PREDICTABILITY OF SURGICAL APGAR SCORE ON SHORT TERM OUTCOMES OF LAPAROTOMIES AT THE UNIVERSITY TEACHING HOSPITAL IN LUSAKA, ZAMBIA

BY

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University Of Zambia

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DEDICATION

To my children Namwiinga, Peter-Simwiinde and Sarah Luyando

DECLARATION

I Felix Michelo, do hereby declare that this dissertation herein presented for the Degree of Master of Medicine General Surgery represents my own work. It has not been previously submitted either in whole or in part for any other Degree at this or any other university, nor is it currently being submitted for any other Degree.

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APPROVAL

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ABSTRACT

The Surgical Apgar Score (SAS) is a very easy and objective tool for triaging patients post-surgery. It can be used as an assessment tool for performance of hospitals, units or individual surgeons. However, not much research has been done to assess its utility in resource limited settings like Zambia. This study was undertaken to assess the predictability of SAS in laparotomy patients at UTH in Lusaka, Zambia.This was a prospective cohort study. A total of 50 patients were recruited, their intraoperative data collected and SAS calculated. The patients were followed up for 30 days. The primary end point was incidence of any major complication and/or death as defined by the Dindo-Clavien classification. Two out of the 50 patients enrolled were lost to follow up, leaving a total of 48 patients. Age ranged from 17 to 89 years with mean age of 38.8 years (SD 17 years). Out of the patients enrolled, 79 percent were male with 73 percent of operations being emergencies. Intestinal obstruction was the most common diagnosis accounting for 31.3 percent followed by viscus perforation. Of the patients enrolled, 58.3 percent had no complications. Overall, complications rate was 41.3 percent which was consistent with published literature. Deep surgical site infection was the most common complications at 12.5 percent. Patients who did not develop complications had a significantly higher SAS compared to patients who did ($p<0.001$). Mortality rate in the high risk group was higher than predicted by SAS ($p=0.23$). Period of operation and gender did not significantly affect the SAS of patients (p values =0.45 and 0.28 respectively).

This study confirms that SAS is adequate at predicting outcome in laparotomy patients in resource limited settings like UTH.

Key words; laparotomy, postoperative complications, Surgical Apgar score

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ABBREVIATIONS

ASA	American Society of Anaesthesiologists
AUC	Area under the Curve
APACHE	Acute Physiological and Chronic Health Evaluation
BP	Blood Pressure
EBV	Estimated Blood Volume
EBL	Estimated Blood Loss
ERES	Educational Records Evaluation Services
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
HR	Heart Rate
ICU	Intensive Care Unit
IRB	Institutional Review Board
MAP	Mean Arterial Pressure
NSQIP	National Surgical Improvement Program
POSSUM	Physiological and Operative Severity Score for enumeration of Mortality
ROC	Receiver Operating Characteristics
SAS	Surgical Apgar Score
UTH	University Teaching hospital
WHO	World Health Organisation

CHAPTER ONE: INTRODUCTION

1. Background

In 1953 Virginia Apgar developed a score system to identify newborns at risk of developing complications immediately after birth based on a number of physiological parameters. (Apgar, 1953). Based on this model, Gawande et al developed the Surgical Apgar score in 2007. It uses the patient intraoperative MAP, lowest heart rate and estimated blood loss. (Gawande et al 2007). The score's components capture elements of the overall patient condition, extent of the surgical insult and ability of the team to respond to and control hemodynamic changes during a procedure. (Dullo, 2013).

However, the score has not been evaluated beyond major academic medical centers because of a lack of reliable and comprehensive outcomes assessment against which these measures could be validated. (Regenbogen, 2009). It is possible that, among other patient populations, some modifications to the score factors could be necessary.

At a global level, a number of studies have been undertaken that have validated this score. Regenbogen postulates that: Even after accounting for fixed preoperative risk—due to patients' acute condition, comorbidities and/or operative complexity—the Surgical Apgar Score appears to detect differences in intraoperative management that reduce odds of major complications by half, or increase them by nearly three-fold.(Regebogen et al, 2008). In a study conducted at VA medical center in New York, it was found that SAS is easily calculated from three routinely available intraoperative measurements, correlates with fixed preoperative risk, and effectively identifies veterans at high risk for postoperative complications. (Melis et al, 2014). However, all of these studies were retrospective in nature.

At a regional level, a similar study done at Nairobi hospital found SAS to be adequate in stratification of post-operative risk of major complications following laparotomy with good predictive accuracy. (ROC AU of 0.796, CI 0.727-0.865). (Dullo, 2013).

Locally, we could not find any study done to assess the predictive accuracy of SAS. While it has been validated mostly in developed countries, more global studies in different populations need to be carried out before the SAS becomes as widely accepted as APACHE and PPOSSUM (Regenbogen et al., 2008)). Very few studies have been done in resource limited settings like Zambia. (Dullo, 2013). The patient in a resource limited setting is different from that of a developed countries due to various social, economic and cultural reasons. (Ahmed, 2016).

This study explored the accuracy of Surgical Apgar score at predicting the outcomes in Zambia. Patients were followed postoperatively for 30 days to observe any complications. The observed outcomes were compared with the expected (as predicted by the Score) to assess whether the score is predictive of outcome in this setup.

Because of its simplicity, this score can be used to plan for post-operative management of laparotomy patients and as a means of communication with other cadres like ICU nurses and critical care doctors. The score can also be used to assess performance of hospitals or firms by comparing predicted and observed outcomes of their operations. Its main weakness is that it cannot predict outcome preoperatively. (Regenbogen, 2008).

1.1. Statement of the Problem

Laparotomies in resource limited settings like The University Teaching Hospital (UTH) are associated with many adverse outcomes including death .(Baison, 2015). While SAS is being used in a number of centers to identify patients at risk of developing complications in the immediate postoperative period, (Regenbogen, 2008), there has been very few studies done to prove the predictability of short term outcomes in laparotomy patients using SAS in resource limited settings. (Dullo, 2008). This study will identify these common complications and assess whether surgical Apgar score can be used to identify patients at risk.

1.2. Significance

The post laparotomy complication rate tend to be higher in resource limited centers like UTH compared to the global picture. (Jamison et al, 2006). Surgical Apgar score can identify patients

at risk of these complications immediately after operation. (Regenbogen, 2008). This will enable care teams to put in place appropriate post-operative management protocols to improve outcome.

1.4. Objectives

1.4.1. General Objective

To explore the accuracy of SAS at predicting short term post laparotomy complications at UTH.

1.4.2. Specific Objectives.

1.4.2.1. To measure the SAS in patients undergoing laparotomy.

1.4.2.2. To determine the short term complications in patients who have undergone laparotomies.

1.4.2.3. To determine the association of the short term complications post laparotomy with those predicted by SAS.

1.5. Ethical Issues

1.5.1. Benefits

There were no direct benefits for the participants. The participants did not receive any special treatment and did not receive any financial benefits for participating in the study. All procedures, investigations and follow ups were as per standard routine management.

