstracts and articles were screened for their relevance. Full articles were reviewed. Due to the nature of the topic, most reviewed papers were either descriptive, expert opinions, or epidemiologic studies. Considering value and strength of presented evidence of such work is irrelevant. World Health Organization published guidelines were considered as a reference point.

In order to decide on a minimum surgical armamentarium, the first question that must be answered is the kind of operative procedures that need to be performed. To decide on the most appropriate procedures needed to be performed in remote areas we need to investigate the most common life or limb endangering conditions that are encountered in these areas. Finally we need to ask the questions of the capability of the medical personnel available on site to use this equipment.

Definition

If we can perform a surgical intervention in space, the final frontier, on oil rigs in the middle of the ocean or in deep underwater facilities, then what is a remote setting?

One factor leading to the paucity of data about rural surgery relates to the difficulty in defining rural. Unfortunately, dichotomous definitions permit classification into only two categories, metro/urban or nonmetro/rural. This cannot describe the metro/nonmetro continuum or the range of variation that exists in nonmetro areas. (1) Rural and remote in developed countries may be, and usually are, far more advanced in sophistication than even the capital city of an emerging country. (2) 'Remote' therefore is not so much a matter of kilometers from a place of care, as one 'far from the desirable availability of quality of care'. The federal United States government has multiple definitions of rural, often used by different agencies. Most descriptions of rural surgery include a low population density in an area with limited medical resources. The number of general surgeons per 100,000 populations varies widely between rural and urban locations. In the US this ratio is 4.48 in rural locations to 6.36 in urban locations.(3) This ratio cannot be used as a cutoff point for a global definition of rural since in many parts of sub-Saharan Africa, there is one surgeon for every 250,000 people and in some more remote areas there is only one surgeon for every 2.5 million people (4)

For this essay as rural or remote will be defined as any place, indifferent of its actual geographical location, that essential surgical needs are not met by existing health facilities due to restricted resources.

Stating the problem

Surgery can cure cancers, correct birth defects in the young and heart disease in the old, heal fractures, avert maternal deaths, and alleviate suffering. Thus surgery has become a central and essential tool in the sustenance of human life. For example, the average American has nine operations in her/his lifetime. More than half of hospital admissions are surgical, and 30 million operations are performed annually in the United States alone. Yet surgical care is surprisingly unevenly delivered throughout the United States and even more unevenly across less privileged parts of the world. For example, in large territories of Southern Africa and Asia, cesarean section is simply unavailable. When a mother cannot pass a baby through the birth canal, both are routinely left to die. (5) Of the estimated 234 million operations performed annually worldwide, only 26% occur in the developing countries where 70% of the world's population resides. (6) Emergency surgery hits the same lows as elective. Almost 90% of all deaths from road traffic injuries occur in low- and middle-income countries. (7) For example, in 1998 injury-related mortality was as high as 63% in Kumasi, Ghana but was 55% in Monterrey, Mexico and 35% in Seattle, Washington, USA. (8) Of the severely injured people, only 31% are thought to have access to health facilities in rural areas. (9) It has been confirmed by a number of studies that most trauma related deaths are preventable. Deaths in Low and Middle income countries result from conditions that could be treated in most health facilities by simple means. Such conditions are airway obstruction and isolated intra-abdominal organ injury. (10-14) Even those patients who manage to get access to surgical treatment, in most developing countries,

they will be exposed to a peri-operative death rate and rate of major complications much higher than those of industrialized countries. (15, 16, 17)

The practice of general surgery in rural areas is also very consuming for the surgical health providers. The practice of general surgery is often more complex because of scarce resources, overwhelming need, and a paucity of subspecialists, forcing general surgeons to take on advanced gynecologic, urologic, orthopedic, head and neck, and even neurosurgical cases, in addition to general surgery and trauma. Patients often present with advanced disease. A surgical practitioner in a remote setting must be equipped with the maturity, experience, and judgment to face these challenges. (18)

Defining the surgical needs

The public health and donor communities have recently used health disparities as a measure of global health equity, but there are few data available from low- and middle- income countries to measure the disparity in injury-related mortality and morbidity or to compare with data from resource-rich settings. (19-21)

