THE SCOPE OF ELECTIVE SURGICAL PROCEDURES AND ITS IMPLICATIONS ON POSTGRADUATE TRAINING AT MNH, DAR ES SALAAM, TANZANIA

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By

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A Dissertation Submitted in (Partial) Fulfillment of the Requirements for the Degree of Master of Medicine (General Surgery) of Muhimbili University of Health and Allied Sciences

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CERTIFICATION

The undersigned certify that he has read and hereby recommend for acceptance by Muhimbili University of Health and Allied Sciences a dissertation entitled: "***The scope of elective surgical procedures and its implications on postgraduate training at MNH, DSM, Tanzania",*** in fulfillment of the requirements for the degree of Master of Medicine (General Surgery) of Muhimbili University of Health and Allied Sciences.

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Dr. M. Mchembe

Supervisor

_____

Date

DECLARATION

AND

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I, **Byomuganyizi Moses**, declare that, this **dissertation** is my original work and that it has not been presented and will not be presented to any other University for similar or any other degree award.

Signature……..... Date…….

ACKNOWLEDGEMENTS

My supervisor and head of the department of surgery at MUHAS, Dr. M. Mchembe; for the tireless constructive inputs and continuous encouragement from proposal development to finalizing the dissertation report. Dr. L. Akoko, lecturer in the department of surgery, for a very significant assistance, throughout the various stages towards completion of this dissertation. To members of the department of surgery MUHAS, for taking their time at different occasions to provide important ideas and corrections as necessary towards completion of this work. To all doctors, department of surgery MNH, for listening to the proposal draft and providing appropriate inputs, and for the daily encouraging comments throughout the study period.

To the block managers, MNH and cardiac theatres and all the ward and theatre nursing staff for their assistance and cooperation during the period of data collection.

Finally many thanks to my fellow residents, whose presence and cooperation have made this task seem easier, despite the difficulties encountered.

DEDICATION

To my lovely wife Amelia and my beloved children Moses, Bernadetha and Leocadia; their unconditional love and continuous support keep me moving day by day.

To all my teachers; it is by their guidance that I have reached this stage.

ABSTRACT

Background: Little is documented on the availability of surgical care both globally and locally. Majority of the countries have no data on surgical volume. Recent years have experienced the epidemiological transition, the multiplicity of surgical disorders among the increasingly noted. The increasing role of surgery therefore has been of paramount importance. Limited access to surgery can undoubtedly lead to significant morbidity and mortality. Training in surgery among other things relies on exposure and hands-on learning by students, on a variety of procedures. The importance of adequate volume of surgeries to that end, cannot be questioned, in line with the level of students' involvement. Yearly volume of surgery both at surgeon and hospital level, has been found to be among parameters with significant influence on patient outcome as measured by length of hospital stay, mortality and complication rate.

Thus an understanding of the quantity and distribution of surgical interventions is essential to guide efforts to improve its safety, address shortages of such services and improve on various aspects of training in surgery. Scope of surgical services is part of the components of quality assurance in general surgery and an important one especially in developing countries where resources are limited.

Objectives: The aim of this study was to determine the scope of elective surgical procedures and its implications on postgraduate training at MNH, DSM.

Methodology: This hospital based descriptive study looked into the volume of elective surgical procedures and the level of postgraduate involvement at MNH, DSM; from April to December 2013. It cut through general surgery, urology, cardiothoracic surgery, paediatric surgery, as well as plastic and reconstructive surgery. The data were analyzed using SPSS software.

Results: A total 2315 procedures were performed on the 2214 studied patients during the 9 months study period at MNH from April to December 2013. Majority of the patients were males, 1414 (63.9%) patients with M: F ratio of 1.76:1. The age ranged from 2 days to 112 years with a mean of 39.5± 26.1 years. The most common age group was over 50 years at

37.1% and the paediatric age group was at 22%. The overall average number of procedures per month was 257.2, and the overall average number of procedures per day was 12.9. The top ten performed procedures in order of occurrence were 290 (13.1%) urethrocystoscopies ± biopsy ± EUA, followed by 161 (7.3%) skin graftings, 108 (4.9%) TURPs, 111 (4.8%) WLEs, 104 (4.5%) mastectomies, 87 (3.9%) BSOs/ orchidectomies, 76 (3.4%) DVUs, 70 (3.2%) open prostatectomies, 68 (2.9%) rigid oesophagoscopies plus exploratory laparotomies respectively, and finally 56 (2.6%) thyroidectomies. Of the 2315 performed surgeries, residents participated in 72.1% of the procedures. The predominant residents' role was that of first assistant in 1214 (54.8%) procedures, followed by role as surgeon in 561 (25.8%) procedures, and finally the second assistant role in 355 (16%) procedures.

Conclusion: The surgical output found at MNH and the overall residents' participation during this study period were at relatively low levels.

Recommendations: It appears important to conduct larger studies and surveys looking into factors associated with the observed surgical output and residents' participation with the aim of optimizing theatre utilization and increasing surgical output at MNH and increasing residents' involvement in all aspects of surgery especially for the role as a surgeon, an important aspect in general surgery training.

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ACRONYMS AND ABBREVIATIONS

AEA	Above elbow amputation
AKA	Above knee amputation
APR + C	Abdominal perineal resection plus permanent colostomy
AVF	Arteriovenous fistula
BEA	Below elbow amputation
BKA	Below knee amputation
BSO	Bilateral subcapsular orchidectomy
CBD	Common bile duct
DSM	Dar-es-Salaam
DVU	Direct vision urethrotomy
ENT	Ear, nose, throat
EUA	Examination under anaesthesia
ICU	Intensive care unit
IMTU	International Medical and Technological University
M: F	Male to female ratio
MNH	Muhimbili National Hospital
MOI	Muhimbili Orthopaedic Institute
MUHAS	Muhimbili University of Health and Allied Sciences
M. Med	Master of Medicine

PDA Patent ductus arteriosus

PSARP/ ASARP Posterior/ anterior saggital anorectalplasty

SG Skin grafting

SPC Suprapubic cystostomy

TURP Transurethral resection of the prostate

WLE Wide local excision

INTRODUCTION

The importance of surgical services in the health care system, be it clinical medicine or public health, is well noted. Surgery occurs in every setting from the most resource rich to the most resource limited countries. The need has increased greatly with the shifting patterns of disease. However, little is documented on the availability of surgical care globally, since only anecdotal evidence exists. Most countries, and for that matter respective hospitals do not have data on surgical volume, (1).

Surgical services at the third referral level are an essential component of the health care delivery system. Conditions treated with surgery account for an estimated 11% of the world's disability-adjusted life years, (1, 2, 3). In other words, 11% of the global burden of disease can be treated with surgery, (2, 4, 5). Inadequate access to surgical services, can lead to significant morbidity and mortality from a broad range of manageable surgical conditions which can be prevented by early intervention. Improving the access to surgical services, which goes hand in hand with the surgical volume / output at respective facilities in developing countries included; can be an important component towards reducing the global burden of disease, (3).

Public-health as well as other health related initiatives worldwide have traditionally been based on surveillance and control of infectious disease, education, health promotion and disease prevention. Within recent years a clear epidemiological transition has been noted, with disorders afflicting populations shifting from diseases of pestilence and infection, to those that are identified in industrialised and rising economies, among them cancers and trauma related injuries, (1, 6).

With this epidemiological transition, the increasing role of surgery in public health is inevitable. Public health and clinical medicine go hand in hand. Surgery carries its own risks and complexities. In view of these an understanding of the quantity and distribution of surgical interventions is therefore essential to guide efforts to improve its safety and address shortages of such services, (1). In addition to these, sustainabilty towards provision of adequate surgical services is of paramount importance. Manpower development is a key element, and surgical postgraduate training is one of the various involved aspects.

Three quarters of operations worldwide are done in developed countries, despite being residence for less than a third of the world's people. On the other hand, developing countries, harbouring a third of the world's population receive just 3.5% of the operations that are undertaken worldwide, (1).

The volume of surgery is tremendous worldwide, in both rich and poor settings. Implications from the above are substantial, and shows a great need for efforts to improve the monitoring and availability of surgical services among other things, considering their high risk and expense. Treating surgical diseases in developing countries has recently been shown to be cost-effective compared with immunizations, (1, 4).

Having reasonable surgical volume at respective hospitals entails investing considerable resources towards maintaining operating suites as well as an adequate number of surgeons, theatre staff and a sustainable system to ensure their continued supply, (7). Yearly hospital volume of surgery and yearly surgeon volume have been found to be among parameters with significant influence on patient outcome as measured by length of hospital stay, mortality and complication rate, (8). In most developing countries, published data on surgical output, even institution based ones are lacking. Whenever present, such data are usually inconsistent and inadequate most of the time. Many studies report on one or a few surgical procedures, such as hernia repair, mastectomy and others, (9). Developing countries have limited resources, which however can be used effectively for optimum surgical outputs. Little research has been done on various surgery related areas including output of major and minor operations and availability and use of surgery-related resources such as manpower, equipment and supplies, (6, 9).

Various methods exist for expressing surgical output / volume, such as: number of operations per respective hospital bed capacity (in some cases per departmental bed capacity), number of operations per number of surgeons, number of specific operations as performed at a given hospital within a year, number of specific operations as performed by individual surgeon per year, number of operations per 100, 000 population, to list but a few. These parameters allow self assessment and comparisons among different institutions.

LITERATURE REVIEW

Little is documented on the amount and availability of surgical care both globally and locally, (1). Included is little knowledge of the number of surgical procedures performed at many hospitals especially in developing countries, (7). Little evidence exists to answer basic questions about the prevalence and incidence of surgical conditions and the provision of surgical interventions in sub-Saharan Africa. The lack of information about surgery in sub-Saharan Africa was noted since more than 20 years ago, (4).

During the survey on the estimation of global volume of surgery in 2004, more than two thirds of the countries could not offer data on surgical volume; only 20% of the surveyed countries could provide data on the major surgical procedures and 5% provided only surgical rates without specifications. This indicates inadequacies in healthcare surveillance. The global volume of major surgery in 2004 was estimated to be between 187.2 million and 281.2 million cases per year. To translate this result, it implies about one operation for every 25 human beings, which has substantial implications for public-health planning, but as already stated public health and clinical medicine are two entities that go hand in hand. The yearly volume of childbirth, an estimated 136 million births which occurred in 2006, is exceeded by double. Mean rate of surgery was highest in countries with more expenditure per head on health care. Developing countries had an estimated mean rate of major surgery of 295 procedures per 100, 000 population per year, whereas developed countries had a mean rate of 11, 110 procedures per 100, 000 population per year. In addition to this, developing countries accounting for 34.8% of the global population undertook only 3.5% (8.1 million) of all surgical procedures in 2004. In this survey, for countries without published surgical rates, multiple imputation to generate estimated surgical rates with use of predictive model were used, (1).