1.5.2. Risks

There were no direct risks to participants as the study was not interventional.

1.5.3. Confidentiality

Confidentiality was maintained. Participants' names were not used, instead numbers were used for identification. The data collection sheets were kept under lock and key and only the researcher had access. Once information was entered into a computer, it was password protected and only the researcher had the password.

1.5.4. Voluntarism

Participation in this study was completely voluntary, no coercion was used. Patients that felt inconvenienced by participation, were free to withdraw from the study at any time without having to give a reason and this had no implications on their management.

1.5.5. Privacy

Permission was sought from every participant before any interview and participants were free not to answer any questions they considered personal or uncomfortable with. All interviews were conducted in secluded places.

1.5.6. Informed Consent

An informed consent was obtained from each participant prior to their enrolment in the study. For patients who could not read and write, the patient information sheet was read to them by a literate next of kin or witness and asked to append their thumb print as provided for on the consent form.

Permission to carry out the study at the University Teaching Hospitals' Adult Hospital was obtained from management and the Department of Surgery (UTH). Ethical clearance and approval were obtained from ERES Converge IRB

CHAPTER TWO: LITRETURE REVIEW

2.1. Background

Surgery is a fundamental aspect of healthcare delivery globally. According to WHO, the global need for surgery in 2010 was 4664 per 100 000 population giving a total of about 324 million operations globally representing about 11 percent of the entire disease burden. Central sub Saharan African, where Zambia is found, had a need of about 4343 per 100 000 population. Of the 234 million surgeries done per year worldwide only 3.5 percent are from low to middle income countries. (Jamison et al., 2006 and Weiser et al, 2008). In industrialised countries preventable postoperative adverse events are estimated at 3-23 percent of inpatient surgeries with a mortality rate of about 0.4-0.8 percent. In developing countries studies have shown that as much as 5-10 percent major surgeries end up in mortalities. (Jamison et al, 2006).

2.2. Surgical Apgar Score

In 1953, Virginia Apgar formulated a scoring system for evaluating the condition of newborns using basic physiological parameters. Its simplicity and effectiveness in predicting performance of the newborn after delivery led to its wide acceptance worldwide (Apgar, 1953). Equally in 2007, Gawande et al, using the same principle, came up with an intraoperative scoring system known as the Surgical Apgar score (SAS). The SAS is based on three easily calculated physiological parameters; estimated blood loss, lowest intraoperative heart rate and the lowest intra operative mean arterial blood pressure. Preoperative, intra operative and postoperative data was collected in three cohorts of patients, starting from a single type of procedure to a broader category of patients in general and vascular surgery, after which a score was derived using multivariate linear regression. The outcomes database obtained from the National Surgical Quality Improvement Program (NSQIP) and 28 intraoperative variables from anesthetic data for each patient where analyzed. Two preoperative and nine intra operative variables were associated with major complications and death within 30 days of surgery. From these, lowest heart rate, estimated blood loss and lowest MAP where found to be independent predictors of post-surgery outcomes (Gawande et al, 2007).

The score derived from these parameters composes a predictive model for categorizing patients at risk of major postoperative complications in general and vascular surgical procedures. It was found that a lower score increased the chances of developing complications. Major complications occurred in 58.6 percent of patients with a score of less than four, while only 3.6 percent of patients with a score of 9 or 10 developed complications (Gawande et al, 2007). Cardiovascular performance and the degree of blood loss in surgery play a critical role in determining the postoperative course of a patient. The collective importance of heart rate, blood pressure and blood loss and their contribution towards gauging intraoperative performance can be easily recognized by the SAS (Hartmann, 2007 & Rolrig, 2003). Data obtained from this scoring system can be used to plan an aggressive postoperative approach in patients with a low score and also guide clinicians in taking preventive measures such as optimizing blood pressure, heart rate and restoring intravascular volume.

The surgeon, having an immediate score after surgery, is able to categorize the patients who need intense postoperative monitoring from those who are more likely to have an uneventful course (Table 1 and Table 2). This suggests that the SAS may be useful to laparotomy patients who are prone to a high rate of postoperative morbidity and mortality (Straatman, 2016). The score can also serve as a mode of communication between surgeons, residents and nursing staff about a patient's post-operative status and assist in decision making. This includes decisions like when to discharge the patient after surgery, admission to ICU, frequency of postoperative visits, follow up at outpatient clinics and having a high index of suspicion to pick up a complication early

According to Ghaferi et al, surgical mortality in different centers is not explained by postoperative complications but rather by the ability to "rescue" patients from these complications (Ghaferi et al, 2009). The score has also been used to grade health care institutions by comparing their predicted versus observed scores (Regenbogen et al, 2008). From the time Gawande introduced this scoring system it has gained interest in different fields of surgery like general surgery, vascular surgery, gynecology, urology and neurosurgery with promising predictive values (Reynolds et al, 2007).

There has been some critique on calculation of estimated blood loss and its subjectiveness (Delikan, 1972). However studies done to evaluate the score, categorizes blood loss in categories of 0–100 ml, 101–600 ml, 600–1,000 ml, >1,000 ml which are easily within the observers' range of precision. (Gardiner, 1962*).*

There is also a dispute over the influence of anesthetic manipulations and drugs on intra operative hemodynamic parameters which comprise the score. However, evidence shows that alteration in blood pressure and heart rate whether caused by the patients' pathology or influenced by the anesthetic drugs during surgery will have a final impact on the outcomes of surgery. (Monk et al, 2006).

The score in all previous studies has been used across all groups of patients with different preoperative comorbidities. Regardless of the complexity of preoperative risks stratification, the score has been proven to be effective as a measure of the postoperative condition of the patient (Regenbogen et al, 2008). While it has been validated mostly in developed countries, more global studies in different populations need to be done before the SAS becomes as widely accepted as APACHE and PPOSSUM (Regenbogen et al, 2008).

2.3. Post-operative complications.

According to a 2010 study done by Sanjay Basin in India, the lifetime prevalence of a major surgical procedure is 12.3 percent with adult females having a 15.8 percent prevalence and males a 12.6 percent ($p<0.001$). These procedures at times end up with complications and/or death. In a study done in Rwanda by Baison, post-operative complication rate after laparotomy was at 29.9 percent with a postoperative mortality rate at 12 percent. This is in agreement with WHO data (Jamison et al, 2006). In this study the most common predictors for postoperative complications and mortality were found to be need for ICU, home province, having generalized peritonitis and high ASA score (OR 1.30 (95% CI: 1.12, 1.49)).(Baison, 2015).

