Surgical need & capacity in low and middle income countries
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Undertaking the research for this thesis was a complex project involving many colleagues in various countries and in various institutions who collaborated, assisted, advised, and criticized this work. They all agreed however, on its mission of defining the surgical disease burden and to work on the assessment of surgical capacity in order to focus attention on surgically treatable conditions at the level of local ministries of health as well as at the UN and WHO. We expected that this will assist in the allocation of donor funding as well as in the allocation of various necessary resources. Before surgical care is fully accepted as an important component of health care systems more countries need to do similar assessments and publicize their surgical needs and their current insufficient surgical capacity. Therefore, before going into a general discussion of our results and discussion of consequent recommendations, we wish to thank and commend the Sierra Leone Ministry of Health and Sanitation for their helpful participation in many of our studies and for their permission for me to use, distribute, and publish the collected data.

As noted in the introduction, the aim of the thesis was two-fold, to document the need for surgical care in Sierra Leone and to determine the surgical capacity, including safety measures for health care personnel. This discussion will be structured accordingly with the exception of some related-topics on pediatric surgical need and capacity. Although ideas and recommendations are generated throughout the discussion, general recommendations and ideas for further studies are briefly summarized in the last paragraph of the discussion.

Surgical need

The data presented in this thesis clearly show a high prevalence of untreated surgical conditions in Sierra Leone. In the final analysis of our survey we found that 25% of respondents had a condition that likely required a surgical intervention. The survey also showed that 25% of deaths identified in the previous year could likely have been prevented if there was adequate access to surgical services. If one was to extrapolate these findings to the entire population of Sierra Leone, the population at risk would be projected to be almost 1.5 million individuals who would have benefited from a surgical consultation in Sierra Leone at the time of the study [1]. Our survey tool, SOSAS, was also used for a national assessment of operative needs in Rwanda, a country with greater financial support and which is considered more advanced on the development scale than Sierra Leone. In Rwanda, 6.4% (95% CI 5.6 – 7.3%) of the population was found to have an active current need for a surgical evaluation [2]. Using a very rough metric, including the lower limit of the confidence interval for surgical need in Rwanda (which appears to be a major underestimation), it can be extrapolated to 56 million people in sub-Saharan Africa that are currently in need of minimal surgical evaluation and most likely will need an intervention. I am not aware of any other study which has documented, as we have, the overall surgical need in a low income country in Africa. There have been several studies published on the surgical needs and inadequacies in the field of management of trauma in Africa. Using SOSAS we found a yearly nonfatal injury prevalence of 12.4% with a 5.6% incidence of mortality related to trauma [3]. The single most common cause of nonfatal injuries was due to falls; this is consistent with previous studies in Iran, Sri Lanka and in China [4-6]. Not unexpectedly, falls from trees have been reported as a leading cause of injury in rural areas of developing countries such as Nigeria and Papua New Guinea [7-9] where the products of tall trees are an important source of food and therefore, income. Studies in rural Ghana [10] and Tanzania [11] have described lacerations to be the leading cause of injuries, with the majority of such injuries sustained during agricultural work. In Tanzania, most cuts and stab wounds were due to injuries inflicted by instruments such as axes and machetes which were used by rural residents engaging in agricultural activities without the use of any protective equipment which is not available. Although motor vehicle-related non-fatal injuries were less common (fourth most common cause of injury overall), they were found to be the most common cause of injury-related deaths, accounting for 32% of injuries during the week prior to death. Similarly, Mock et al [12] reported that in rural and urban Ghana, transport-related injuries were more severe than other types of injuries in terms of duration, of disability, economic consequences, and death. One of the best and most reliably investigated surgical conditions is diagnosis and management of inguinal hernia. This extremely common condition will affect 27% of males and 3% of females throughout their lifetime [13]. In the US there is an estimated 800,000 hernia operations per year making this one of the most common
GENERAL DISCUSSION

Undertaking the research for this thesis was a complex project involving many colleagues in various countries and in various institutions who collaborated, assisted, advised, and criticized this work. They all agreed however, on its mission of defining the surgical disease burden and to work on the assessment of surgical capacity in order to focus attention on surgically treatable conditions at the level of local ministries of health as well as at the UN and WHO. We expected that this will assist in the allocation of donor funding as well as in the allocation of various necessary resources. Before surgical care is fully accepted as an important component of health care systems more countries need to do similar assessments and publicize their surgical needs and their current insufficient surgical capacity. Therefore, before going into a general discussion of our results and discussion of consequent recommendations, we wish to thank and commend the Sierra Leone Ministry of Health and Sanitation for their helpful participation in many of our studies and for their permission for me to use, distribute, and publish the collected data.