The figure for the global volume of surgery is more than twice the number of yearly births and seven times the 33·2 million people infected with HIV. The estimate was based solely on major procedures, minor procedures or non-operative surgical care (for example management of most blunt injuries) being excluded. The implication is that the actual surgical workload may be much higher, (5).

A meta analysis done by Chowdhury and colleagues to look at the relationship between hospital yearly surgical volume and surgeon yearly volume found better patient outcome at institutions with large volumes for both parameters. With some analysis, some cutoffs were developed, which were individualized per procedure, (8).

High-volume hospitals had significantly better overall outcome in 74 % of the studies. This was consistent for all outcome measures as demonstrated by lower mortality rate in 76 %, shorter hospital stay in 79 % and fewer complications in 62 % of the studies. For each of these procedures, the annual volumes recommended to achieve significantly better outcomes were: 20 lung cancer operations, 40 colorectal cancer operations, 50 pancreaticoduodenectomies, 30 abdominal aortic aneurysms, 200 coronary artery bypass-grafts, 100 paediatric cardiac surgical procedures and 200–250 trauma procedures, (8).

In addition to this, high surgeon volume had significantly better overall outcomes in 74 % of the relevant studies. This effect was measured by lower mortality rate in 71%, shorter hospital stay in 78% and fewer complications in 81% of the studies. For each of these, the annual volumes recommended to achieve significantly better outcomes were 13 colectomies, 50 lobectomies, six gastrectomies, 21 operations for colorectal cancer, 11 angioplasties and 75 paediatric cardiac surgical procedures, (8).

Most centers (consultant / tertiary referral level) are also teaching hospitals for universities. Postgraduate students (residents) take part in the day to day activities.
Experience in the operating room is an essential component of the education and training for general surgery postgraduate students. It is also largely in the operating room that residents develop the surgical judgment that they require to ultimately practice competently and independently. There are many levels of involvement that a resident may have in the operating room namely: surgeon under supervision, first asssistant or second assistant. In a study done in Canada, the mean total major operations, reported by graduating surgical residents in the role of surgeon under supervision ranged from 231 to 252 cases. The reported first assistant median operative case volume ranged from 49 to 231 cases, (10). In some centres competition for cases was noted , affecting procedural competency acquisition during residency, (11). It has been noted that some procedures are

encountered rarely, some are not encountered enough, (12). Increased case volume has been correlated with competence for some procedures, (13).

A study conducted from March 2009 to February 2010 at Bugando Medical Centre, a consultant, tertiary and teaching hospital for the Catholic University of Health and Allied Sciences, with bed capacity of 1,000, in Tanzanian, revealed that 756 general surgery patients were booked for operation during that one year period, and among them only 68.5% were operated; the rest being cancelled. For urological patients, 423 patients were booked for operation, out of whom 82.4% were operated, the rest being cancelled. Ninety eight patients were booked for cardiothoracic surgery and eventually 93 patients were operated, (14).

In Meru district, Kenya, a study was done in 2002 to look at annual surgical output of five hospitals in it. The results were 0 to 12 thyroidectomies; 0 to 4 mastectomies; 0 to 31 operations of the stomach and gastrointestinal tract; 0 to 13 prostatectomies; 0 to 12 amputations of arm/leg; 0 to 2 hemorrhoidectomies; 0 to 1 splenectomy; 1 to 13 hydrocoelectomies plus 0 to 4 cleft lip/palate repairs for each of the respective hospitals. The mentioned include only elective surgical procedures, (15).

A one year study from April 1996 to March 1997 in the Department of General Surgery, Jawaharlal Institute of Postgraduate Medical Education and Research, Pondicherry in India with 125 beds for general surgery patients and 2 general surgery theatres, found out the following: A total of 1773 major cases were operated upon during 279 days of work. Mean number of operations per day were between 6.1 to 6.5, (16).

At Ayub teaching hospital with 3 theatres, in Pakistan; a study looking at the total number of general surgical operations performed in a one year period from July 2006 to June 2007 found out that 3756 patients were scheduled for surgery out of which 2820 (75%) patients were operated. The operation theatre was functional for 285 days during the study period resulting in an average of 9.8 cases per day, (17).

A study done at El Obeid hospital in Westen Sudan for the year 2007 revealed that there were 1633 elective major general surgical operations performed out of 1812 patients scheduled for surgery, (18).

A study to look on the scope of surgical procedures done in the first level referral facilities within 8 districts in Tanzania, Mozambique, and Uganda found out that the scope was narrow. The performed procedures included mainly essential and life-saving emergency procedures. These findings clearly indicate low levels of surgical care provision at the district level for the hospitals studied, (19). Similar situation was revealed by a study looking at 48 first level referral facilities in Tanzania, where the capacity to provide emergency and surgical services was low, (3). From these observations the need for optimal surgical output at tertiary level referral hospitals is obvious; not to mention the need for adequate supply of manpower.

PROBLEM STATEMENT

Little is documented on the totality of availability of surgical care globally and locally. The understanding of the quantity and distribution of surgical interventions is essential to guide efforts to improve its safety and address shortages of such services. Third world harbouring third of the world's population receive just 3.5% of the operations that are undertaken worldwide. Hence there is the need to know the local surgical volumes at different levels. (1)

MNH is a consultant, tertiary level referral hospital in Tanzania, serving the whole country. There are other tertiary referral hospitals, but MNH plays a pivotal role towards health services provision. MNH is also a teaching hospital for MUHAS and IMTU. Master of science program in surgical gastroenterology and M. Med in urology have currently been introduced. Postgraduate and undergraduate training in surgery have been present from the beginning. The current number of postgraduate trainees in general surgery and urology has almost trebled from the previous average of 1-3 postgraduate students per year to around 6-12 per year. Training in surgery at all level**s** entails among other aspects exposure and hands-on on a variety of operations. Knowing the scope of surgical services at MNH, will reflect on the above aspects. Most importantly will give a hint on possible factors as well as possible solutions if at all some deficiencies arise; and will be a good starting point for future research to address matters pertaining to elective surgical procedures, whether independently or in line with training.

Further more, the documentation on surgical volume at MNH theatre, just sums up all operations and gives numbers of average operations per unit, except for cardiac surgery unit where all the procedures and respective percentages are documented. The theatre documentation books for performed operations are available, but they need formal analysis to provide a clear picture with regard to surgical output.

RATIONALE

It has been proven that large surgical hospital volumes and large surgeon volumes are important determinants of patients outcome in terms of length of hospital stay, mortality and complication rates. (8)

The scope of surgical services is part of the components of quality assurance in general surgery and an important one especially in developing countries where resources are limited.

This study will provide an insight into some of the aspects of the scope of surgical services at MNH, serving a dual purpose reflecting on the exposure postgraduate trainees in surgery get as part of their training at MUHAS.

The information obtained will provide bases for future research consideration: why output for some procedures is low and the need for external rotation during postgraduate surgery training. The information will assist the department, hospital, university and individual surgeons to plan for further training and resource allocation.

OBJECTIVES

Main Objective

To determine the scope of elective surgical procedures and its implications on postgraduate training at MNH, DSM.

Specific Objectives

To determine the numbers and types of performed elective surgical procedures at MNH, DSM.

To determine the numbers and types of elective surgical procedures in which residents are involved and the level of such involvement at MNH, DSM.

METHODOLOGY

Study design

This study was a hospital-based descriptive prospective study.

Study area

The study was conducted at MNH – surgical department from April, 2013 to December, 2013. MNH is a consultant, tertiary level referral hospital located in Dar-es-Salaam, Tanzania's commercial city. It receives patients from the whole of Tanzania. It is also a teaching hospital for MUHAS, whereby surgical M. Med and surgical gastroenterology Master of Science (super-specialty) students participate fully in the day to day activities. It has a total bed capacity of 1500 and among them 262 beds are specifically for the surgical department. However there are other 64 beds shared between the plastic surgery unit and the dental department. For the sake of this study it will be assumed that the plastic surgery unit utilizes 32 beds making a total of approximately 294 beds for the whole surgical department. It has a wide range of specialist and super specialist services. The surgical department provides the following services: general surgery, thoracic surgery, urology, paediatric surgery, cardiac surgery and plastic surgery. There are a total of approximately 32 specialists serving at different levels within the mentioned units.

The hospital has four operating theatres; the main operating theatre, cardiac surgery theatre, emergency theatre and obstetric theatre. The main operating theatre has 7 suites used interchangeably among different departments namely general surgery, urology, gynaecology, ENT and ophthalmology; periodically being used for arthroscopic surgeries or any other type of surgery as the need arises. General surgery uses three suites on permanent bases; periodically may use any other of the suites as the need arises. It provides services from Monday to Friday, Saturdays and Sundays being used for private services and special situations. Each surgical unit has specific operating days per week. There are two ICUs with an average bed capacity of 14.

Patients are usually seen at outpatient clinics and if they have indication for surgery are either booked right-away after appropriate workup to come for listing for surgery or are admitted to await surgery. There are usually major ward rounds in each unit, led by senior surgeons during which names for patients to be operated are picked. Each unit has a special

day for listing patients to be operated, listing being done in a team fashion in each respective unit. There are other patients who are operated on private basis and these are usually planned by individual surgeons. During the listing process, residents participate actively in collaboration with respective specialists in selecting important procedures relevant for surgical training, and seeing to it that appropriate preparations are made to the time of the listed procedure.

Study population

All patients who were listed for operation in the surgical department from April, 2013 to December, 2013 were included in the study.

Sample size estimation

The average number of patients operated at MNH, department of surgery; is 310 patients per month. So throughout the study period, an average of 2800 patients were expected to be studied.

Data collection and analysis

A data collection tool was used to collect data regarding patients' particulars and relevant information pertaining to the study as per the study's specific objectives. The data was obtained on daily basis from the daily operating theatre documentation books and the patients' files. The main data documented included patients' demographic data, the type of operation listed and if performed or not, the surgeon (with the level of that surgeon) and assistants (together with their levels). For procedures in which postgraduate (M. Med surgery) students took part, their level of participation was also documented. The data was entered into a computer and analysed accordingly using SPSS software.

Ethical consideration

Ethical clearance for this study was sought from MUHAS Ethical Review Committee and permission to conduct the study was sought from the Director of Surgical Services – MNH.

Inclusion criteria

All patients listed for elective surgery in the department of general surgery during the study period.