A major postoperative complication according to the definitions used by the American College of Surgeons' National Surgical Quality Improvement Program (NSQIP) is the presence of one or more of the following in the postoperative period: 1. Acute renal failure; 2. Bleeding requiring four units of red cell transfusion within 72 hours after operation; 3. Cardiac arrest requiring

cardiopulmonary resuscitation; 4. Coma for 24 hours; 5.Deep venous thrombosis;6. myocardial infarction; 7.unplanned intubation; 8.ventilator use for 48 hours;9. Pneumonia;10.pulmonary embolism;11. Stroke; 12.major wound disruption; 13.surgical site infection; 14.sepsis; 15.septic shock; 16.systemic inflammatory response syndrome; 17.unplanned return to the operating room; and 18.vascular graft failure.(Dindo, 2004)

CHAPTER THREE: METHODOLOGY

3.1.Study Design

The study design was a prospective cohort study.

3.2.Study Site

The study was conducted in the Department of Surgery, General Surgery unit at the University Teaching Hospital, Lusaka, Zambia.

3.3.Target Population

The study was undertaken on all patients undergoing laparotomy in the Adult Hospital of the University Teaching Hospitals after the attending unit has made the decision to do a laparotomy.

3.4.Study Population

The study population consisted of all patients meeting the inclusion criteria.

3.5.**Inclusion criteria**

The inclusion criteria was as follows:

i. All patients undergoing non trauma related laparotomy regardless of indication; and
ii. Patients undergoing laparotomy for trauma with no other major injuries like traumatic brain injury, long bone fractures, pelvic fractures etc.

3.6.**Exclusion criteria**

The exclusion criteria included:

i. Non consenting patients;
ii. Patients with incomplete data on intraoperative mean arterial pressure, blood pressure and estimated blood loss; and
iii. Patients undergoing laparotomy for trauma whose prehospital blood loss could not be easily estimated.

3.7.**Sample size**

Sample size was calculated using web based open source OpenEpi version 3 The sample size was 50 with percentage of exposed with outcome at 42%. Power was at 80%

3.8.**Sampling strategy**

All patients undergoing laparotomy and meeting the inclusion criteria were conveniently sampled.

3.9.**Procedure**

Patients that presented to the department of surgery needing a laparotomy had the study explained to them and consent obtained. Their demographic details were collected and entered on a data collecting sheet. Their lowest heart rate, lowest mean arterial pressure and estimated blood loss were extracted from the anaesthetic charts in the immediate post-operative period. This information was used to calculate their Surgical Apgar score using Table 1.

Table 1: A 10-point Surgical Apgar score

	0 points	1 point	2 points	3 points	4 points
Estimated blood loss (mL)	> 1,000	601–1,000	101–600	≤ 100	—
Lowest mean arterial pressure (mmHg)	< 40	40–54	55–69	≥ 70	—
Lowest heart rate (beats/min)	> 85	76–85	66–75	56–65	≤ 55†

Surgical score = sum of the points for each category in the course of a procedure.
*Based on model 1 from cohort 1.
†Occurrence of pathologic bradyarrhythmia, including sinus arrest, atrioventricular block or dissociation, junctional or ventricular escape rhythms, and asystole also receive 0 pts for lowest heart rate.

Source: Gawande, 2007

Patients were them grouped into risk groups using Table 2

Table 2: SAS relative risk

SAS	**Relative risk**
0 – 4 high risk	14% mortality 56% - 75% major complication including death
5 – 6 medium risk	4% mortality 16% major complication including death
7 – 10 low risk	0% - 1% mortality 4% - 6% major complication including death

Source: Gawande, 2007

Where estimated blood loss was not available on the chart, calculations using a mathematical formula which uses a patient's hematological parameters were done. Where Blood loss = {EBV x (H (i) - H (f)) / ((Hct (i) + Hct (f))/2} + (500 x T (u))

Where:

i. Estimated blood volume (EBV) is assumed to be 70 cm3/kg;
ii. H (i) and H(f) represent pre and post-operative hemoglobin;
iii. Hgb(i)and Hgb(f) represents pre and post-operative hematocrit;
iv. T (u) is the sum of whole blood, packed red blood cells, and cell saver units transfused; and
v. Hct is hematocrit. (Gardiner, 1962*).*

Patients were followed up on the wards and the outpatient clinic for up to 30 days post-operative to record any complications. For the patients that could not come to the clinic for reviews, the next of kin was contacted to find out the outcome using the phone number on the data collection sheet. The observed complications were compared with the expected as predicted by the patient's SAS calculated immediately after surgery from the intraoperative data. The control group was an internal one which was determined after data collection. The end point for follow up was either at the end of the 30 day period or occurrence of a complication including death. The data collected was entered on data collecting sheet and analyzed.

3.10. Variables

i. **Dependent (outcome) variables** were MAP, lowest heart rate, EBL which were necessary for calculation of SAS and stratification of patients.
ii. **Independent (exposure) variables were** Age, sex, nature of operation (emergency vs elective) and duration of operation.
iii. **Potential confounders were** Inaccurate EBL estimate, missing data on some complications, blood pressure and heart rate.

3.11. Data analysis

All data collected was entered in excel spreadsheets which was password protected. Statistical analysis were performed using SPSS in consultation with a statistician. Because of small sample size, P values were generated using Wilcoxon signed rank test and where applicable Fischer's

exact test. Value of $p < 0.05$ were considered significant. Data was presented as graphs and pie charts. Errors were minimized by using a double entry system, ranges and consistent checks.

CHAPTER FOUR: RESULTS

4. Patients Characteristics

There were a total of 50 patients enrolled for this study; two were lost to follow up. A total of 48 patients met the inclusions criteria. The age ranged from 17 to 89 years with mean at 38.8 years (SD 17 years). This is illustrated in Figure 1.)

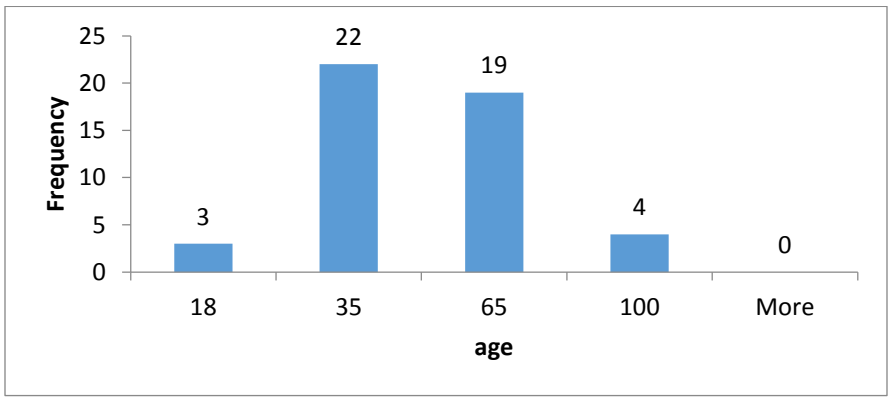

Figure 1: Age distribution

Out of the total number of 48 patients that were analyzed 38 were male making up 79%, 10 were females making up a 21%. This is illustrated in the pie chart labeled as Figure 2.