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One of the best and most reliably investigated surgical conditions is diagnosis and management of inguinal hernia. This extremely common condition will affect 27% of males and 3% of females throughout their lifetime [13]. In the US there is an estimated 800,000 hernia operations per year making this one of the most common
procedures performed [14]. In contrast, in Sub-Saharan Africa (SSA), where there are an extremely large number of unrepaired inguinal hernias, patients often present late in the course of their disease with gangrenous bowel or with giant scrotal hernias [15, 16] which require immediate or well-planned surgical interventions depending on the bowel function and viability. Such patients, as well as others such as those with carcinoma of the breast, suffer from lack of access to timely surgical services, leading to frequent fatalities and enormous economic losses.

Using SOSAS data, 7% of the male population had a ‘soft groin mass’ [manuscript in preparation]. Although this does not translate directly to hernias, it is likely that most of the "soft groin masses" in the male respondents were unrepaired hernias and thereby represent a very large backlog of cases in Sierra Leone. A sub-analysis of pediatric population in the SOSAS survey in Sierra Leone revealed that children also had a large proportion of soft masses located in the groin (n=38) and abdominal wall (n = 50), in which the soft abdominal masses most likely represented umbilical hernias (UH) [17]. Umbilical hernias have the potential to resolve in the first 4-5 years of life and are therefore not in need of immediate repair as long as they are asymptomatic. A large review of UH repairs in the United States revealed that most were repaired around 4 years of age [18], indicating that the UH found in the younger children in this survey might overestimate the current surgical need. In the US study however, 7% (34 cases) of the total UH required emergent repairs because of (recurrent) incarceration, enteric fistula, strangulation, and evisceration [18], therefore indicating that all those with an UH should have access to immediate surgical care. The ideal age of UH repair remains uncertain since the timing of repairs in the Western countries is due more to social aspects (repairs are mostly done before starting school) than to the natural course of the disease. The soft groin masses in children are likely to be inguinal hernias. Therapy for inguinal hernias is mandatory, as incarceration is likely [19].

Based on hospital data from eastern Africa it was estimated that 175 per 100,000 individuals are in need of hernia repair each year [20]. A systematic review from sub-Saharan Africa estimated a higher total annual need for inguinal hernia repair at 205/100,000 population, with estimates of an unmet need of 175/100,000 population annually [21]. These figures compared to our data imply that there is indeed a major backlog of hernia cases in Sierra Leone. A second review on the same topic emphasizes the insufficiency of accurate information on the true burden of inguinal hernias in Africa, especially in the sub-Saharan region [22]. Since published studies are predominantly extrapolations from hospital data, they significantly underestimate the true burden of the disease among the African population. According to the authors, there were no reported population-based studies that could provide accurate data on the epidemiology of inguinal hernias. The current SOSAS data on ‘soft groin masses’ partially fills this gap. We strongly recommend that relevant questions regarding surgical needs are included in all countrywide DHS. Even more so based on the suggestion by colleagues like Kingsnorth and others who advocated that hernia repair should be considered a public health priority [23]. Determination of the incidence of hernias is feasible when appropriate questions are added to the DHS. Other parameters of surgical need that can be measured by appropriate questions are related to open wounds, as well as disability related to sustained trauma. We have begun to obtain more precise data on the surgical burden in specific areas and countries and propose in this thesis that this is a necessary precedent to any eventual approach to these health problems and to their solutions.

Using the SOSAS Sierra Leone database we performed a focused analysis on female health since this should be a major component of the health delivery systems in sub-Saharan Africa based on the central role women play in the society and the fact that some funds are available to address maternal mortality (MDGs) in SSA. It was encouraging to find that family planning used by reproductive-aged females in Sierra Leone, was estimated to be at 20%, which is substantially higher than the 8.2% previously reported by WHO for Sierra Leone [24]. It has been previously shown that age-delay of childbearing as well as spacing of deliveries decreases maternal mortality [25-28] and improves perinatal outcomes and child survival [29]. The current analysis, however, documented that only 1.4% of the recalled deliveries were done by cesarean section while fewer than 1% were instrumental delivery (vacuum/forceps); these data were far below the predicted need for that population [30]. Financial constraints were mentioned by half of the families as the main reason for not being able to access modern obstetrical care. The conclusion therefore is that, despite the free health care initiative for pregnant females in
Sierra Leone, adequate access to modern obstetrical care does not meet the reproductive needs of the women of Sierra Leone [31].