RESULTS

Procedures were performed on 2214 patients during the 9 months study period at MNH from April to December 2013. Majority of the patients were males, 1414 (63.9%) patients, with M: F ratio of 1.76:1. The age ranged from 2 days to 112 years with a mean of 39.5± 26.1 years. The most common age group was over 50 years at 37.1% followed by 31 to 50 years at 26.8%; paediatric age group at 22% and 11 to 30 years at 14.3%. Male were the majority in all the age groups except for those aged between 31 to 50 years where females were the majority. The differences observed in this table were statistically significant, p-<0.001. **[Table 1]**

Table1: Age and sex distribution of the patients on whom procedures were performed

	Sex		
Age (years)	**Female n (%)**	**Male n (%)**	**Total n (%)**
Less than 10	161 (33)	327 (67)	488 (22.0)
11 to 30	124 (39.1)	193 (60.9)	317 (14.3)
31 to 50	312 (53.1)	276 (46.9)	588 (26.8)
More than 50	203 (24.7)	618 (75.3)	821 (37.1)
Total	800 (36.1)	1414 (63.9)	2214 (100)

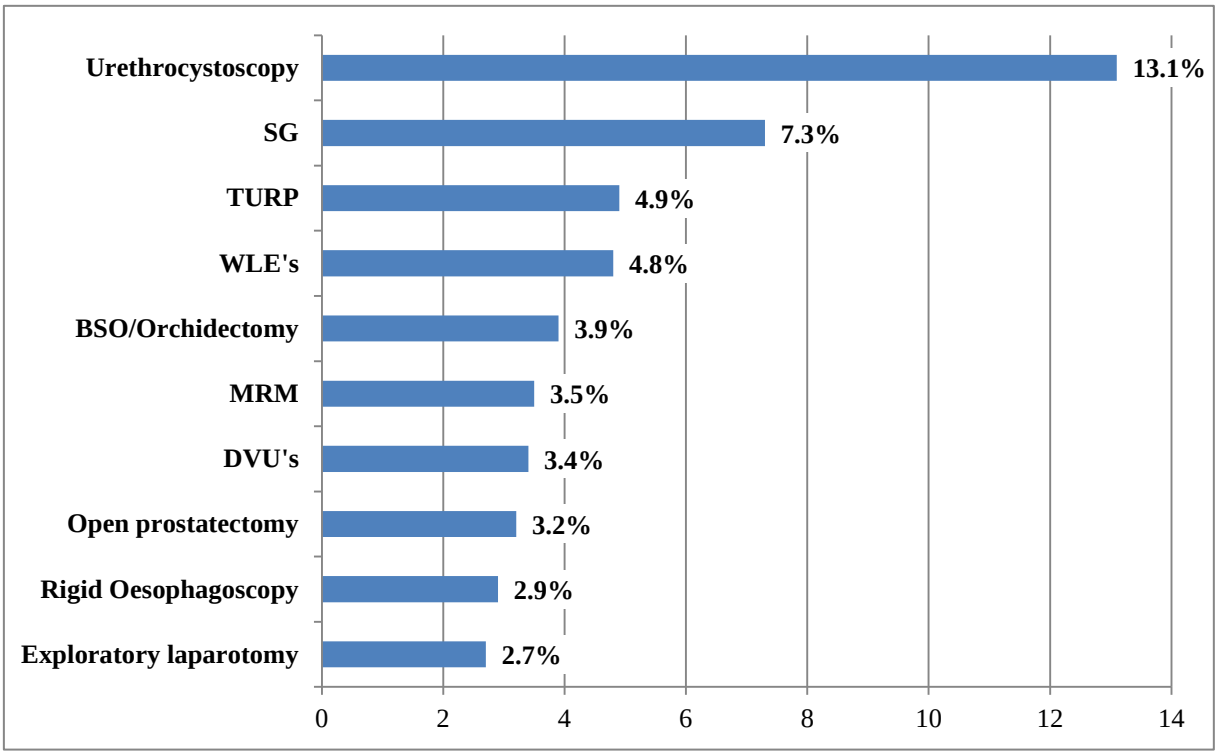
(Chi-square= 122.6, *p*-value<0.001)

Two thousand three hundred and fifteen (2315) procedures were performed on the 2214 studied patients. The overall average number of procedures per month was 257.2, and the overall average number of procedures per day was 12.9. (See appendix II for full list of performed operations).

The top ten performed procedures in order of occurrence were 290 (13.1%) urethrocystoscopies ± biopsy ± EUA, followed by 161 (7.3%) skin graftings, 111 (4.8%) WLEs, 108 (4.7%) TURPs, 104 (4.5%) mastectomies, 87 (3.9%) BSOs/ orchidectomies, 76 (3.4%) DVUs, 70 (3.2%) open prostatectomies, 68 (2.9%) rigid oesophagoscopies, 62

(2.8%) exploratory laparotomies and finally 56 (2.6%) thyroidectomies. **[Figure 1]** (See appendix II for full list of performed procedures).

Figure 1: **Overall top ten performed procedures**



One thousand four hundred and sixty eight procedures were performed on males, with M: F ratio of 1.7:1. Of the procedures performed on females, there were 111 (13.9%) urethrocystoscopies ± biopsy ± EUA, followed by 101 (9.3%) mastectomies, 62 (7.8%) skin graftings, 57 (6.7%) WLEs, 34 (4.2%) colostomies, 30 (3.8%) EUAs, 25 (3.1%) PSARP/ ASARP, 22 (2.8%) herniorrhaphies/ hernioplasties plus colostomy closures respectively and 23 (2.7%) rigid oesophagoscopies. (**Figure 2**) (See appendix II for full list of procedures performed on females).

The most performed operations in males were 179 (12.7%) urethrocystoscopies ± biopsy ± EUA, followed by 108 (7.6%) TURPs, 99 (7.0%) skin graftings, 87 (6.2%) BSOs/ Orchidectomies, 76 (5.4%) DVUs, 70 (5%) open prostatectomies , 54 (3.7%) WLEs, 53 (3.7%) inguinal herniotomies, 45 (3.1%) rigid oesophagoscopies and 44 (3%) exploratory laparotomies. (**Figure 3**) (See appendix II for full list of procedures performed on males).

Figure 2: Top ten procedures on female patients

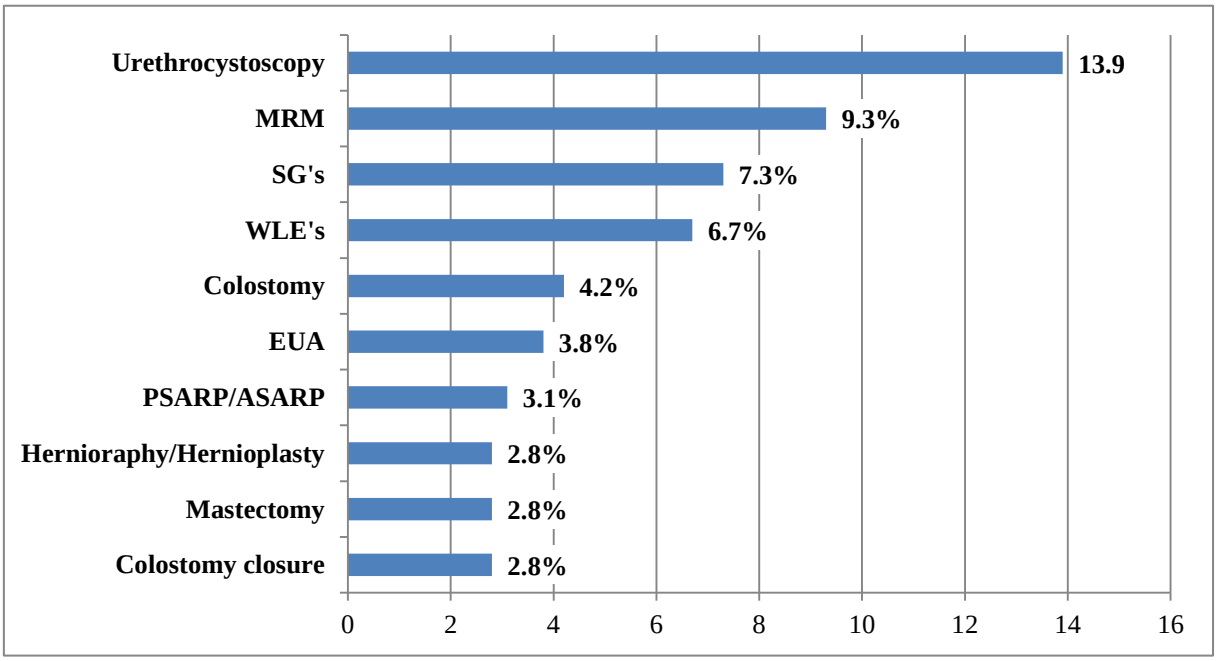
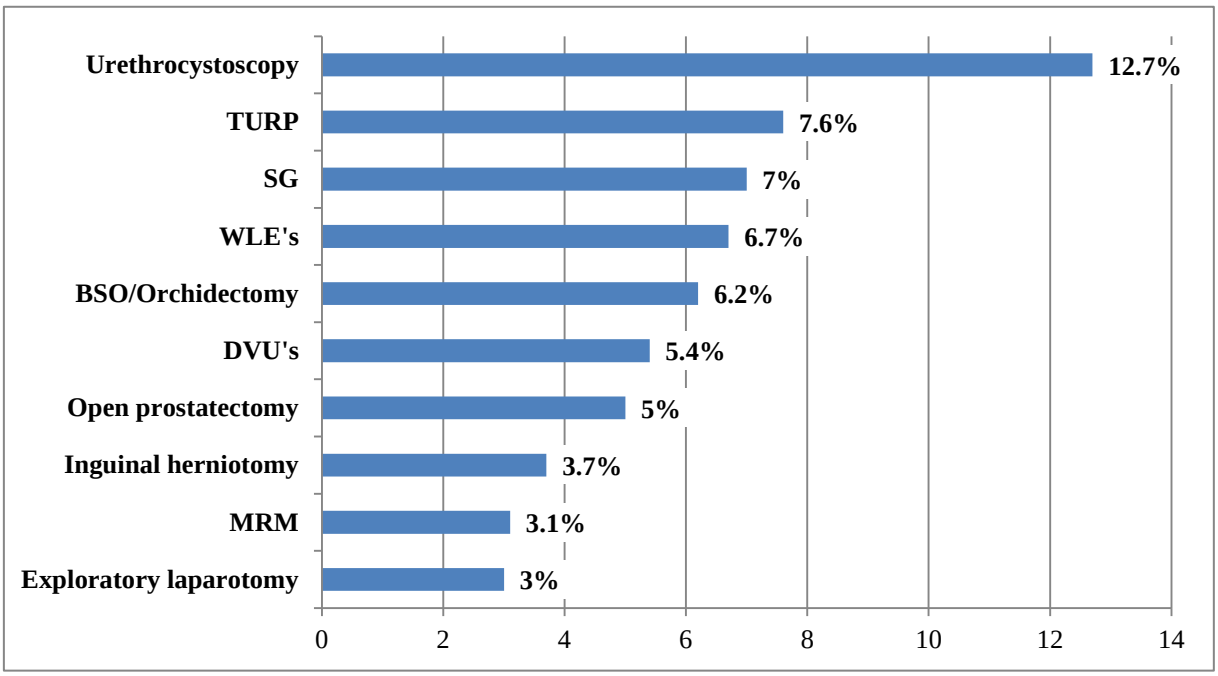