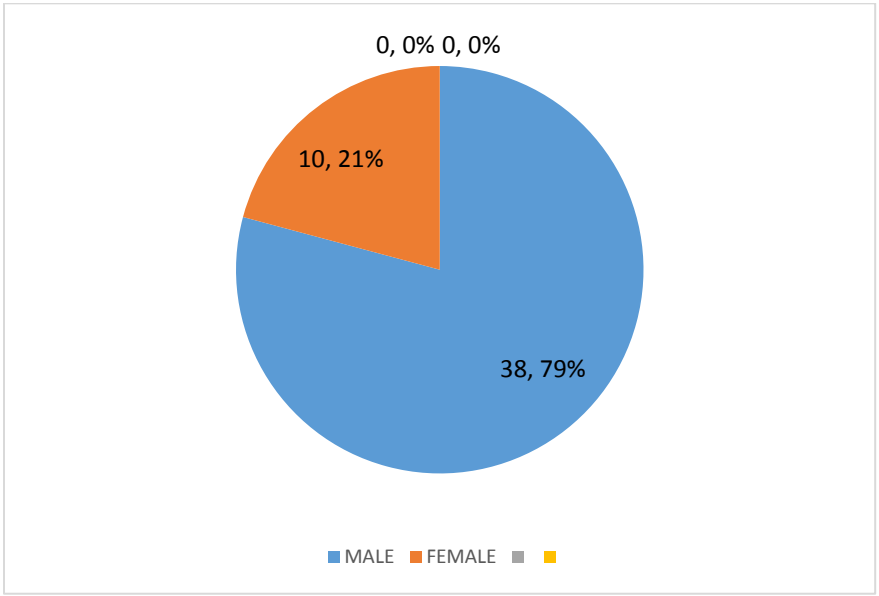

Figure 2: Gender distribution

4.1.Nature of Operation

27% (N=13) of the patients were operated as electives while 73% (N=35) were emergencies. This is illustrated in Figure 3. All the patients in this study were admitted to general wards postoperatively. No patient was admitted to intensive care unit after their operations.

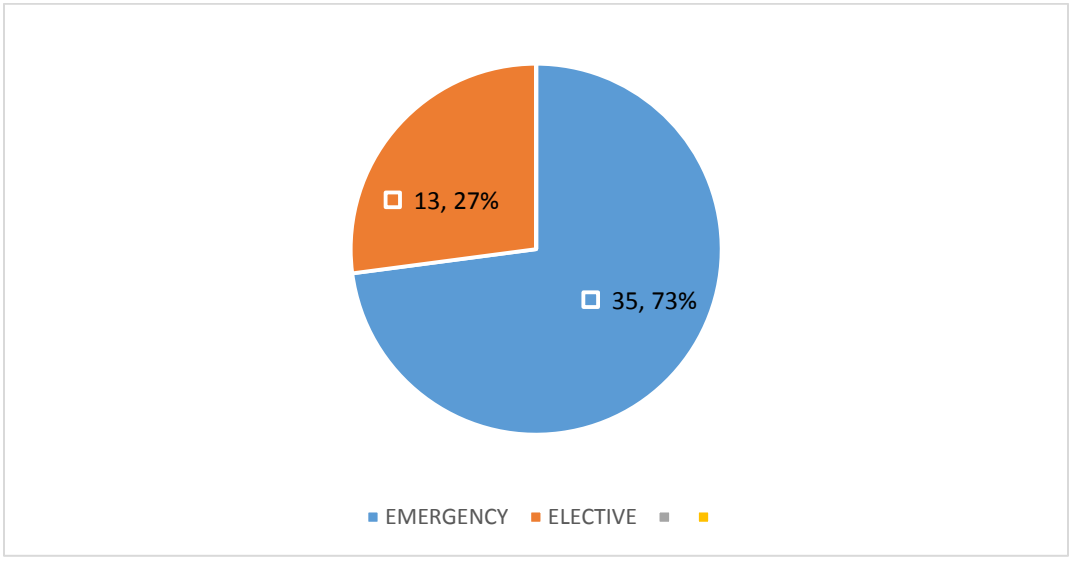

Figure 3: Nature of operation

4.2.Duration of Operation

The duration of operation was recorded in minutes. The mean number of minutes was 106(SD 40mins) 69 percent (N=33) lasted less 120 minutes or less while 31percent (N=15) lasted longer than 120 minutes. The shortest operation took 45 minutes while the longest took 198 minutes. Figure 4 shows duration of operation.

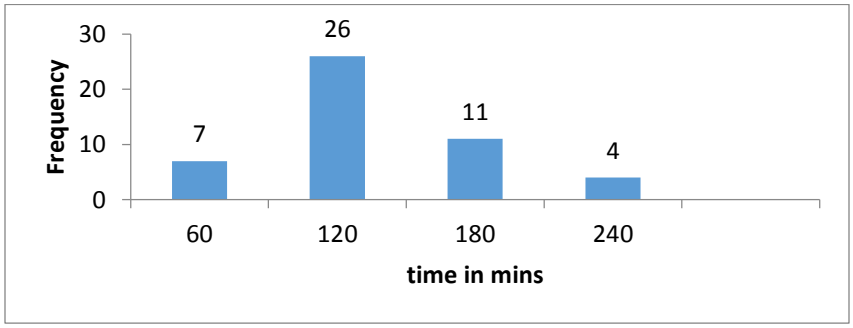

Figure 4: Duration of operation

4.3.Intraoperative Diagnoses

Intestinal obstruction was the most common intraoperative diagnosis with 31.3 percent (N=15) of cases. This is expected as most of the cases enrolled were emergencies. Table 3 presents intraoperative diagnosis.

Table 3: Intraoperative diagnosis

No	diagnosis	Frequency	Percentage N=48
1	Intestinal obstruction	15	31.3%
2	Viscus perforation	14	29.2%
3	Gangrenous bowel	4	8.3%
4	Penetrating stab wound	4	8.3%
5	Anastomotic leak	3	6.3%
6	Malignancies	3	6.3%
7	Pancreatitis	2	4.2%
8	Obstructive jaundice	2	4.2%
9	Primary peritonitis	1	2.0%

4.4.Post-operative Outcomes

Postoperative complications were recorded based on Dindo-Clavien classification of surgical complications. Total number of outcomes is more than 48 because all the dead patient had at least one or more of the complications listed as outcomes. Deep surgical site infection with wound dehiscence in some cases was the most common complications with 12.5 percent. The overall complication and mortality rates were 41.6 percent and 16.7 percent respectively.

Table 4: Post-operative Outcomes

No	Outcome	Frequency	Percentage N=48
1	No complication	28	58.3%
1	Death	8	16.7%
2	Deep SSI	6	12.5%
3	Anastomotic leak	5	10.4%
4	Renal failure	4	8.3%
5	MOD	3	6.3%
6	Aspiration	2	4.2%
7	Cardiac arrest	1	2.1%

4.5.Risk Stratification

After collection of intraoperative data, patient's SAS were calculated using Table 1. Later on they were stratified based on their scores into risk groups using table 2. A 33 percent (N=16) were categorized as low risk. This means they had zero to one percent (N=0) predicted risk of mortality and four to six percent (N=1) predicted risk of developing complications. From this group, two patients developed surgical site infection during the 30 days follow up and there was no mortality recorded.