Recognizing these needs and the unique problems of rural surgery the Global Initiative for Emergency and Essential Surgical Care was established by the World Health Organization in December 2005. It's general purpose is to reduce "death and disability from road traffic accidents, trauma, burns, falls, pregnancy related complications, domestic violence, disasters and other

emergency surgical conditions” by improving collaborations between relevant organizations, institutions, and agencies (“Global Initiative for Essential and Emergency Surgical Health Care (GIEESC)”). Despite the lack of data the World Health Organization planning tool for emergency and essential surgical services at the first referral level has identified as major, surgically addressable diseases, injury, pregnancy related complications, wound infections and abscesses, acute abdominal conditions and congenital deformities. (22) Table 1 depicts the burden of surgically related diseases expressed in DALYs. DALY stands for disability-adjusted life year and is a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability or early death. It becomes evident that injuries are the most common surgically treatable condition and along with obstetrical complications they account for almost 50% of all surgical conditions.

Performing simple surgical interventions targeted against these conditions can be both life-saving and disability preventing. (23) These interventions should be carried out in an environment that optimizes quality and safety.

Minimum surgical armamentarium

The minimum surgical armamentarium necessary to perform life saving surgical interventions in remote, under-funded settings consists of more than a toolkit of surgical instruments.

Since the needs have been clearly defined, the most important aspect of implementing such a program is political commitment and funding. In most remote areas safe infrastructure cannot be taken for granted. By definition rural areas are deprived of the necessary number and expertise of health care personnel to carry out surgical procedures. In order to attract health care personnel a minimum of measures to ensure their safety must be in place. Last but not least all the above will become useless if the health facility does not have low complication indexes in order to gain the community's trust.

Global health care priorities

Local ministries of health and the World Health Organization (WHO) began to focus available resources on primary care. At the 1978 World Health Conference in Alma Ata, USSR, WHO embarked on a 30-year experiment in primary health care. The primary health care push sought to extend basic health services to all people as a fundamental human right. Investment was made in low-cost, community-based interventions focusing on a smaller number of diseases using non-professional health workers. (24) While the aims were laudable, the unintended consequences were devastating to the surgical infrastructure and workforce in many countries, hitting rural areas particularly hard. In addition to neglect of surgical services in rural areas, there has been an enticement of the surgical workforce away from these areas. Because of the lack of investment and commitment to surgeons and surgical infrastructure in rural areas, surgeons have concentrated in the major cities at university centers or in private practice where salaries are sufficient to

support families, education is available for children, call schedules are sustainable, and basic equipment is available. (19)

Deaths due to surgically treatable diseases may not be as important as the great killers (malaria, pneumonia, diarrhea, and malnutrition in children and HIV/AIDS in adults), however, surgical treatment of common surgical conditions (traumatic injuries and obstetrical complications) is increasingly emerging as an integral part of public health and health systems development worldwide. (25) Though surgery might have been thought to lie outside the scope of public health, as estimated in 1990, 10% of all deaths and almost 20% of deaths of young adults are still likely to be due to an untreated surgical condition. Without surgical and obstetrical services, up to 10% of the population will die from injury and 5% of pregnancies will result in maternal death. (26)

Regardless of this fact, and despite numerous limitations, the demand for surgery in rural areas worldwide should not be any different from the surgery carried out in large cities. Providing the same type and level of surgical care in both urban and rural settings, however, poses great challenges even in the most advanced and affluent societies. Both national and international organizations and NGO's have committed themselves to this task.

Infrastructure

From the work of Debas et al (27) and a similar guideline by WHO (22) a small hospital/ health center should be the front line facility taking care of patients in rural areas. These level 1 institutions should have a small number of beds and a sparsely equipped operating room for minor procedures. They should be capable to provide emergency measures in the treatment of 90-95% of trauma and obstetric cases. A minimum of certain drugs, technical equipment and personnel should be available in order to fulfill the targets set beforehand. Recommended drugs for this level of care facility include Ketamine, Lidocaine, Diazepam, Pethidine, Epinephrine, Atropine and Antibiotics. The basic minimum kit of surgical instruments for sutures and small wounds includes a pair of scissors, surgical probes, a scalpel, forceps, a needle holder, sutures and needles. A minimum of resuscitation tools includes chest drain tubes, devices to retain an open airway and oxygen delivery devices. These should be readily available in a variety of adult and pediatric sizes. A referral protocol should be established for the further management at a (22) higher level. The proposed minimal infrastructure is presented in detail in Table 2.