The conclusions in this thesis are drawn from the original SOSAS data; we realize however, that the major limitation of SOSAS is that the findings rely solely on a verbal interview of self-reported conditions and are not confirmed by objective observations or any chart reviews. The respondents’ perception of a surgical condition might not be correct. For example, a mass caused by Burkitt’s lymphoma, which is endemic in certain SSA countries like Congo, with a prevalence of 7/100,000, would need rather chemotherapy than a surgical procedure [32]. Despite this reservation, our enumerators when debriefed found that generally the majority of interviewees were quite knowledgeable most of the time on what constitutes a surgical condition. This is consistent with what I found with qualitative research performed in Sierra Leone via focus group discussions [manuscript in preparation]. Despite this possible limitation of the survey tool, SOSAS, we feel that for the most part the recorded findings accurately reflected the actual need for surgical evaluation and for the most appropriate intervention.

It has been questioned by some whether the conduct of a survey that we describe is financially worth performing in an environment where health care budgets are so very limited and every penny should be dedicated to actual surgical care for the patients. It is well known that Health Care Surveys can be very expensive. Their budgets generally include costs of training, personnel, transportation, and communication which are all important considerations and are country-specific. We performed and highly recommend pilot-testing of SOSAS in the designated country to gain insight in how to use the questionnaire and also to develop appropriate community and national contacts, plan day to day execution along with the most effective logistics and staff selection to execute a full country survey [33]. Cognitive interviewing as well as pilot testing are essential steps for survey development [34-35]. We relied and modeled our study on the lessons firmly expressed by Sudman and Bradburn that ‘If you don’t have the resources to pilot-test your questionnaire, don’t do the study’ [36]. Ideally, our pilot-testing could have been accompanied by the performance of a physical examination which could serve as a validation method. However, in view of substantial ethical and logistical issues, as well as financial implications, such a combined survey could not be undertaken for this thesis. Development of a validation method for SOSAS is the logical next step in this research field. Such a study will help to further determine which questions and/or tests could be most effectively and reliably used to incorporate surgically treatable conditions in the national DHS.

The actual cost of executing our study was less than US$35 000 per country, with the primary investigators not being reimbursed for the investment of their time in the development, execution, and interpretation of the studies. The use of handheld tablets reduced our overall costs substantially in terms of printouts and personnel needed for data entry: the tablets could be sold after completion of the study. The execution of SOSAS in Rwanda demonstrated that the survey could be accurately reproduced by a different principal investigator (PI) with a different research team working in a different cultural and national environment in a country with a different level of development. The full country survey in Sierra Leone, as well as in Rwanda, confirmed that interviewers had little trouble familiarizing them-selves with the technology and found the iPads easy to use in the field, once they were properly instructed and trained by the research team and the PI. Direct data entry limited errors in recording data by avoiding transcriptions, and allowed for early, almost instantaneous, analysis which further added to the benefits of using this type of technology for the survey. Quick feedback was possible by the field supervisors, who reviewed the surveys on both a daily basis and before leaving the cluster (area). It was therefore, possible to promptly identify any missing data and collect the appropriate information in a second visit to the household before proceeding to the next cluster. Through our ability to conduct such immediate corrections, we were able through the SOSAS survey to create a very robust and comprehensive database with fewer than 4% missing data-entry points. One of the most important contributions of this thesis has been the creation and characterization of the survey tool, SOSAS, which we have shown to be highly reliable and effective when used and supervised appropriately.

As we look towards the future and the most effective and practical methods of delivering surgical health care in
underserved countries, it has become clear to us on the basis of this thesis that each country must define its own burden of surgical disease profile. SOSAS, or surgical disease related questionnaire as we have used for Sierra Leone and for Rwanda should be incorporated in the investigation of the disease profile. We have also shown that these methods, appropriately modified, as necessary, can be applied to other countries as well. When results of similar studies from many countries in the SSA become available, it will be possible to correlate the results with development index or gross national income, and this may not only be highly informative, but may also permit development of corrective measures which will be variable from country to country. Identification of health care systems determinants (eg. governmental systems versus private systems) will also provide critical insights for the most effective and practical way of providing surgical care to majority of the population.