Twenty five percent (N=12) were categorized as medium risk with a four percent predicted risk of mortality and 16 percent (N=2) risk of developing complications. After 30 days of follow up, there were three complications and one mortality. The remaining patients, 42 percent (N=20) were categorized as high risk with 14 percent predicted chance of mortality and 56 to 75 percent

of complications including mortality. Of these, 70 percent (N=14) developed complications including death while 35 percent (N=7) were mortalities. Figure 5 shows distribution of patients into different risk groups.

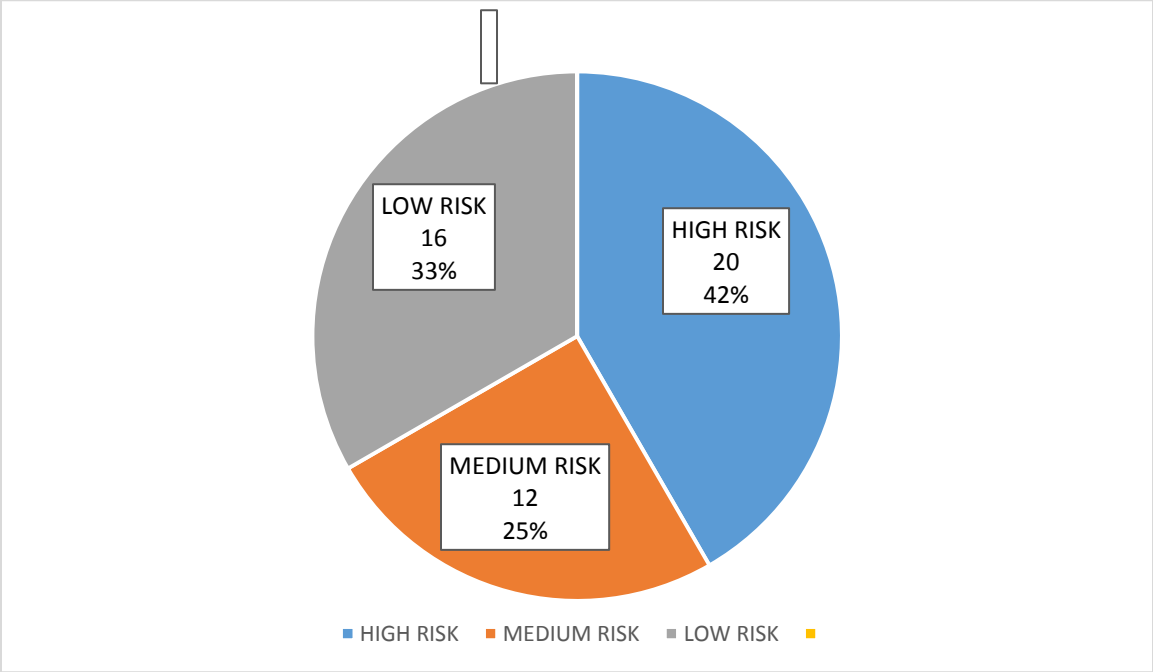

Figure 5: Risk stratification.

To assess whether SAS scores differed between patients with complications and those without complications, their SAS scores were compared. The mean SAS score for patients without complications was 6.35 (±1.82) while for patients with complications was 4.05 (±1.83). Mann Whitney U test (p-value < 0.001) indicated that the SAS scores for patients without complications were significantly higher than the SAS scores for patients with complications.

Patients SAS were also compared based on the period of the operation. A total of 29 patients had an operation lasting 120minutes or less with an average SAS of 5.4(SD 2.2). Those who had an operation longer than 120 minutes were 19 and had a mean SAS of 4.5 (SD 1.9) Mann Whitney U test(p=0.45) indicated that there was no significant difference in SAS based on duration of operation. When compared for gender the p value was 0.28 suggesting that gender did not influence the patient's SAS.

CHAPTER FIVE: DISCUSSION

The purpose of this study was to determine the predictability SAS on short term complications of laparotomies in our setting. This tool was developed as an objective simple tool that could identify patients at risk of postoperative complication. Laparotomy is one of the most common operations at The University Teaching Hospital (UTH) in Lusaka, Zambia. Some studies have demonstrated a higher than global average risk for postoperative complications in resource limited settings like UTH. (Jamison et al, 2006).

A total of 50 patients were enrolled in this study but two were lost to follow up. This left a total of 48 patients. The mean age was 38years (SD 17years) which ranged from 16 to 89 years. Males accounted for 79% (N=38) and females 21 percent (N=10) giving a male to female ratio of 3.8:1 similar to a study done in Kenya by Dullo etal in 2013 which gave a ratio of 3:1. The majority of the studies done in the western countries were mainly retrospective studies giving them an advantage of comparing equal number of male and female patients.

In this study, 79 percent of the operations done were emergencies with 21 percent being elective. Dullo et al had 86.8 percent of patients as emergencies with 13.2 percent as electives. Intestinal obstruction was the commonest indication for laparotomy with viscus perforation ranking second. Major postoperative complications occurring in this study where classified according to the Dindo-Claven classification (Regenboegen 2008). Anastomotic leak and deep surgical site infection had the highest complication rate of 10.4% respectively occurring within the thirty days of follow up. Other common major complications occurring in this study were renal failure and multi organ failure.

Patients who did not develop major postoperative complications (58.3%) were more than those who did (41.6%) (P-value = 0.029). at the same time patients who developed complications had significantly lower mean SAS score of 4.05 compared to 6.35 for those with no complications($p<0.001$). However, occurrence of complications did not significantly vary with gender (p-value = 0.28). Duration of operation did not significantly influence patients SAS. Patients whose operation took longer than 120 minutes were compared with those whose operations took less than 120 minutes and no significant difference was found. ($p=0.45$).

The observed 30-day mortality in our study was 16.7 percent which was in agreement with the findings of Baison in 2016 but slightly higher than Dullo et al in 2013. Surgical mortality is frequently used as a surrogate marker for performance to enable comparisons between individual surgeons and units. This can sometimes be misleading due to differences in case mix as can be seen in differences between patients in our study and that from Dullo et al in which patients with advanced malignancies were excluded from the study.

After SAS was categorized into High risk (0 to 4), Medium risk (5 to 7) and Low risk (8 to 10), Majority of patients who did not develop major complication (58.3%) fell into low risk category of SAS. The high risk category mainly comprised patients who developed most major complications (70%) and mortality (35%). The mean SAS score for patients without complications was 6.35 (±1.82) while for patients with complications was 4.05 (±1.83). Mann Whitney U test (p-value < 0.001) indicated that the SAS scores for patients without complications were significantly higher than the SAS scores for patients with complications. This demonstrates the ability of the SAS in identifying patients at a higher than average risk of major post-operative complications. It also shows that mortality, being the worst outcome, can be predicted using the SAS. Dullo et al demonstrated that patients with low, medium and high risk categories had a 58.3 percent, 35.6 percent and 16.6 percent complication rate respectively (p =0.04) which shows a similar relationship to our study where poor scores correlate with higher morbidity and mortality.