The current literature, although limited, documents the expected, that availability of physical resources parallels the economic resources of each country. However, in all countries, resources for acute resuscitation are extremely limited at level 1 facilities. Especially problematic is oxygen. Problems range from no supply to frequent, prolonged shortages with the one tank per clinic away for re-filling. Likewise, airway equipment and fluid resuscitation capabilities are extremely limited. In Ghana, IV fluids are available but for restricted uses, such as labor and delivery—not for trauma.

Even in those places where the equipment is in place, they are not used to their maximum efficiency. Airway equipment is often kept in operating rooms (theaters), not in the Emergency Department, and there is considerable delay in its availability in emergency situations. The same situation pertains to the availability of chest tubes in some locations. Some airway and other equipment (e.g., urinary catheters) are available in adult sizes only. Some equipment, such as pulse oximetry and ventilators, are available in limited numbers and thus are not available to all who need them on an emergency basis. (28) Thus the first prerequisite for safe surgical intervention would be a secure building staffed with the most basic equipment and drugs that must be readily available.

Medical personnel

The critical shortage of surgeons in rural parts of Africa is increasingly recognized as a global public health crisis. Many efforts and strategies have emerged to address this issue and to build up the surgical workforce in low- and middle-income countries. (29) The origins of the crisis run deep. With independence and the end of colonial rule in the middle of the 20th century, many physicians and surgeons left Africa and returned to Europe, leaving a massive shortage of health care workers. For example, in Mozambique only 80 physicians remained at the time of independence for a nation of 14 million people. (30) Western countries are guilty of actively recruiting physicians from

low-and middle-income countries to fill the gap in their own workforces. It is estimated that 25% of the physician workforce in the United States are foreign medical graduates and 60% of those are from low-income countries. The problem is even worse in the UK, with nearly 30% of the physician workforce from outside the UK and 75% of those being from low-income countries. (31)

In terms of human resources, there is a shortage in doctors available for trauma care worldwide. Shortages of nurses are especially evident. This is only in part related to inadequate capabilities for training. It is related in larger part to the “brain drain” issues that have led many trained professionals to migrate from rural to urban areas and especially from LMICs to industrialized countries. This is especially a problem in Africa and has reached critical levels for nurses. Strategies to promote retention of trained personnel are desperately needed. Barriers should also be created to prevent the early loss of graduates from medical and nursing schools. Recruitment of nurses by foreign agencies should be strongly confronted and regulated. (32-34)

In order overcome the shortages of health care personnel in rural areas a number of strategies have been implemented.

1. Tele medicine

Certain clinical environments, including military field hospitals or rural medical centers, lack readily available surgical subspecialists. It has been hypothesized that telementoring by a surgical subspecialist using a robotic platform is feasible and can convey subspecialty knowledge and skill to a remotely located general surgeon. Overall mean performance scores have

been shown to be superior in all scenarios when residents were proctored than when they were not. (35)

Other applications for robotics invoke the “tele” part of telerobotics, which permits viewing, monitoring, collaborating, and even performing surgery from a distance. Teleconsultation was the first to be used. It permits a centrally located expert surgeon at a medical center to provide assistance or collaboration during a difficult procedure to a less experienced surgeon at a remote site. There are a few such programs that are thriving, especially in regions where there are underserved populations. It was envisioned that robotics would be used in telementoring, telemonitoring, and teleproctoring to help train and certify surgeons in the new robotic procedures. The reports of these applications have been rather sporadic, and the much anticipated use in teleproctoring for new procedures has not materialized. This is likely due to the amount of time that is required by the centrally located proctor, as well as to the cost of the equipment. (36)

2. Charity Hospitals

Mission hospitals run by faith-based organizations (FBO) and short-term humanitarian missions often provide high-quality surgical services. These efforts will likely be an essential component to improving surgical care in rural Africa in the short term. (4) These hospitals have made substantial contributions to health care delivery in many countries. For instance, up to 48% of healthcare delivery in Kenya is provided by religious non-profit organizations and humanitarian nongovernmental organizations (NGOs). (37) In fact, FBOs and NGOs are thought to contribute 40% of the health care

services in sub-Saharan Africa. (38) However, in recent years, many such organizations have been closing hospitals, refocusing resources on community health initiatives and infectious diseases such as HIV, TB, and malaria. (39)