Surgical Capacity
Another important factor in redefining and restructuring a surgical health care system in an underserved country must include evaluation of the available surgical capacity of a country studied not only by total number but especially by regional and even individual hospital capacity. Realizing the importance of such an evaluation we explored the surgical capacity of Sierra Leone with PIPES (Personnel, Infrastructure, Procedures, Equipment, and Supplies) a new tool, developed by modifying the WHO (World Health Organization) tool. Given the limitations of the WHO tool, including difficulty in data analysis, duration of the survey, poor reliability of process methods sections, and limited access to data collected by WHO [37] a modification was indicated. The final survey tool had 105 total data items, as compared to 256 in the original WHO tool which makes it more malleable and practical to use. The 105 data items were divided into five sections: Personnel, Infrastructure, Procedures, Equipment, and Supplies (PIPES). Reassessment with this new tool revealed an apparent increase in surgical capacity in Sierra Leone [38]. The use of the PIPES tool in Sierra Leone confirmed that it could be easily administered, and that the data thus obtained could be analyzed in a more simplified fashion. We also showed that we could readily calculate a useful outcome index as was previously done with the WHO tool by Kwon et al [39], in a rather complex manner secondary to the more elaborate WHO-survey. Using the PIPES tool, projections can be made by matching of the surgical needs (SOSAS) with the PIPES index of surgical capacity for a country or a region, in order to develop data-driven plans for restructuring of a surgical care delivery system for that specific region or country.

In the same fashion that we looked at the surgical capacity for adults, we also investigated the pediatric surgical capacity in Sierra Leone and as expected, found deficiencies in aspects of Personnel, Procedures performed and Equipment and Supplies [40]. It became clear that any analysis of surgical needs and/or capacity requires a specific Pediatric PIPES survey for a more detailed evaluation which will differ from that found for the adult patient. Specific capacity assessment for the pediatric population are critical, since earlier estimates indicated that 85% of children in LIMCs need some form of surgical care before their 15th birthday [41]. The SOSAS sub-analysis of pediatric needs in Sierra Leone indicated that, 17.6% of pediatric population (under 18 years of age) had a possible surgical condition in need of a consultation at the time of interview [17]. A cross-sectional survey in 29 hospitals in south-western Uganda estimated an annual rate of surgery for children <15 years of age to be 180 operations per 100,000 population [42]. In Rwanda, a representative survey of district and regional hospitals across the country found that pediatric surgical cases constituted only 1% of the 45,759 cases performed each year [43]. Information on overall personnel involved in pediatric care has been provided by Chirdan et al. in a survey of eight African countries representing 402 million people. In these countries, there were a total of 231 pediatric surgeons—only a fraction of the estimated 1,006 needed for their populations [44]. Compared to Europe and North America, which have two to three pediatric surgeons per million people, Nigeria, the most populous country in Africa, has 0.43 pediatric surgeon per million and Malawi only 0.06 per million. Some countries, such as Sierra Leone, do not have a single pediatric surgeon. Such deficits appear at first look to be insurmountable. However, no effective health care planning can be activated without first defining in detail the deficits in surgical capacity, in a similar manner to the definition of surgical needs which we have emphasized in this thesis previously.

Despite the lack of even one pediatric surgeon in the whole country, pediatric surgery is performed effectively in Sierra Leone by skilled general surgeons [45]. It is unknown whether more pediatric lives could be saved if a fully
trained pediatric surgeon was available or whether more surgeons and more training in pediatric surgery for the general surgeons is sufficient.

In this study we were able to evaluate the pediatric procedures (under 5 year of age) actually performed only in Connaught Hospital, the only tertiary hospital in Sierra Leone (Chapter 9). The PIPES analysis, on the other hand, only indicated the possible surgeries that might be performed in all hospitals in Sierra Leone [40] (Chapter 8). Most cases that we analyzed were related to congenital abnormalities (including inguinal hernias). The study concluded that the number of operations on children under 5 years of age increased by 500%, from 42 to 210, after the introduction of the free health care program. Interestingly, males outnumbered females at 20:1 before the establishment of the free health care program, but this unbalanced ratio decreased to 6.5:1 after the start of the program, indicating that free healthcare also promoted gender equity. Our data from SOSAS however, indicated a similar distribution of gender in children who reported having undergone a surgical procedure [17] (Chapter 4). These two findings, the observation in which male children were more likely to present for surgical care in the analysis of pediatric case load of Connaught hospital versus an almost equal sex distribution in children who underwent a procedure seem to contradict each other. More detailed analysis of the ages of children who underwent surgery according to the SOSAS database is currently being processed, and might provide an answer to the gender equity question. Another explanation might be found in the relatively high number of urology cases (predominantly male) given the presence of an urologist at Connaught Hospital, resulting in clinicians referring these types of cases which are more likely to be boys.