Figure 3: Top ten procedures on male patients



In the more than 50 years age group 135 (16.4%) urethrocystoscopies ± biopsy ± EUA were performed, followed by 104 (12.7%) TURPs, 83 (10.1%) BSOs/ orchidectomies, 69 (8.4%) open prostatectomies, 50 (6.1%) DVUs, 41 (4.7%) mastectomies, 34 (4.1%) rigid oesophagoscopies, 28 (3.4%) WLEs, 27 (3.3%) exploratory laparotomies, 22 (2.7%) EUAs and 20 (2.4%) gastrojejunostomies. (**Figure 4**) (See appendix III for list of all procedures by age groups)

In the 31 to 50 years age group, there were 107 (18.2%) urethrocystoscopies ± biopsy ± EUA, followed by 58 (9.6%) mastectomies, 44 (7.5%) skin graftings, 30 (5.1%) WLEs, 28 (4.8%) thyroidectomies, 23 (4%) herniorrhaphies/ hernioplasties, 21 (3.6%) exploratory laparotomies, 19 (3.2%) rigid oesophagoscopies, 18 (3.1%) EUAs, 17 (2.9%) highligation for varicocele veins and 15 (2.6%) DVUs. (**Figure 5**) (See appendix III for list of all procedures by age groups)

Figure 4: Top ten performed procedures in the more than 50 years age group

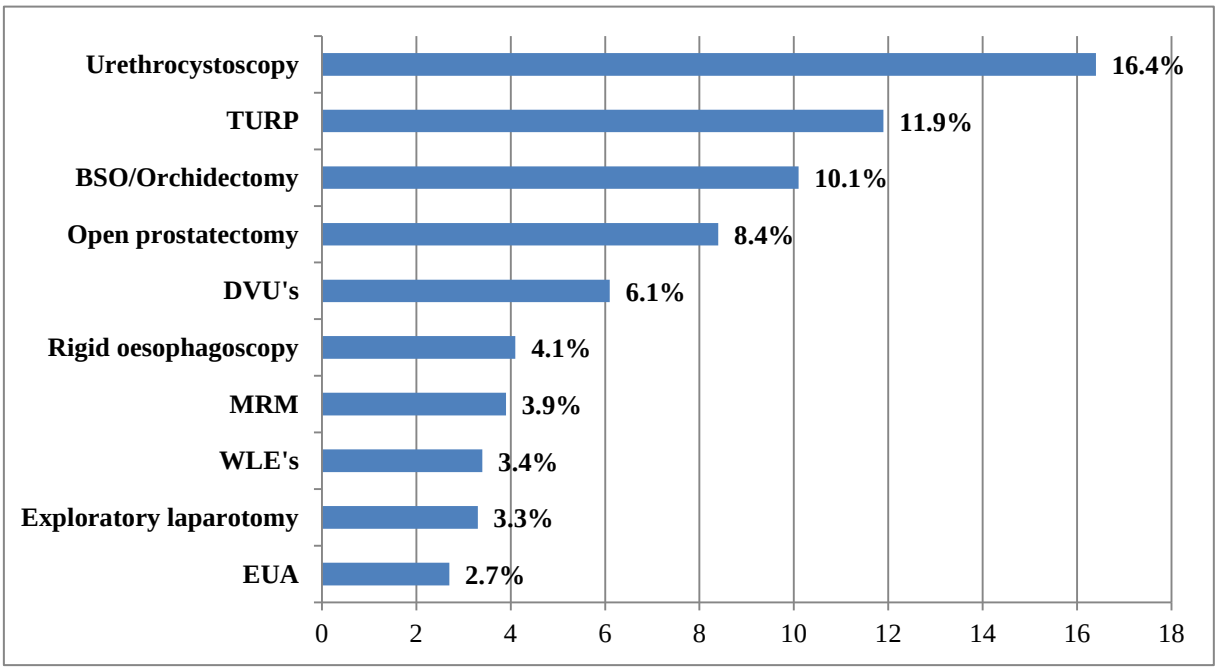
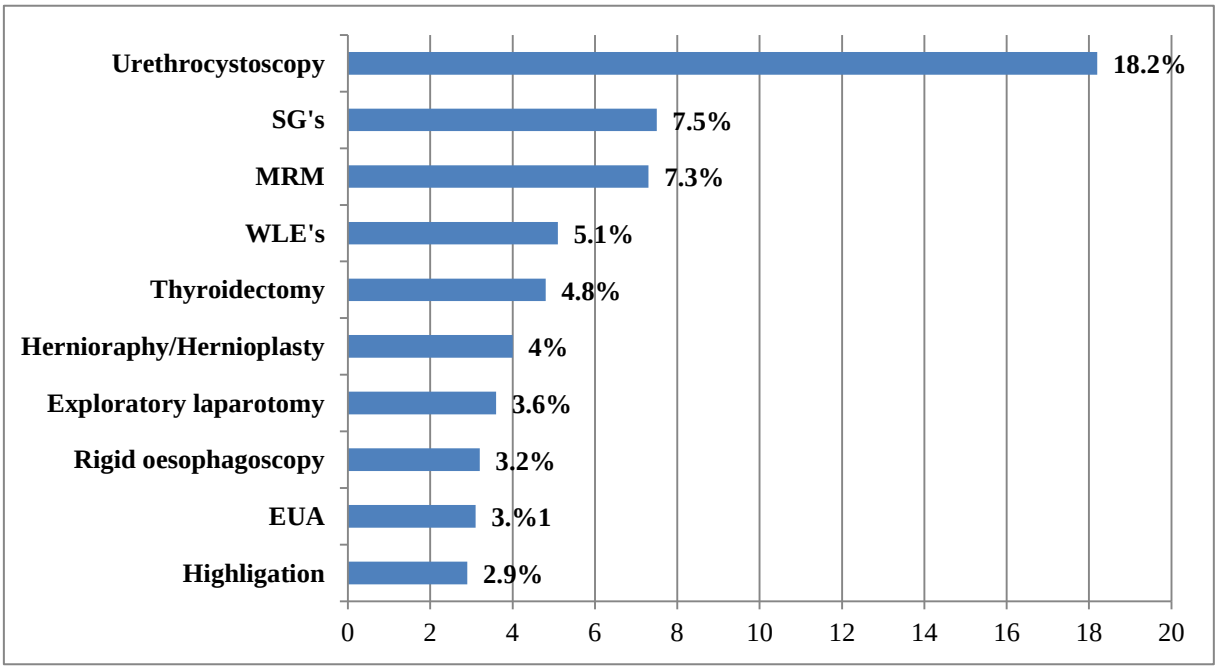
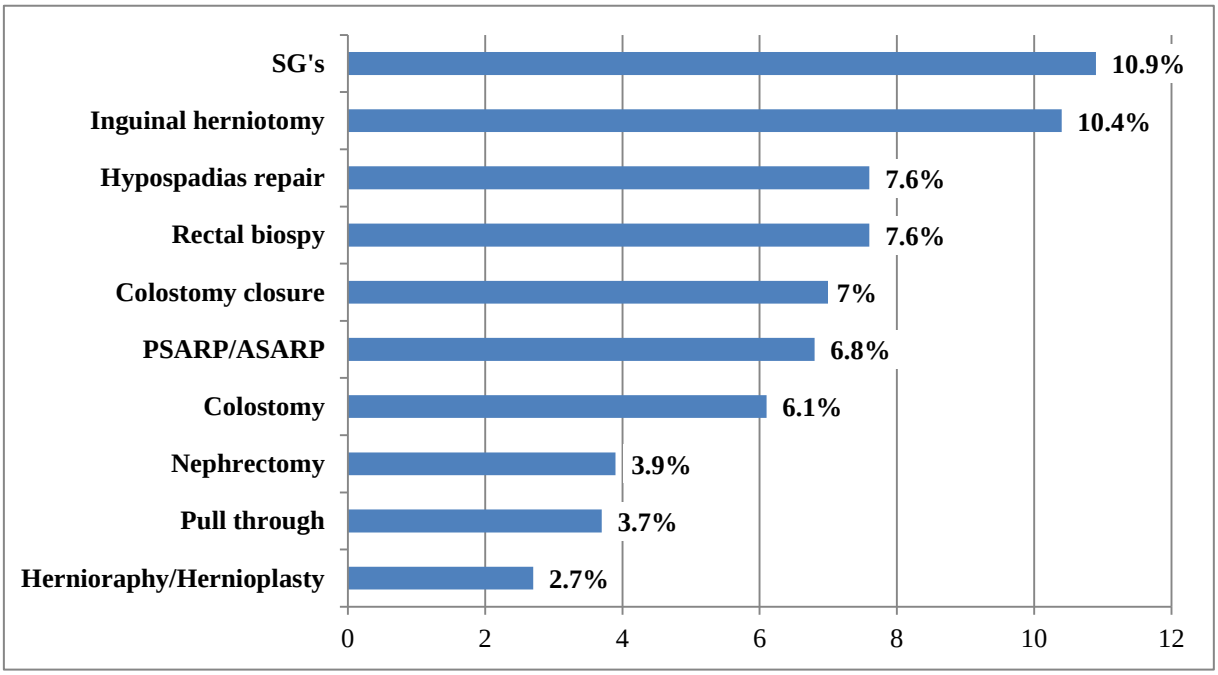