In a developing country like Zambia, a simple tool like the SAS would be useful in routine post-operative risk stratification thereby facilitating easier identification of high-risk patients. This would allow for prudent allocation of limited resources for post-operative monitoring and follow up. Studies indicating a link between intra-operative anesthetic and surgical performance and SAS suggest possibility of its use in surgical audit. Serial monitoring of SAS within a unit may be used as a tool for improving performance. (Regenbogen 2008).

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1. CONCLUSION

The SAS, despite using simple and widely available intra-operative parameters, is an adequate tool at predicting occurrence of short term major complications and mortality following laparotomies in resource limited settings.

6.2. RECOMMENDATIONS

From the study, it can be recommended that:

i. Surgical apgar score can be used as a tool for triaging patients after laparotomy;
ii. Further research is recommended with a larger sample size and in other surgical specialties.

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APPENDICES

Appendix 1. Data collection sheet.

Serial number…… Mobile number…… Date of op…….....

1.0. Demographics

1.1. Age

2.1.1 >18yrs **2.1.2** 18 – 34yrs **2.1.3** 35yrs – 54yrs **2.1.2** ≤55yrs

1.2. Sex

1.2.1. Male **1.2.2.**Female

2.0. Duration of operation

3.0.1. ≤1hr **3.0.2**. 1 to 2 hrs **3.0.3**. 2 to 3 hrs **3.0.4**. ≥3hrs

3.0. Type of operation:

3.0.1 Emergency **3.0.2** elective

4.0 Intraoperative diagnosis

4.1 Primary peritonitis **4.2** visceral perforation **4.3.** Abdominal tumor **4.4** intestinal obstruction.

4.5. Hepatobiliary pathology

5.0. Intraoperative physiological parameters

5.1. Estimated Blood Loss

5.1.1 >1000mls **5.1.2.** 601 – 1000mls **5.1.3.** 101 – 600mls **5.1.4** ≥ 100mls

5.2 Lowest Heart Rate

5.2.1 >85bpm **5.2.2** 76 – 85bpm **5.2.3** 66 – 75bpm **5.2.4** 56 – 65bpm **5.2.5** ≤55bpm

5.3. Lowest MAP

5.3.1 <40mmHg **5.3.2** 40 – 54mmHg **5.3.3** 55 – 69mmHg **5.3.4.** ≥ 70 mmHg

5.4. SAS score

5.4.1 0 – 4 **5.4.2** 5 – 6 **5.4.3** 7- 10

6.0. Ward patient admitted to postoperatively

6.0.1. ICU **6.0.2** HDU **6.0.3** General ward

7.0. Complications

7.1. Complication noted

7.1.1 Cardiac

7.1.2 Respiratory

7.1. 3. Gastrointestinal

7.1.4 Renal

7.1.5 Other

7.2. **Days post operatively**

7.2.1 within 24hrs

7.2.2 24 – 48hrs

7.2.3 2 – 7 days

7.2.4 7 - 30 days

Appendix 2. Participant Information Sheet

Title of Research- Predictability of Surgical Apgar Score on Short Term Outcomes of Laparotomies at The University Teaching Hospital.

Principal Investigator: Dr. Felix Michelo

Introduction

You are invited to participate in a research study. This form explains the research you are being asked to join. Please review this form carefully and ask any questions about the study. If you would like more information or there is anything that you do not understand please feel free to ask. You can ask questions at any time during the study and you are free to withdraw at any point.

PURPOSE OF RESEARCH STUDY

The purpose is to help us understand whether an already developed tool called Surgical Apgar Score can be used to predict the occurrences of complications after opening up of the abdomen. This will help medical personnel to plan treatment of patients immediately after an operation better to prevent these occurrences.

WHO CAN JOIN

All patients who have or are about to undergo laparotomy for any reason can join. You are therefore being asked to join this study because you meet this description. A total of 50 patients will be taking part in this study.

VOLUNTARY PARTICIPATION

Your participation in this study is strictly on voluntary basis. In the event that you later decide to withdraw after joining in the study, you will still receive the same quality of medical care available to you at this hospital. You should ask the principal investigator (whose details are given below) any questions you may have about this study. You may ask questions in the future if you do not understand something that is being done. You are free to skip questions or parts of questions you may deem personal or otherwise without any consequences.

WHAT HAPPENS WHEN YOU JOIN THE STUDY

If you agree to join this study, we will ask you to give us some information about yourself. This information will include your name, age, gender and your mobile number together with that of your next of kin. On top of this information we will collect more data from your medical file as entered by your doctor. The information we will be collecting includes; the date of the operation, start and end time of the operation, findings of the operation, the amount of blood you may have lost during the operation, your blood pressure and heart rate. We will also want to know where you will be admitted after operation and whether you will develop any complications related to the operation up to 30 days after the operation.

PAYMENT FOR PARTICIPATING

You will not be paid or be asked to pay for participating in this study.

RISKS IN TAKING PART

There are NO perceived risks or disadvantages of taking part in this study. If however, you should experience any discomfort or disadvantage as a result of taking part in this research study, you should make this known to the researcher promptly.

IMMEDIATE BENEFITS OF PARTICIPATION

The information collected for the study will be coming from your doctors but if it's discovered that they may have missed something, this information will be given to them so that appropriate interventions are taken.

CONDIFENTIALITY

Only the study investigator collecting and analyzing the data will have information on the answers you give to the questions asked.

You will not be named in any reports about this research. All the data collected will only be used for this research and will kept with utmost confidentiality

RESULTS OF STUDY

The study team will do their best to inform you of findings that potentially could improve your care. The results of this study will be published in a medical journal. All participants of the study will not be identifiable from the published results.

WHAT WILL HAPPEN IF YOU WANT TO STOP TAKING PART

As a participant in this study, you can withdraw at any time, without explanation. Results up to the period of your withdrawal may be used, if you are happy for this to be done. Otherwise you may request that they are destroyed and no further use is made to them.

Persons to Contact: If you want to talk to someone about this study because you think you have not been treated fairly, or think you have been hurt by joining the study, or you have any other questions about the study, you should contact the principal investigator Dr. Felix Michelo of the Department of Surgery at UTH on cell phone number 0977-346820 or e-mail michelofelix@gmail.com and he will try to help you.