The exploration of the increase of surgical care for children under 5 after the exemption of the health care fees in Chapter 9, indicates that surgical care is not affordable for many people in Sierra Leone. Therefore introduction of a flexible payment schemes or seasonal reduction of payment, as well as cross-subsidizing from the wealthy patients to the poor (the Robin Hood approach) might be a partial solution to access to surgical care for children. Currently Connaught hospital has a private ward which is part of cross-subsidizing program for those who are not able to pay their bills and this approach awaits evaluation.

Recommendations
The surgical capacity assessment of Sierra Leone which we describe was a first step following identifying surgical needs. However the study did not include an assessment of the adequacy of the current surgical care and of surgical capacity. Since adequate surgical care includes safe performance of anesthesia and availability of well-trained surgical staff who can perform surgical procedures not only with adequate knowledge and skills, but also in adequate sterile conditions with protective equipment for the medical operating staff, we have included some summary comments on quality of surgical care. We explore the use of protective equipment for the staff which was initially sorely lacking when we began our studies in Sierra Leone and were recently corrected; this is explored in Chapter 10. Many other aspects of quality of care are not addressed in this thesis, but need to be more thoroughly explored and corrected in the future. Morbidity and mortality meetings as well as monitoring of the numbers of surgical procedures and complication rates in a national registry could help maintain quality of care and identify gaps of knowledge or skills both locally and regionally. Similar thorough root cause-analysis of morbidities and mortalities, along with more thorough descriptions of surgical capacities and deficiencies in equipment and supplies, we are convinced, will in the future lead to overall improvement in the surgical health care in LIMC's.

Since deficiencies are noted in many areas of surgical capacity, our recommendations are for the time being general in nature, rather than specific. Task-shifting of some surgical procedures to general medical doctors, or even assistants, should be further explored, to improve human resources for surgical interventions and especially to improve access to surgical care in rural areas and in regions with very poor road conditions [46-51]. Since training of new surgeons, as well as of surgical assistants and of surgical health care workers, is critical to implementing improvement of surgical care in Sierra Leone, there is an absolute need for the development of a surgical residency program in Sierra Leone where none exists at present. This must become a priority in order to address the surgical need of the population. Furthermore collaboration of the Ministry of Health and Sanitation together with NGOs or academia from high-income countries could lead to training-collaborations and
specialized surgical-camps to reduce the backlog of, for example, pediatric surgical cases, or hernia repairs. The success of all such interventions, idealistic though they seem, will rely on effective logistics for supplies and equipment, funding for instruments, sutures, drains etc, and on well controlled and efficient patient flow, as well as maintenance of equipment, and salaries for the needed staff. Evaluation of various programs for their surgical capacity should ideally be accompanied by research on the quality of care as well as evaluation of existing training, guidelines, supervision, and career opportunities and salaries for those who could be additionally trained to assist surgeons or substitute for them in minor cases, and thus enlarge the qualified personnel pool.

Surgical capacity (availability of services), adequacy (safety and quality of care) as well as affordability as are keystones in providing health care in general and surgical care specifically. However accessibility for those in the rural areas in a country such as Sierra Leone with limited road network, poses yet another hurdle in the provision of care, necessitating a referral system, which includes better communication, as well as upgrades of the ambulance system, which currently is hardly available for those outside of Freetown.

Lastly, the acceptability of surgical care by the community and its leaders is critical for the individual patient’s timely presentation to the hospital and thereby having a better likelihood of a good surgical outcome. Cultural beliefs and practices probably affect the decision to seek surgical care and accepting the risks of a surgical procedure as advised by medical personnel [52-54]. Other medical interventions, such as vaccinations and treatment for epilepsy and tuberculosis, also have specific cultural and behavioral aspects related to health-care seeking behavior [54-56]. Favorable outcomes can positively affect societal perceptions of care and can likewise affect timely presentation for an intervention. It is very clear and must be thoroughly understood by all health care providers and planners that an increase in surgical capacity and services depends on much more than on the availability of personnel, facilities, equipment, and even government support. It depends on all that but in addition it must also include the public values and norms in addressing illnesses which can be positively affected by educational programs and in assurance of the quality of the delivered surgical services.
General discussion

References