Figure 5: Top ten performed procedures in the 31 to 50 years age group



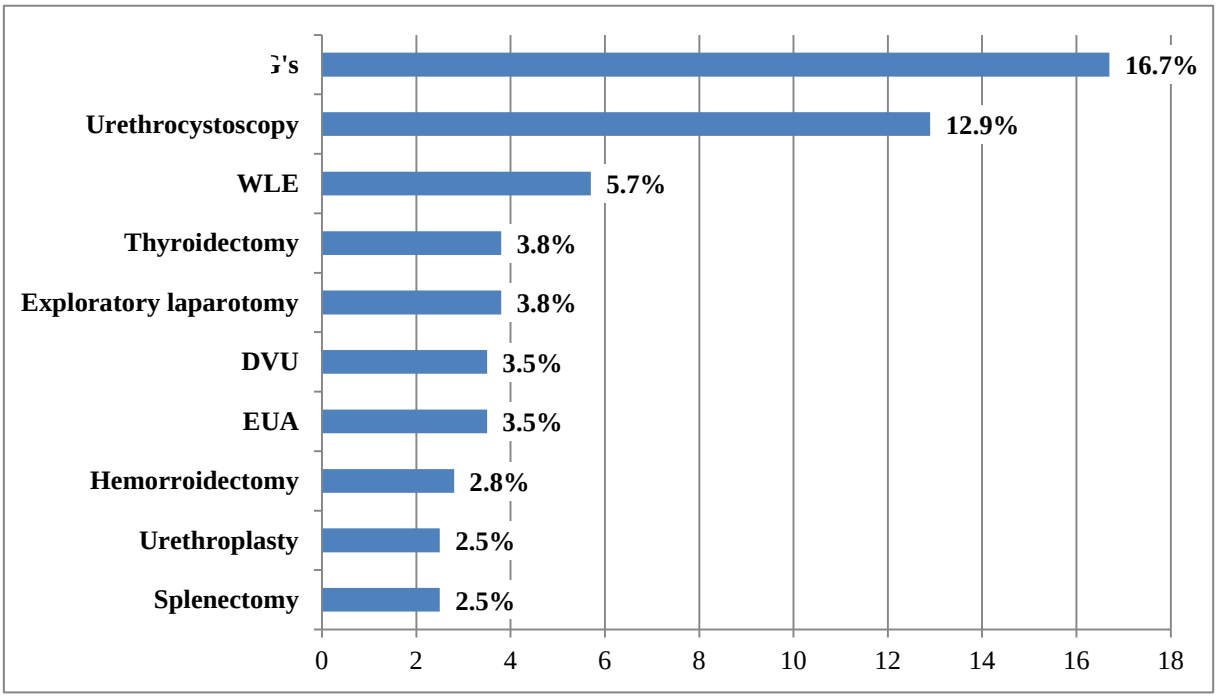
For the paediatric age group, the leading procedures were 53 (10.9%) skin graftings and inguinal herniotomies respectively, followed by 37 (7.6%) rectal biopsies and hypospadias repairs respectively, 35 (7.2%) WLEs, 34 (7.0%) colostomy closures, 33 (6.8%) PSARP/ ASARPs, 30 (6.1%) colostomies, 19 (3.9%) nephrectomies, 18 (3.7%) pull throughs , 18 (3.7%) circumcisions, 15 (3.1%) orchidopexies and 13 (2.7%) herniorrhaphies/ hernioplasties. (**Figure 6**) (See appendix III for list of all procedures by age groups)

Figure 6: Top ten performed procedures in the paediatric age group



In the 11 to 30 years age group, the top ten performed operations included 53 (16.7%) skin graftings, 41 (12.9%) urethrocystoscopies ± biopsy ± EUA, 18 (5.7%) WLEs, 12 (3.8%) exploratory laparotomies, 11 (3.5%) EUAs and DVUs respectively, 9 (2.8%) hemorrhoidectomies and thyroidectomies respectively, including 8 (2.5%) splenectomies, lumpectomies and urethroplasties respectively. (**Figure 7**) (See appendix III for list of all procedures by age groups)

Figure 7: Top ten performed procedures in the 11 to 30 years age group.



Of the 2315 performed surgeries, residents participated in 1597 (72.1%) procedures. The predominant residents' role was that of first assistant in 1214 (54.8%) procedures, followed by role as surgeon in 571 (25.8%) procedures; the second assistant role accounting for 355 (16%) procedures. Considering important procedures for a general surgeon, residents were involved by at least 65% in the majority of each specific procedure. The involvement at different levels was highest in urological procedures. **(Table 2)** (See appendix IV for list of all procedures and residents' role)

As surgeons, procedures performed by residents were mostly urological ranging from 47.6% to 93.3% of performed urological procedures. For thyroidectomies and mastectomies, residents performed 15 (26.8%) and 40 (38.5%) of each respectively. Residents performed very few gastrointestinal surgeries (less than 5% and mostly at 0%), predominantly participating as first and second assistants from 20% to 48% and from 30% to 80% respectively. (**Table 2**) (See appendix IV for list of all procedures and residents' role)

Table 2: Residents' participation in elective surgeries at MNH

Procedure	Total	Residents' role n (%)			
		Involved	Performed	First assistant	Second assistant
Cystolithotomy	15	14 (93.3)	14 (93.3)	8 (53.3)	4 (26.7)
Elective SPC	9	9 (100)	8 (88.9)	6 (66.7)	0 (0)
BSO/ Orchidectomy	87	70 (80.5)	61 (70.1)	66 (75.9)	0 (0)
Open prostatectomy	70	58 (82.9)	41 (58.6)	48 (68.6)	12 (17.1)
Hydrocelectomy	21	14 (66.7)	10 (47.6)	11 (52.4)	0 (0)
Mastectomies	104	70 (67.3)	40 (38.5)	45 (43.3)	10 (9.6)
Rigid oesophagoscopy	68	40 (58.8)	21 (30.9)	16 (23.5)	8 (11.8)
Circumcision	21	14 (66.7)	6 (28.6)	14 (66.7)	0 (0)
Thyroidectomy	56	40 (71.4)	15 (26.8)	25 (62.5)	12 (21.4)
Herniorrhaphy/ hernioplasty	53	36 (67.9)	14 (26.4)	32 (60.4)	10 (18.9)
Cholecystectomy	18	14 (77.8)	4 (22.2)	6 (33.3)	9 (50)
Splenectomy	22	11 (50)	3 (13.6)	9 (40.9)	5 (22.7)
Hemorrhoidectomy	22	18 (72)	3 (12)	12 (48)	0 (0)
Cholecystojejunostomy	20	13 (65)	2 (10)	6 (30)	8 (40)
Inguinal herniotomy	53	28 (52.8)	4 (7.5)	28 (52.8)	3 (5.7)
Gastrojejunostomy	34	22 (64.7)	2 (5.9)	11 (32.4)	11 (32.4)
Feeding gastrostomy	14	8 (57.1)	0 (0)	8 (57.1)	4 (28.6)
Right hemicolectomy	14	10 (71.4)	0 (0)	5 (35.7)	8 (57.1)
Brawn enteroenterostomy	13	8 (61.5)	0 (0)	5 (38.5)	5 (38.5)
Fistulectomy	11	9 (81.8)	0 (0)	8 (72.7)	0 (0)
Microdochectomy	9	9 (100)	0 (0)	9 (100)	2 (22.2)
Sinus excision	8	0 (0)	0 (0)	8 (100)	0 (0)
Sigmoidectomy	7	5 (71.4)	0 (0)	2 (28.6)	4 (57.1)
Anterior resection	7	7 (100)	0 (0)	7 (100)	5 (71.4)
CBD exploration	6	6 (100)	0 (0)	4 (66.7)	4 (66.7)
Left hemicolectomy	5	3 (60)	0 (0)	2 (40)	2 (40)
APR + C	5	4 (80)	0 (0)	1 (20)	4 (80)
Gastrectomy	5	3 (60)	0 (0)	0 (0)	3 (60)
SG	161	28 (17.4)	0 (0)	28 (17.4)	12 (7.5)
Nephrectomy	38	28 (73.7)	0 (0)	4 (10.5)	28 (73.7)
Highligation (For varicose veins)	23	0 (0)	0 (0)	0 (0)	0 (0)

DISCUSSION

Major and minor surgery is a service of great importance both for the people in need and for health workers and managers trying to develop and provide comprehensive primary health care services, (15). Throughout the study period, procedures were performed on 2214 patients during the 9 months study period at MNH from April to December 2013. Majority of the patients were males, 1414 (63.9%) patients; with M: F ratio of 1.76:1. This could be attributed to the presence of a larger number of urological procedures and male paediatric surgery procedures, with majority of procedures on female patients being predominantly performed in the gynaecology department. A study by Hagos G et al at Ayder teaching hospital found approximately the same M: F ratio at 1.97:1, (20); similarly a study in Southern Sudan found a higher M: F ratio at 2.4:1, (21). However, in some other third world countries and studies done in Haiti, majority of operated patients were females, (22, 23).

The age in this study ranged from 2 days to 112 years with a mean of 39.5± 26.1 years. A similar mean age was found by Hagos G et al, (20). El Bushra et al had age range of 2 years to 80 years, (18); while Giuseppe et al found age range of 2 to 80 years in Southern Sudan, (21). A study conducted at Chang Gung Memorial Hospital found a mean age of 48 years, (24) ; while that by Kathryn et al in looking at some third world countries found a lower mean of 28 years, (22).

The most common age group was over 50 years at 37.1% followed by 31 to 50 years at 26.8%; paediatric age group at 22% and 11 to 30 years at 14.3%. Similar observation was seen in some other studies (25). Male were the majority in all the age groups except for those aged between 31 to 50 years were females were the majority. The differences observed between males and females were statistically significant with a p-<0.001. Hagos G et al in their study found the predominant age group to be 31 to 45 years at 30.9%; while the paediatric age group was at 10.9%, (20); a study in Haiti finding the commonest age group to be 21 to 40 years at 40%, (23).

Two thousand three hundred and fifteen (2315) procedures were performed on the 2214 studied patients at MNH, with a total bed capacity of 1000 beds and general surgery bed capacity of around 294 beds. The overall average number of procedures per month was

257.2, and the overall average number of procedures per day was 12.9. The common perception that surgical care is merely a luxury in third world countries seems to be refuted by the above numbers, (26).

The surgical output at MNH was twice per bed than that found at Bugando Medical Centre which has 1000 inpatient beds, (14), and was higher than both the 6.3 operations per day observed at Jawaharial Institute of Postgraduate Medical Education and Research, Pondicherry, (16); and the 138 operations per month found at El Obeid hospital in Western Sudan,(18). The surgical output was approximately equal to that found at Ayub Teaching Hospital, Abbottabad, Pakistan, (17). The average surgical output was lower than the 378 operations per month seen at a Norwegian hospital, (27). Chang Gung Memorial Hospital was far beyond the above surgical outputs performing 1467 operations per month, (24). MNH being a third level referral hospital was significantly superior in surgical output compared to most regional and distric hospitals both in Tanzania and neighbouring countries like Mozambique, Sudan, Sierra Leone, Kenya and Uganda; a finding expected as a tertiary level referral hospital is expected to provide a wide range of consultant and super-specialty services, (3, 15, 19, 21, 28, 29). However to properly relate above parameters, more information on aspects such as hospital bed capacity, theatre capacity and number of surgeons is needed.