If however, you are still unhappy or have a complaint which you feel you cannot come to him with, then you should contact ERES Converge IRB office at the following physical address: 33 Joseph Mwilwa Road, Rhodes Park, Lusaka, Zambia. You can also email to eresconverge@yahoo.co.uk or phoning the office on +260 955 155633/+260 955 155634

Appendix 3. Nyanja information participant information sheet

Nyanja Information Sheet

Pepala yacizindikiso Kwaodwala otengapo mbali

Colinga ca punzuro – Kaneneledwe Kazosatila zakusegula mumula zapafupi kusebenzesa Surgical Apgar Score pa University Teaching Hospital.

mufufuzi: Dr Felix Michelo

MAU OYAMBILILA

Mwaitanidwa kutengako mbali muzimene tifuna kufufuza. Ici cipepala cifotokoza za kufufuza kumene mwapempedwa kutengako mbali. Conde muwerenge modeka mtima zomwe zalembedwa. Ndipo ngati muli ndi funso lililonse pali zomwe tili kufufuza, munga funse kopanda ciliconse cokulesani. Ngati mufuna kuziwa zina zace zilizonse pa nkani imeneyi kenaka ngati kuli zina zomwe simunamvetse kalani omasuka kupereka mafunso. Mungafunse nthawi ili yonse pa nthawi zofufuzazi zizakala zili kucitika. Siapo peka, ngati simuli okonzeka kupitiliza kutengako mbali mu nchito imeneyi ndinu omasuka kusiya.

COLINGA CA NCHITO YA ZOFUFUZA ZIMENEZI

Colinga ca nchitoyi ndi kutandiza a dotolo pa nkani ya Surgical Apgar Score kuti aziwe zovuta zimene zimabwela pambuyo pa opalasyoni yo ng'amba pa mimba. Ndemanga yanu izatandiza a dotolo kucilitsa anthu amene akala ndi opalasyoni ya mutundu otele ndi kubasamalila bwino ngati kwakala zovuta zili zones. Keneka kucingiliza zovuta zili zones pa nthawi yabwino.

KONDI NDANI ANGATENGEKO MBALI

Ali yense amene ali pafupi ndi kukala ndi opalasyoni ya LAPAROTONY angatengeko mbali. Kamba kaici mupempedwa kutengako mbali pa zofufuza zimenezi. Amene ali kudwala okwanila 50 ndi amene afunika kutengako mbali.

KUTENGAKO MBALI MODZIPERERKA

Pamene mutengako mbali mu zofufuza zimenezi ziwani kuti mucita zimenezi kopanda wina aliyense kukukakamizani. Ngati mwaganiza zosiya kutengako mbali mu nchtoyi muzalandila ndithu tandizo ku cipatala monga odwala ali yense. Ngati muli ndi mafunso ali onse mungate kufunsa wa mukulu pa nchito ya zofufuza zimenezi (Dr Felix Michelo).

NGATI MUTENGAKO MBALI, NZOTANI ZICITIKA?

Ngati mutengako mbali tizakupempani kuti mutifotokozere paza mbili yanu. Mbili imeneyi monga zaka zobadwa, ngati ndinu amuna kapena akazi. Kuongezelapo tizatenga mbili yanu yaku cipatala. Mbili imene tazatenga ndi iyi:

- Mbili ya opalasyoni yanu
- Inatenga ma mineti kapena ma hawazi angati
- Anapeza zotani mu opalasyoni
- Magazi amene anataika anali ambili bwanji
- BP ndiponso mtima unali kugunda motani

Ndiponso tizafuna kudziwa kuti azakucitilani adimiti kuti pa mbuyo pa opalasyoni yanu. Ndipo ngati kuzakala zovuta pa opalasyoni patapita masiku okwanila 30. Kuyopa kuti tingauluse pa zainu sitizalemba dzina lanu. Tsono tizakupasani nambala imene izakala ngati dzina lanu. Ndinu omasuka kusayanka funso ngati mwaganiza kuti funsolo likukuzani mwa njila ya padela ndiponso simuli okonzeka kuulusa zimenezo.

MUKATENGAKO MBALI, KODI KULI MALIPILO OTANI?

Kulibe malipilo ali onse pa nchito imeneyi ndiponso simuzapempedwa kulipila ndalama ili yonse po tengako mbali mu nchito imeneyi.

MUKATENGAKO MBALI, KODI KULI ZOOPSA ZILI ZONSE?

Kulibe coopsa cili conse. Ngati muzaona zili zones zodesa nkawa pa nchito imeneyi ziwisani bene bake ba nchito imeneyi mwamusanga.

MUKATENGAKO MBALI, KODI PINDU NDI YOTANI?

Mbili imene tizatenga pa zainu izacokera kwa adotolo anu. Koma kukapezeka zina zomwe sadalembe kapena zimene saziwa, adotolo anu azakala ndi mwayi opasidwa mbili imeneyi kuti akutetezeni ndi kukucilitsani bwino.

CISINSI CA NCHITO

Amene azaziwa za mayanko amene muzapereka ndi adotolo amene ayanganila nchito imene ya zofufuza pa nkani imeneyi. Dzina lanu sizalembedwa mu ripoti ililonse pa zofufuza zimenezi. Zili zonse zizalembewa zizagwilisidwa nchito mu zofufuza zimenezi ndiponso zizasamalidwa mwakabisila.

Zotulukamo mu zofufuza zimenezi

Gulu loyanganila nchito imeneyi izayesetsa kukuziwisani palizimene azafufuza pa inu makamaka ngati zimenezo zingate kutandiza adotolo kukusamalirani bwino. Zimene azapeza muzofufuza zimenezi azazilemba mu buku la za mankwala. Koma bene ace a mbili imeneyi maina awo sazalembedwa mu buku limeneli. Tsono musade nkawa kuti amene azawerenga zotuluka mu kufufuza kumeneku azakuzindikirani.

NIZOTANI ZIMENE ZIZACITIKA NGATI MWAGANIZA KUSIYA KUTENGAKO MBALI

Ngati otengako mbali ku mapunziro amenewa, muli ndi ufulu osiya kutengako mbali kopanda kufotokoza cifukwa cimene cakupangisani kuti muime kucita nchito imeneyi. Koma mayanko amene muzapereka mpaka nthawi imene muzafuna kusiya kutengako mbali, adotolo angawagwilise nchito ndi cilolezo canu. Koma ngati simufuna kuti mayanko anu asawagwilise nchito muta kuwapempa kuti awaonenge.

Ngati mufuna mukambitsana ndi oyanganila pali ma phunziro amenewa cifukwa cakuti kuli zina zimene simunakondwere nazo kapena muli ndi zofunsa mungate kuonana ndi a Dr Felix Michelo akucigawo ca Surgery ku cipatala ca UTH keneka nambala yao ndi 0977346820 keneka email ndi michelofelix@gmail.com. Ndipo azakutandizani

Ngati kuli zina zokulesani kuti mulankule ndi a Dr Felix Michelo mungate kupita kuma ofesi awa: ERES Converge IRB, 33 Joseph Mwila Road, Rhodes Park, Lusaka, Zambia. Email: eresconverge@yahoo.co.uk telephone +260 955 155633/ +260 955 155634

Appendix 4. Consent form

Consent Form

Title of research: Predictability of Surgical Apgar Score on Short Term Outcomes of Laparotomies at The University Teaching Hospital.