3. Training surgeons

The Pan-African Academy of Christian Surgeons (PAACS) was formed in 1997 as a strategic response to this profound need for surgical manpower. It is training surgical residents through a 5-year American competency-based model. Trainees are required to be of African origin and a graduate of a recognized medical school. To date, PAACS has established six training programs in four countries. During the 2009–2010 academic years, there were 35 residents in training. A total of 18 general surgeons and one pediatric surgeon have been trained. Two more general surgeons are scheduled to complete their training in 2011. Four graduates have gone on to sub-specialty training, and the remaining graduates are practicing general surgery in rural and underserved urban centers. (4) The evident drawback is that with this rate of training highly educated surgeons, it will be a long time before these experts meet the needs of the rural population.

4. Surgical technicians

Many recent efforts to increase surgical capacity in Africa have focused on “task shifting.” This is a term borrowed from HIV/AIDS work, and it involves the provision of surgical training to nonprofessional health workers or general medical practitioners. In Mozambique, common surgical

problems such as herniorrhaphy, circumcisions, the incision and drainage of abscesses, amputations, and cesarean sections are performed by “tecnico de cirurgias”, assistant medical officers with three years of training. Complication rates are reported to be acceptably low (40) In the Democratic Republic of Congo, nurses were trained to provide emergency obstetric surgery (41) Niger, Ethiopia, and Senegal have trained general practitioners to provide surgical care in rural areas. (42-44)

An external audit examining the capacity and performance of the 'técnico de cirurgia', in the Mozambican health system, stressed the life-saving skills of these cadres, the advantages resulting from a reduction in the need for patient referrals and the considerable cost reduction for patients and their families. When first introduced these cadres were met with some resistance from medical doctors and nurses. Among some of this staff, TCs were perceived as second class professionals leading to lack of consideration and commitment in the pursuit of their training. Nonetheless, TCs are usually assigned as the only 'surgeon' in a rural hospital with functioning theater. All such health facilities in Mozambique are now staffed with at least one TC, the predominant cadre providing much needed emergency surgical care in rural areas. The young doctors deployed at this level have limited surgical experience and are in fact often being trained by this cadre of 'non-physicians' to perform major surgery. The quality of their work has been shown to be very good (45)

These surgical technicians seem to be the optimal health personnel as their sufficient number and certified health skills have had a positive impact in the provided health services.

The second prerequisite for safe surgical intervention would be manning the formed facilities. Nurses and surgical technicians or equivalents can immediately man remote area facilities and provide good quality of care. At the same time more surgeons need to be trained and assigned to rural facilities at a later time to optimize the provided surgical health care.

Personnel safety

It essential, in order to attract health care personnel, to provide the means for their personal safety. Protection from potential body-fluid-borne diseases has shown to be, at least, partially adequate in most established level 1 clinics. Training in universal precautions, the use of gloves, appropriate handling of sharps and biological waste disposal has been shown to be utilized even in these level 1 facilities. In many, but not all, situations, antiretroviral medications are available. However, the practice of testing patients and providers involved with needle-stick exposure is not well utilized in most locations.(30)

Documentation

Surgical care is associated with a considerable risk of complications and death. The risk of complications is poorly characterized in many parts of the world, but studies in industrialized countries have shown a perioperative rate of death from inpatient surgery of 0.4 to 0.8% and a rate of major complications of 3% to 17%. These rates are likely to be much higher in

developing countries. (17, 18) Thus, surgical care and its attendant complications represent a substantial burden of disease worthy of attention from the public health community worldwide. Data suggest that at least half of all surgical complications are avoidable. (46)

In 2008, the World Health Organization (WHO) published guidelines identifying multiple recommended practices to ensure the safety of surgical patients worldwide. (47)

Introduction of the WHO Surgical Safety Checklist (Table 3) into operating rooms in eight diverse hospitals was associated with marked improvements in surgical outcomes. Postoperative complication rates fell by 36% on average, and death rates fell by a similar amount. (48)

In addition proper documentation will provide the much needed information on health needs in remote areas for future targeted interventions.

Conclusion

Building a minimum surgical armamentarium for safe operations in remote, recourse deprived areas is a major task. A relative small number of simple surgical procedures can have major impact on the rural population in remote areas. These procedures can be safely performed by minimally trained health personnel with scarce resources in a safe environment. In order for health care personnel to do their job, there should be political commitment and funding towards the necessary infrastructure and personnel development.