A wide range of procedures was performed at MNH during the study period, from general surgery, urology, paediatric surgery, plastic surgery and finally cardiac surgery, reflecting the status of the centre as a tertiary referral level hospital.

However very little is available in literature with regards to surgical output at different centres especially in Africa, and most centres do not have data at all on the matter, thus cross center comparison and interpretation is difficult, (1, 7).

The proportions of each of the performed procedures is far beyond the basic surgeries performed by most district and regional hospitals in Tanzania, Kenya, Uganda, Sierra Leone, Sudan and Mozambique (3, 7, 15, 19, 21, 28, 29); as MNH is a tertiary referral level hospital. These other hospitals performed few of the major elective surgeries, providing predominantly emergency services. The performed individual procedures were also significantly higher than those done at Hospital Bon Sauveur, in Haiti, (23).

Yearly surgical volume and most importantly surgeon yearly volume have been consistently linked with better patient outcome at institutions with large volumes for both parameters, and cutoffs related to better overall outcome were developed for majority of the major surgical operations from a meta analysis by Chowdhury et al, (8). For the 40 cororectal cancer operations required yearly, 38 colorectal cancer operations were done at MNH during the nine months study period, thus the hospital delivering accordingly with respect to colorectal cancer surgeries. However for the rest of the operations, upper gastrointestinal, hepatobiliary, thoracic, cardiac and vascular surgery, the surgical output was far below the proposed cut offs consistent with high volume centres and automatically better outcome for the respective operations.

In line to yearly surgeon output, the surgical output at MNH was far below the cutoffs consistent with high output centres and respective better outcome. However, almost all of the analysed studies were from the developed world with highly specialised centres for specific surgical pathologies. In addition to that the surgical conditions in those settings may be different from those existent in the third world countries, not ensuring adequate patient volume to meet above criteria. Whether other factors like self initiative and lack of motivation contribute towards the situation, are issues that could be addressed by specifically designed studies.

In this study, residents were involved at various levels from surgeon, first assistant to second assistant. Of the 2315 performed procedures, residents participated in 1597 (72.1%) procedures. The predominant residents' role was that of first assistant in 1214 (54.8%) procedures, followed by role as surgeon in 571 (25.8%) operations; the second assistant role accounting for 355 (16%) procedures. Considering important procedures for a general surgeon, residents were involved by at least 65% in the majority of each specific operation. The involvement was highest in urological procedures.

As surgeons, procedures performed by residents were mostly urological ranging from 47.6% to 93.3%. For thyroidectomies and mastectomies, residents performed 26.8% and 36.3% of each respectively. Residents performed very few gastrointestinal surgeries (less than 5% and mostly at 0%), predominantly participating as first assistant (from 20% to 48%) and second assistants (from 30% to 80%). At MUHAS/ MNH, in the department of surgery, for the recent years there are from 12 to 22 residents at any time who participate in

the above operations. The duration during which residents rotate through general surgery units is 16 to 18 months, meaning as a surgeon a resident completes a course (3 years) having performed approximately a maximum of 100 operations, and being involved as first assistant in approximately a maximum of 208 operations; assuming the operations are equally distributed among the residents. The rest of the time is for external rotations including orthopaedics, trauma and neurosurgery, ENT and obstetrics and gynaecology. Urological procedures and minor surgeries like rigid oesophagoscopies, EUAs and proctoscopies accounted for a significant proportion of performed procedures.

In Africa no available literature addressing the same topic was found. However with European and American standards, the numbers for role as surgeon are very low in this study, partly because the programs overseas are of 4 to 6 years duration depending on the country. Other possible explanations such as participating specialists not letting residents participate in these procedures as surgeons and number of enrolled residents could be looked into by specifically designed studies.

In a study done in Canada, the mean total major operations reported by graduating surgical residents in the role of surgeon under supervision ranged from 231 to 252 cases. The reported first assistant median operative case volume ranged from 49 to 231 cases, (10). A study done in America found the number of total major operations reported by residents through the 5 years training as surgeon ranged from 909 to 930, as surgeon chief from 231 to 252 and surgeon junior operations from 677 to 678. The median number of first assistant and teaching assistant cases ranged from 49 to 231 and 23 to 67 respectively. In addition, all these are augmented by the highly evolving surgical simulation adding to the overall acquired surgical experience, (10). From all the abovee, it's very obvious how the postgraduate exposure at MNH/ MUHAS is low compared to those centres in America and Canada.

The current American Board of Surgeons specified total number of major operations that a resident must have performed to sit for the qualifying examination is 750, (10). With the output and the ever evolving numbers of residents at MNH/ MUHAS, such number of operations cannot be met within 3 years, leave alone 5 years.

A study in Chicago, looking at perceived resident's competence with important procedures in their field found graduates did not feel competent performing many operation relevant to their practice, and the results of such surveys were believed could provide information on

how to improve clinical curriculum, (13). With such a load case at a centre like Chicago, it would be important to look of the situation in our environment, where we have even lower residents' case loads at all levels of participation, and clues toward improvement can be obtained.

Another study looking at teaching residents in the operating room in Tennessee, found that of all cases scrubbed in one year, most residents felt as though they only actually performed the procedure between 26% and 50% (29%) or between 51% and 75% (32%) of the time. However, more than half of all residents (51%) loggged these procedures for Accreditation Council for Graduate Medical Education as primary surgeon 76%–100% of the time. These findings suggested that residents may be logging cases without feeling as though they actually performed the operations, (31). The situation at MUHAS/ MNH may be worse, but all these are matters to be studied accordingly.

In some centres in the United States of America, competition for cases was noted , affecting procedural competency acquisition during residency, (11). It was also noted that some procedures were encountered rarely, some were not encountered enough in training institutions in the United States of America, (12). This is likely to be the case for majority of the important general surgery procedures a graduant resident is supposed to be competent with in our settings, the current study having shown the relatively overall fewer such operations; compounded by the relatively high number of residents.

Increased case volume has been correlated with competence for some procedures, (13). Therefore from the perspective of this study and overall in our settings, it would be important to look at ways of increasing residents case volume at each level of involvement starting with the performed operations, for which the performance is still low at each level; later on looking at other parameters involving institutions and overall training programs.

Another study found overall shortening of required surgical rotations, residents feeling they needed more time in their respective surgical rotations, (32). This is again another important area we could look at in our training, on top of the many more areas risen by above studies with respect to residents' training in general surgery.

CONCLUSION

The surgical output found at MNH, though lower, similar or higher that found at other hospitals, could have been relatively higher than the observed, considering that 29% of the procedures were minor surgeries like rigid oesophagoscopies, proctoscopies, EUA, BSO/ Orchidectomies and urethrocystoscopies ± biopsy ± EUA which take less time.

The hospital yearly surgical volume met preset standards for colorectal cancer surgeries alone, but for the other surgeries and with regards to surgeon yearly volume, low volumes were noted. It would be important to look into these matters widely for possible refinements.

The overall surgical output seen reveals quite a wide range of a number of diseases, thus the need of improving on these parameters cannot be taken for granted, and surgical services need to be prioritized and be adequately supplied for the sake of providing appropriate treatment to the patients.

The overall residents' involvement and participation in surgical services at all levels at MNH was low. The room for improvement is wide considering the percentages were low at each level of resident's involvement. However other studies looking into this matter would provide more insight rather than rushing into conclusions.

RECOMMENDATIONS

1) Optimizing theatre utilization and increasing surgical output.
2) Increasing residents' involvement in all aspects especially for the role as a surgeon.
3) Looking into the number of enrolled residents with respect to available surgical output
4) Looking at possible external rotations to be reduced
5) Looking into residents motivation in day to day services especially in procedures
6) Checking if external rotations to other hospitals could increase residents surgical exposure and performance
7) Improving resident's assessment tools, by establishing specific cut offs for each stage during the training.

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APPENDICES

Appendix I: Data collection tool

1. Serial number: _____
2. Ward/Unit_____
3. File number: _____
4. Age: _____
5. Sex:

   1. Male 2. Female
6. Diagnosis_____
7. Type of performed operation _____
8. Date of surgery: _____
9. Operating team
    a. Surgeon(s) _____
    b. Resident(s) _____
        i. Perform procedure under supervision
        ii. First assistant
        iii. Second assistant
    c. Registrar(s)
    d. Undergraduate student(s)
    e. Others

Appendix II: Distribution of the performed surgeries by sex

Procedure	**Sex**		
	Female n (%)	**Male n (%)**	**Total**
WLE	57 (6.7)	54 (3.7)	111 (4.8)
Mastectomy	101 (12)	3 (0.2)	104 (4.5)
Rigid oesophagoscopy	23 (2.7)	45 (3.1)	68 (2.9)
Exploratory laparotomy	18 (2.1)	44 (3)	62 (2.7)
Thyroidectomy	51 (6.4)	5 (0.4)	56 (2.5)
Colostomy	34 (4.2)	20 (1.4)	54 (2.4)
Colostomy closure	22 (2.8)	32 (2.3)	54 (2.4)
EUA	30 (3.8)	23 (1.6)	53 (2.4)
Herniorrhaphy/ hernioplasty	22 (2.8)	31 (2.2)	53 (2.4)
Proctoscopy and biopsy	22 (2.8)	18 (1.3)	40 (1.8)
Gastrojejunostomy	15 (1.9)	19 (1.3)	34 (1.5)
Open biopsy	16 (2.0)	14 (1.0)	30 (1.4)
AKA	11 (1.4)	17 (1.2)	28 (1.30
Hemorrrhoidectomy	9 (1.1)	13 (0.9)	22 (1.0)
Splenectomy	8 (1)	14 (1)	22 (1)
Cholecystojejunostomy	13 (1.6)	7 (0.5)	20 (0.9)
Disarticulation	4 (0.5)	14 (1)	18 (0.8)
Cholecystectomy	13 (1.6)	5 (0.4)	18 (0.8)
BKA	5 (0.6)	12 (0.8)	17 (0.8)
Lumpectomy	15 (1.9)	0 (0)	15 (0.7)
Feeding gastrostomy	4 (0.5)	10 (0.7)	14 (0.6)
Right hemicolectomy	3 (0.4)	11 (0.8)	14 (0.6)
Brawn enteroenterostomy	7 (0.9)	6 (0.4)	13 (0.6)
Colostomy revision	4 (0.5)	8 (0.6)	12 (0.5)
Fistulectomy	1 (0.1)	10 (0.7)	11 (0.5)
Microdochectomy	9 (1.1)	0 (0)	9 (0.4)