Principal investigator: Dr. Felix Michelo

1. I confirm that I have read and understood the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.
2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my rights being affected.
3. I understand that I can at any time ask for access to the information I provide and I can also request the destruction of that information if I wish.
4. I understand that I will not be identified or identifiable in any report subsequently produced by the researcher.

5. I understand that I am free to skip questions or parts of questions I find personal or otherwise without any consequences.

6. I accept that taking part in this study is voluntary and confirm that any risks associated with this have been explained to me.

7. I agree to take part in the above study.

Participant'sName:……Signature/Thumbprint……Date:……

Witness: ……Signature/Thumbprint……Date: ……..

For further questions please contact Dr. Felix Michelo, UTH, 0977-346820 or e-mail michelofelix@gmail.com

Appendix 5. Nyanja participant consent form.

Nyanja Consent form

Pepala yacivomekeso

1. Ndi simikiza kuti ndawerenga ndiponso ndamvetsa zomwe zalembedwa pa nkani ya zofufuza. Ndinali ndi mpata osinkasinka pa nkani imeneyi, ndinafunsa mafunso ndipo Kamba kaici ndine okutila ndi mainko omwe ndapeleka.
2. Pamene ndi tengako mbali mu nchito imeneyi ndizindikila kuti kulibe malipilo ndiponso ndili ndi ufulu osiya kutengako mbali kopanda kupeleka cifukwa cili conse.
3. Ndiziwa kuti pa nthawi ili yonse ndili ndi mpata okatenga zonse zimene ndinapeleka ku zofufuza ndipo ngati ndifuna ndingawapempe kuti aononge za mbili yanga.
4. Ndiziwa kuti dzina langa sizalembedwa mu maripoti ali onse okuza zofufuza zimenezi Kamba kaici kulibe munthu amene azandizindikila.
5. Ndivomeleza kuti kutengako mbali mu nchitoyi ndakala ozipeleka pa ine ndeka ndipo ndisimikiza kuti ngati kuli zovuta zili zonse zimene zingapezeke bene ace andiunikila ndithu.
6. Ndiziwa kuti ndili ndi ufulu osayanka mafunso amene omwe mtima wanga wandilesa kuyanka.
7. Ndavumera kutengako mbali mu mapunziro amenewa.

Zina:……cizindikilo…….siku: ……

Mboni……CizindikisoCamboni……Siku:……

Kuziwa vambiri tumani lamya kuli ba Dr. Felix Michelo, UTH, 0977-346820. michelofelix@gmail.com

Appendix 6. Dindo-Clavien Classification of major postoperative complications

TABLE 1. Classification of Surgical Complications

Grade	Definition
Grade I	Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic, and radiological interventions
	Allowed therapeutic regimens are: drugs as antiemetics, antipyretics, analgetics, diuretics, electrolytes, and physiotherapy. This grade also includes wound infections opened at the bedside
Grade II	Requiring pharmacological treatment with drugs other than such allowed for grade I complications
	Blood transfusions and total parenteral nutrition are also included
Grade III	Requiring surgical, endoscopic or radiological intervention
Grade IIIa	Intervention not under general anesthesia
Grade IIIb	Intervention under general anesthesia
Grade IV	Life-threatening complication (including CNS complications)* requiring IC/ICU management
Grade IVa	Single organ dysfunction (including dialysis)
Grade IVb	Multiorgan dysfunction
Grade V	Death of a patient
Suffix "d"	If the patient suffers from a complication at the time of discharge (see examples in Table 2), the suffix "d" (for "disability") is added to the respective grade of complication. This label indicates the need for a follow-up to fully evaluate the complication.

*Brain hemorrhage, ischemic stroke, subarrachnoidal bleeding, but excluding transient ischemic attacks.
CNS, central nervous system; IC, intermediate care; ICU, intensive care unit.

Source: Dindo D,2004

Appendix 7. Clinical examples of Dindo-Clavien classification of post operative complications.

TABLE 2. Clinical Examples of Complication Grades

Grades	Organ System	Examples
Grade I	Cardiac	Atrial fibrillation converting after correction of K^+-level
	Respiratory	Atelectasis requiring physiotherapy
	Neurological	Transient confusion not requiring therapy
	Gastrointestinal	Noninfectious diarrhea
	Renal	Transient elevation of serum creatinine
	Other	Wound infection treated by opening of the wound at the bedside
Grade II	Cardiac	Tachyarrhythmia requiring β-receptor antagonists for heart rate control
	Respiratory	Pneumonia treated with antibiotics on the ward
	Neurological	TIA requiring treatment with anticoagulants
	Gastrointestinal	Infectious diarrhea requiring antibiotics
	Renal	Urinary tract infection requiring antibiotics
	Other	Same as for I but followed by treatment with antibiotics because of additional phlegmonous infection
Grade IIIa	Cardiac	Bradyarrhythmia requiring pacemaker implantation in local anesthesia
	Neurological	See grade IV
	Gastrointestinal	Biloma after liver resection requiring percutaneous drainage
	Renal	Stenosis of the ureter after kidney transplantation treated by stenting
	Other	Closure of dehiscent noninfected wound in the OR under local anesthesia
Grade IIIb	Cardiac	Cardiac temponade after thoracic surgery requiring fenestration
	Respiratory	Bronchopleural fistulas after thoracic surgery requiring surgical closure
	Neurological	See grade IV
	Gastrointestinal	Anastomotic leakage after descendorectostomy requiring relaparotomy
	Renal	Stenosis of the ureter after kidney transplantation treated by surgery
	Other	Wound infection leading to eventration of small bowel
Grade IVa	Cardiac	Heart failure leading to low-output syndrome
	Respiratory	Lung failure requiring intubation
	Neurological	Ischemic stroke/brain hemorrhage
	Gastrointestinal	Necrotizing pancreatitis
	Renal	Renal insufficiency requiring dialysis
Grade IVb	Cardiac	Same as for IVa but in combination with renal failure
	Respiratory	Same as for IVa but in combination with renal failure
	Gastrointestinal	Same as for IVa but in combination with hemodynamic instability
	Neurological	Ischemic stroke/brain hemorrhage with respiratory failure
	Renal	Same as for IVa but in combination with hemodynamic instability
Suffix "d"	Cardiac	Cardiac insufficiency after myocardial infarction (IVa–d)
	Respiratory	Dyspnea after pneumonectomy for severe bleeding after chest tube placement (IIIb–d)
	Gastrointestinal	Residual fecal incontinence after abscess following descendorectostomy with surgical evacuation. (IIIb–d)
	Neurological	Stroke with sensorimotor hemisyndrome (IVa–d)
	Renal	Residual renal insufficiency after sepsis with multiorgan dysfunction (IVb–d)
	Other	Hoarseness after thyroid surgery (I–d)

TIA, transient ischemic attack; OR, operating room.

Source: Dindo D,2004