The health community's attention has shifted this last decade from the great infectious killers towards surgically preventable deaths. With the support of WHO and other international and national partners today we have reached a point at which these services are becoming available even in the most remote areas. As far as surgical instruments are in question, a scalpel and some ties will do the job every time, even in the most remote of settings.

Tables

Table 1. Burden of Common Surgical Conditions

Condition	Surgical DALYs		Estimated surgical DALYs as a percentage of total DALYs	Estimated surgical DALYs per 1,000 population
	Estimated (millions) ^a	Percentage		
Injuries	63	38	4.3	10
Malignancies	31	19	2.1	5
Congenital anomalies	14	9	1.0	2
Obstetrical complications	10	6	0.7	2
Cataracts and glaucoma	8	5	0.5	1
Perinatal conditions	7	4	0.5	1
Other	31	19	2.1	5

DALY: disability-adjusted life year is a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability or early death

Debas HT, Gosselin R, McCord C, Thind A. Surgery. In: Jamison DT, Breman JG, Measham AR, Alleyne G, Claeson M, David DB, Jha P, Mills A, Musgrove P, ed. 2006 Disease Control Priorities in Developing Countries, 2nd edition. Washington (DC): World Bank. Chapter 6

Table 2. Resource Requirements for Surgical Services and Surgical Procedures for Level 1 Care

Infrastructure	Equipment and supplies	Human resources	Services Provided	Drugs
Weatherproof building (100 square meters) Storage space Clean water supply Power supply	Furniture Refrigerator Blood pressure machine Minor surgical trays Sterile and burn dressings Autoclave Intravenous sets and solutions Bandages and splints Wireless communication equipment Materials for recordkeeping	Nurse or nurse equivalent Skilled birth attendant Orderly	Simple suturing and dressing of wounds Incision and drainage of abscesses Care of simple burns Control of hemorrhage Splinting Deliveries Vacuum extraction and manual vacuum aspiration	Local anesthetics Nonsteroidal anti-inflammatory drugs Antibiotics Tetanus toxoid Silver nitrate ointment Oxytocin Magnesium sulfate

Debas HT, Gosselin R, McCord C, Thind A. Surgery. In: Jamison DT, Breman JG, Measham AR, Alleyne G, Claeson M, David DB, Jha P, Mills A, Musgrove P, ed. 2006 Disease Control Priorities in Developing Countries, 2nd edition. Washington (DC): World Bank. Chapter 67

Table 3. WHO Surgical Safety Checklist

<p style="text-align: center;">Sign in</p> <p>Before induction of anesthesia, members of the team (at least the nurse and an anesthesia professional) orally confirm that:</p> <ul style="list-style-type: none">The patient has verified his or her identity, the surgical site and procedure, and consentThe surgical site is marked or site marking is not applicableThe pulse oximeter is on the patient and functioningAll members of the team are aware of whether the patient has a known allergyThe patient's airway and risk of aspiration have been evaluated and appropriate equipment and assistance are availableIf there is a risk of blood loss of at least 500 ml (or 7 ml/kg of body weight, in children), appropriate access and fluids are available <p style="text-align: center;">Time out</p> <p>Before skin incision, the entire team (nurses, surgeons, anesthesia professionals, and any others participating in the care of the patient) orally:</p> <ul style="list-style-type: none">Confirms that all team members have been introduced by name and roleConfirms the patient's identity, surgical site, and procedureReviews the anticipated critical events<ul style="list-style-type: none">Surgeon reviews critical and unexpected steps, operative duration, and anticipated blood lossAnesthesia staff review concerns specific to the patientNursing staff review confirmation of sterility, equipment availability, and other concernsConfirms that prophylactic antibiotics have been administered ≤ 60 min before incision is made or that antibiotics are not indicatedConfirms that all essential imaging results for the correct patient are displayed in the operating room <p style="text-align: center;">Sign out</p> <p>Before the patient leaves the operating room:</p> <ul style="list-style-type: none">Nurse reviews items aloud with the team<ul style="list-style-type: none">Name of the procedure as recordedThat the needle, sponge, and instrument counts are complete (or not applicable)That the specimen (if any) is correctly labeled, including with the patient's nameWhether there are any issues with equipment to be addressedThe surgeon, nurse, and anesthesia professional review aloud the key concerns for the recovery and care of the patient

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