Procedure	**Sex**		
	Female n (%)	**Male n (%)**	**Total**
Sinus excision	3 (0.4)	5 (0.4)	8 (0.4)
Chest wall resection + reconstruction	3 (0.4)	4 (0.3)	7 (0.3)
Pleural biopsy	3 (0.4)	4 (0.3)	7 (0.3)
Sigmoidectomy	2 (0.3)	5 (0.4)	7 (0.3)
Anterior resection	4 (0.5)	3 (0.2)	7 (0.3)
Heller's myotomy	3 (0.4)	3 (0.2)	6 (0.3)
CBD exploration	5 (0.6)	1 (0.1)	6 (0.3)
Gastrectomy	1 (0.1)	4 (0.3)	5 (0.2)
Left hemicolectomy	3 (0.4)	2 (0.1)	5 (0.2)
APR + C	2 (0.2)	3 (0.2)	5 (0.2)
Decortication	4 (0.5)	1 (0.1)	5 (0.2)
Ileostomy	2 (0.2)	3 (0.2)	5 (0.2)
Truncal vagotomy	0 (0)	4 (0.3)	4 (0.2)
Fundoplication	4 (0.5)	0 (0)	4 (0.2)
AEA	2 (0.2)	2 (0.2)	4 (0.2)
BEA	1 (0.1)	3 (0.2)	4 (0.2)
Thymectomy	1 (0.1)	1 (0.1)	2 (0.1)
Pneumonectomy	1 (0.1)	1 (0.1)	2 (0.1)
Open chest window	0 (0.0)	1 (0.1)	1 (0.0)
Inguinal herniotomy	0 (0)	53 (3.7)	53 (2.4)
Rectal biopsy	14 (1.8)	25 (1.8)	39 (1.8)
PSARP/ ASARP	25 (3.1)	8 (0.6)	33 (1.5)
Pull through	2 (0.2)	16 (1.1)	18 (0.8)
Pyloromyotomy	3 (0.4)	7 (0.5)	10 (0.5)
Tongue tie release	1 (0.1)	3 (0.2)	4 (0.2)
Kasai hepatoportoenterostomy	2 (0.3)	2 (0.1)	4 (0.2)
SG	62 (7.8)	99 (7.0)	161 (7.3)
Contracture release	5 (0.6)	9 (0.6)	14 (0.6)

Procedure	**Sex**		
	Female n (%)	**Male n (%)**	**Total**
Urethrocystoscopy, biopsy + EUA	111 (13.9)	179 (12.7)	290 (13.1)
TURP	0 (0)	108 (7.6)	108 (4.9)
BSO/ Orchidectomy	0 (0)	87 (6.2)	87 (3.9)
DVU	0 (0)	76 (5.4)	76 (3.4)
Open prostatectomy	0 (0)	70 (5)	70 (3.2)
Hypospadias repair	0 (0)	43 (3.0)	43 (1.9)
Nephrectomy	15 (1.9)	23 (1.6)	38 (1.7)
Urethroplasty	0 (0)	33 (2.3)	33 (1.5)
Hydrocelectomy	0 (0)	21 (1.5)	21 (0.9)
Circumcision	0 (0)	21 (1.5)	21 (0.9)
Orchidopexy	0 (0)	18 (1.3)	18 (0.8)
Cystolithotomy	7 (0.9)	8 (0.6)	15 (0.7)
Cystectomy	8 (1)	6 (0.4)	14 (0.6)
Fulguration	0 (0)	12 (0.8)	12 (0.5)
Elective SPC	0 (0)	9 (0.6)	9 (0.4)
Pyeloplasty	1 (0.1)	6 (0.4)	7 (0.3)
Ureteric reimplantation	4 (0.5)	3 (0.2)	7 (0.3)
Highligation (For varicose veins)	4 (0.5)	19 (1.3)	23 (1.0)
AVF creation	5 (0.6)	8 (0.6)	13 (0.6)
PDA closure	8 (1.0)	2 (0.1)	10 (0.5)
Valve replacement (mitral or aortic)	3 (0.4)	3 (0.2)	6 (0.3)
Pericardiectomy	1 (0.1)	4 (0.3)	5 (0.2)
Pericardial window	4 (0.5)	1 (0.1)	5 (0.2)
Ileo femoral bypass	1 (0.1)	1 (0.1)	2 (0.1)
Grand total	847 (36.6)	1468 (63.4)	2315

Appendix III: Distribution of performed surgeries by age group

Procedure	**Age (Years) n (%)**				
	Less than 10	**11 to 30**	**31 to 50**	**More than 50**	**Total**
WLE	35 (7.2)	18 (5.7)	30 (5.1)	28 (3.4)	111 (5.0)
Mastectomy	0 (0)	5 (1.6)	58 (9.6)	41 (4.7)	104 (4.5)
Rigid oesophagoscopy	8 (1.6)	7 (2.2)	19 (3.2)	34 (4.1)	68 (3.1)
Exploratory laparotomy	2 (0.4)	12 (3.8)	21 (3.6)	27 (3.3)	62 (2.8)
Thyroidectomy	0 (0)	9 (2.8)	28 (4.8)	19 (2.3)	56 (2.6)
Colostomy	30 (6.1)	3 (0.9)	12 (2.0)	9 (1.1)	54 (2.4)
Colostomy closure	34 (7.0)	5 (1.6)	11 (1.9)	4 (0.5)	54 (2.4)
EUA	2 (0.4)	11 (3.5)	18 (3.1)	22 (2.7)	53 (2.4)
Herniorrhaphy/ hernioplasty	13 (2.7)	7 (2.2)	23 (4)	10 (1.2)	53 (2.4)
Proctoscopy and biopsy	0 (0)	9 (2.8)	15 (2.6)	16 (1.9)	40 (1.8)
Gastrojejunostomy	0 (0)	3 (0.9)	11 (1.9)	20 (2.4)	34 (1.5)
Open biopsy	10 (2.0)	4 (1.3)	7 (1.2)	9 (1.1)	30 (1.4)
AKA	0 (0)	6 (1.9)	7 (1.2)	15 (1.8)	28 (1.3)
Hemorrrhoidectomy	0 (0)	9 (2.8)	5 (0.9)	8 (1.0)	22 (1.0)
Splenectomy	12 (2.5)	8 (2.5)	1 (0.2)	1 (0.1)	22 (1.0)
Cholecystojejunostomy	0 (0)	1 (0.3)	6 (1.0)	13 (1.6)	20 (0.9)
Cholecystectomy	0 (0)	3 (0.9)	11 (1.9)	4 (0.5)	18 (0.8)
Disarticulation	1 (0.2)	3 (0.9)	2 (0.3)	12 (1.5)	18 (0.8)
BKA	0 (0)	1 (0.3)	6 (1)	10 (1.2)	17 (0.8)
Lumpectomy	0 (0)	8 (2.5)	7 (1.2)	0 (0)	15 (0.7)
Feeding gastrostomy	6 (1.2)	3 (0.9)	2 (0.3)	3 (0.4)	14 (0.6)
Right hemicolectomy	0 (0)	1 (0.3)	9 (1.5)	4 (0.5)	14 (0.6)
Brawn enteroenterostomy	0 (0)	0 (0)	3 (0.5)	10 (1.2)	13 (0.6)
Colostomy revision	4 (0.8)	3 (0.9)	3 (0.5)	2 (0.2)	12 (0.5)
Fistulectomy	0 (0)	1 (0.3)	7 (1.2)	3 (0.4)	11 (0.5)
Microdochectomy	0 (0)	2 (0.6)	6 (1.0)	1 (0.1)	9 (0.4)

Procedure	**Age (Years) n (%)**				
	Less than 10	**11 to 30**	**31 to 50**	**More than 50**	**Total**
Sinus excision	0 (0)	0 (0)	4 (0.7)	4 (0.5)	8 (0.4)
Sigmoidectomy	0 (0)	1 (0.3)	2 (0.3)	4 (0.5)	7 (0.3)
Anterior resection	0 (0)	4 (1.3)	2 (0.3)	1 (0.1)	7 (0.3)
Chest wall resection + reconstruction	0 (0)	2 (0.6)	2 (0.6)	3 (0.4)	7 (0.3)
Pleural biopsy	0 (0)	2 (0.6)	3 (0.5)	2 (0.2)	7 (0.3)
Heller's myotomy	0 (0)	2 (0.6)	3 (0.5)	1 (0.1)	6 (0.3)
CBD exploration	0 (0)	1 (0.3)	3 (0.5)	2 (0.2)	6 (0.3)
Decortication	0 (0)	1 (0.3)	3 (0.5)	1 (0.1)	5 (0.2)
Gastrectomy	0 (0)	1 (0.3)	2 (0.3)	2 (0.2)	5 (0.2)
Left hemicolectomy	0 (0)	0 (0)	3 (0.5)	2 (0.2)	5 (0.2)
APR + C	0 (0)	2 (0.6)	1 (0.2)	2 (0.2)	5 (0.2)
Ileostomy	0 (0)	3 (0.9)	1 (0.2)	1 (0.1)	5 (0.2)
Truncal vagotomy	0 (0)	2 (0.6)	2 (0.6)	0 (0)	4 (0.2)
Fundoplication	0 (0)	1 (0.3)	2 (0.3)	1 (0.1)	4 (0.2)
AEA	1 (0.2)	0 (0)	2 (0.3)	1 (0.1)	4 (0.2)
BEA	0 (0)	1 (0.3)	2 (0.3)	1 (0.1)	4 (0.2)
Thymectomy	0 (0)	1 (0.3)	1 (0.2)	0 (0)	2 (0.1)
Pneumonectomy	0 (0)	1 (0.3)	0 (0)	1 (0.1)	2 (0.1)
Open chest window	0 (0)	1 (0.3)	0 (0)	0 (0)	1 (0.0)
Inguinal herniotomy	53 (10.9)	0 (0)	0 (0)	0 (0)	53 (10.9)
Rectal biopsy	37 (7.6)	2 (0.6)	0 (0)	0 (0)	39 (1.8)
PSARP/ ASARP	33 (6.8)	0 (0)	0 (0)	0 (0)	33 (1.5)
Pull through	18 (3.7)	0 (0)	0 (0)	0 (0)	18 (0.8)
Pyloromyotomy	10 (2)	0 (0)	0 (0)	0 (0)	10 (0.5)
Kasai hepatoportoenterostomy	4 (0.8)	0 (0)	0 (0)	0 (0)	4 (0.2)
Tongue tie release	4 (0.8)	0 (0)	0 (0)	0 (0)	4 (0.2)
SG	53 (10.9)	53 (16.7)	44 (7.5)	11 (1.3)	161 (7.3)

Procedure	**Age (Years) n (%)**				
	Less than 10	**11 to 30**	**31 to 50**	**More than 50**	**Total**
Contracture release	3 (0.6)	5 (1.6)	4 (0.7)	2 (0.2)	14 (0.6)
Urethrocystoscopy, biopsy + EUA	7 (1.4)	41 (12.9)	107 (18.2)	135 (16.4)	290 (13.1)
TURP	0 (0)	0 (0)	4 (0.7)	104 (12.7)	108 (4.9)
BSO/ Orchidectomy	0 (0)	3 (0.9)	1 (0.20	83 (10.1)	87 (3.9)
DVU	0 (0)	11 (3.5)	15 (2.6)	50 (6.1)	76 (3.4)
Open prostatectomy	0 (0)	0 (0)	1 (0.1)	69 (8.4)	70 (3.2)
Hypospadias repair	37 (7.6)	6 (1.9)	0 (0)	0 (0)	43 (1.9)
Nephrectomy	19 (3.9)	3 (0.9)	10 (1.7)	6 (0.7)	38 (1.7)
Urethroplasty	1 (0.2)	8 (2.5)	10 (1.7)	14 (1.7)	33 (1.5)
Hydrocelectomy	11 (2.3)	0 (0)	1 (0.2)	9 (1.1)	21 (0.9)
Circumcision	18 (3.7)	3 (0.9)	0 (0)	0 (0)	21 (0.9)
Orchidopexy	15 (3.1)	3 (0.9)	0 (0)	0 (0)	18 (0.8)
Cystolithotomy	2 (0.4)	3 (0.9)	3 (0.5)	7 (0.9)	15 (0.7)
Cystectomy	4 (0.8)	0 (0)	2 (0.3)	8 (1)	14 (0.6)
Fulguration	10 (2)	2 (0.6)	0 (0)	0 (0)	12 (0.5)
Elective SPC	2 (0.4)	1 (0.3)	0 (0)	6 (0.7)	9 (0.4)
Pyeloplasty	2 (0.4)	2 (0.6)	0 (0)	3 (0.4)	7 (0.3)
Ureteric reimplantation	1 (0.2)	2 (0.6)	3 (0.5)	1 (0.1)	7 (0.3)
Highligation (For varicose veins)	0 (0)	2 (0.6)	17 (2.9)	4 (0.5)	23 (1.)
AVF creation	0 (0)	3 (0.9)	6 (1.0)	4 (0.5)	13 (0.6)
PDA closure	7 (1.4)	2 (0.6)	1 (0.2)	0 (0)	10 (0.5)
Valve replacement (mitral or aortic)	0 (0)	2 (0.6)	3 (0.5)	1 (0.1)	6 (0.3)
Pericardiectomy	0 (0)	1 (0.3)	3 (0.5)	1 (0.1)	5 (0.2)
Pericardial window	0 (0)	1 (0.3)	1 (0.2)	3 (0.4)	5 (0.2)
Ileo femoral bypass	0 (0)	0 (0)	2 (0.3)	0 (0)	2 (0.1)
Grand total	509 (100) 509 (22)	327 (100) 327 (14.1)	604 (100) 604 (26.1)	875 (100) 875 (37.8)	2315 (100) 2315 (100)

Appendix IV: Residents' participation in elective surgeries at MNH

Procedure	Total	Residents' role n (%)			
		Involved	Performed	First assistant	Second assistant
Disarticulation	18	18 (100)	16 (88.9)	18 (100)	7 (38.9)
AEA	4	4 (100)	3 (75)	4 (100)	1 (25)
BEA	4	3 (75)	3 (75)	3 (75)	0 (0)
BKA	17	16 (94.1)	12 (70.6)	14 (82.4)	6 (35.3)
Proctoscopy and biopsy	40	30 (75)	22 (55)	18 (45)	0 (0)
EUA	53	40 (75.5)	28 (52.8)	30 (56.6)	0 (0)
AKA	28	19 (67.9)	14 (50)	16 (57.1)	8 (28.6)
WLE	111	78 (70.3)	52 (46.8)	48 (43.2)	4 (3.6)
Mastectomy	104	70 (67.3)	40 (38.5)	45 (43.3)	10 (9.6)
Open biopsy	30	18 (60)	11 (36.7)	6 (20)	4 (13.3)
Colostomy revision	12	8 (66.7)	4 (33.5)	6 (50)	2 (16.7)
Rigid oesophagoscopy	68	40 (58.8)	21 (30.9)	16 (23.5)	8 (11.8)
Colostomy closure	54	32 (59.3)	15 (27.8)	22 (40.7)	8 (14.8)
Thyroidectomy	56	40 (71.4)	15 (26.8)	25 (62.5)	12 (21.4)
Lumpectomy	15	7 (46.7)	4 (26.7)	4 (26.7)	2 (13.3)
Herniorrhaphy/ hernioplasty	53	36 (67.9)	14 (26.4)	32 (60.4)	10 (18.9)
Colostomy	54	34 (63)	14 (25.9)	13 (24.1)	3 (5.6)
Exploratory laparotomy	62	47 (75.8)	14 (22.6)	32 (51.6)	9 (14.5)
Cholecystectomy	18	14 (77.8)	4 (22.2)	6 (33.3)	9 (50)
Splenectomy	22	11 (50)	3 (13.6)	9 (40.9)	5 (22.7)
Hemorrrhoidectomy	22	18 (72)	3 (12)	12 (48)	0 (0)
Cholecystojejunostomy	20	13 (65)	2 (10)	6 (30)	8 (40)
Gastrojejunostomy	34	22 (64.7)	2 (5.9)	11 (32.4)	11 (32.4)
Feeding gastrostomy	14	8 (57.1)	0 (0)	8 (57.1)	4 (28.6)
Right hemicolectomy	14	10 (71.4)	0 (0)	5 (35.7)	8 (57.1)
Brawn enteroenterostomy	13	8 (61.5)	0 (0)	5 (38.5)	5 (38.5)
Fistulectomy	11	9 (81.8)	0 (0)	8 (72.7)	0 (0)

Procedure	**Total**	**Residents' role n (%)**			
		Involved	**Performed**	**First assistant**	**Second assistant**
Microdochectomy	9	9 (100)	0 (0)	9 (100)	2 (22.2)
Sinus excision	8	0 (0)	0 (0)	8 (100)	0 (0)
Chest wall resection + reconstruction	7	7 (100)	0 (0)	7 (100)	2 (28.6)
Pleural biopsy	7	7 (100)	0 (0)	7 (100)	3 (42.9)
Sigmoidectomy	7	5 (71.4)	0 (0)	2 (28.6)	4 (57.1)
Anterior resection	7	7 (100)	0 (0)	7 (100)	5 (71.4)
Heller's myotomy	6	0 (0)	0 (0)	0 (0)	0 (0)
CBD exploration	6	6 (100)	0 (0)	4 (66.7)	4 (66.7)
Decortication	5	2 (40)	0 (0)	0 (0)	2 (40)
Ileostomy	5	5 (100)	0 (0)	4 (80)	4 (80)
Left hemicolectomy	5	3 (60)	0 (0)	2 (40)	2 (40)
APR + C	5	4 (80)	0 (0)	1 (20)	4 (80)
Gastrectomy	5	3 (60)	0 (0)	0 (0)	3 (60)
Truncal vagotomy	4	4 (100)	0 (0)	0 (0)	4 (100)
Fundoplication	4	0 (0)	0 (0)	0 (0)	0 (0)
Thymectomy	2	2 (100)	0 (0)	0 (100)	2 (100)
Pneumonectomy	2	2 (100)	0 (0)	0 (0)	2 (100)
Open chest window	1	1 (100)	0 (0)	0 (0)	1 (100)
Tongue tie release	4	4 (100)	4 (100)	2 (50)	0 (0)
Rectal biopsy	39	26 (66.7)	18 (46.2)	12 (30.8)	0 (0)
Inguinal herniotomy	53	28 (52.8)	4 (7.5)	28 (52.8)	3 (5.7)
PSARP/ ASARP	33	22 (66.7)	0 (0)	22 (66.7)	6 (33.3)
Pull through	18	12 (66.7)	0 (0)	12 (66.7)	6 (33.3)
Pyloromyotomy	10	10 (100)	0 (0)	10 (100)	4 (40)
Kasai hepatoportoenterostomy	4	4 (100)	0 (0)	4 (100)	4 (100)
SG	161	28 (17.4)	0 (0)	28 (17.4)	12 (7.5)
Contracture release	14	0 (0)	0 (0)	0 (0)	0 (0)
Cystolithotomy	15	14 (93.3)	14 (93.3)	8 (53.3)	4 (26.7)

Procedure	**Total**	**Residents' role n (%)**			
		Involved	**Performed**	**First assistant**	**Second assistant**
Elective SPC	9	9 (100)	8 (88.9)	6 (66.7)	0 (0)
BSO/ Orchidectomy	87	70 (80.5)	61 (70.1)	66 (75.9)	0 (0)
Open prostatectomy	70	58 (82.9)	41 (58.6)	48 (68.6)	12 (17.1)
Hydrocelectomy	21	14 (66.7)	10 (47.6)	11 (52.4)	0 (0)
Circumcision	21	14 (66.7)	6 (28.6)	14 (66.7)	0 (0)
DVU	76	58 (76.3)	18 (23.7)	58 (76.3)	0 (0)
Urethrocystoscopy, biopsy + EUA	290	264 (91)	60 (20.7)	264 (91)	0 (0)
TURP	108	96 (88.9)	11 (10.2)	96 (88.9)	0 (0)
Hypospadias repair	43	36 (83.7)	0 (0)	12 (27.9)	32 (74.4)
Nephrectomy	38	28 (73.7)	0 (0)	4 (10.5)	28 (73.7)
Urethroplasty	33	32 (97%)	0 (0)	0 (0)	32 (97)
Orchidopexy	18	12 (66.7)	0 (0)	11 (61.1)	6 (33.3)
Cystectomy	14	13(92.9)	0 (0)	0 (0)	13(92.9)
Fulguration	12	12 (100)	0 (0)	12 (100)	0 (0)
Pyeloplasty	7	6 (85.7)	0 (0)	6 (85.7)	4 (57.1)
Ureteric reimplantation	7	7 (100)	0 (0)	7 (100)	1 (14.3)
Highligation (For varicose veins)	23	0 (0)	0 (0)	0 (0)	0 (0)
AVF creation	13	0 (0)	0 (0)	0 (0)	0 (0)
PDA closure	10	0 (0)	0 (0)	0 (0)	0 (0)
Valve replacement (mitral or aortic)	6	0 (0)	0 (0)	0 (0)	0 (0)
Pericardiectomy	5	0 (0)	0 (0)	0 (0)	0 (0)
Pericardial window	5	0 (0)	0 (0)	0 (0)	0 (0)
Ileo femoral bypass	2	0 (0)	0 (0)	0 (0)	0 (0)
Total	2315	1597 (72.1)	571 (25.8)	1214 (54.8)	355 (16)