UNIVERSITY of RWANDA

College of Medicine and Health Sciences

School of Medicine and pharmacy

Department of Surgery

# THE INTRAOPERATIVE WORKLOAD ASSESSMENT USING SURGERY TASKLOAD INDEX AT UNIVERSITY TEACHING HOSPITAL OF KIGALI, RWANDA

A dissertation submitted in partial fulfillment of the requirements for the award of the Degree of Master of Medicine in General Surgery, University of Rwanda

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**DECLARATION**

This research study entitled **"The intra-operative workload assessment using surgery task load index at University teaching hospital of Kigali"** is my own work and has not been submitted to any other University for the award of a degree. No part of this research should be reproduced without the authors' consent or that of University of Rwanda.

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Sign ___ Date ___27/08/2021_____

**Declaration by the supervisors**

I hereby declare that this dissertation **"The intra-operative workload assessment using surgery task load index at University teaching hospital of Kigali"** was submitted by Dr UWASE Clement with approval.

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Sign ___ Date ____29/08/2021

**- Dr. NTAGANDA Edmond.**

Sign _____ Date 29/08/2021

**DEDICATION**

This research is dedicated to my wife Sandrine, my son, my mother, sisters, and pharmacist Joseph Nzayisenga for their encouragement and support throughout my education.

**ACKNOWLEDGEMENT**

I am grateful to Almighty for giving me strength, support, and good friends throughout my studies.

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## LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| **ACS**: | Acute Care Surgery. |
| **ASA**: | American Society of Anesthesiologists. |
| **CHUK or KUTH:** | University Teaching Hospital of Kigali. |
| **Dr.:** | Doctor. |
| **ECG:** | Electro-Cardio-Gram. |
| **ENT**: | Ear, Nose and Throat. |
| **ERP**: | Early Repolarization Pattern. |
| **HIC:** | High Income Countries. |
| **LMICs:** | Low and Middle-Income Countries. |
| **NASA-TLX:** | The National Aeronautic and Space Administration Task Load Index. |
| **PhD:** | Doctor of Philosophy. |
| **Prof**.: | Professor. |
| **SPSS:** | Statistical Package for Social Science. |
| **SURG-TLX:** | Surgery Task Load Index. |
| **SWAT:** | Subjective Workload Assessment Technique. |
| **UR:** | University of Rwanda. |
| **WP:** | Workload Profile |

## DEFINITIONS OF KEY TERMS

**Surgery Task Load Index**: is an instrument utilized to quantify the intra-operative workload of surgical care providers during a surgical procedure. It has six scales measuring mental demands of procedure, physical demands of procedure, temporal demands of procedure, situational stress during procedure, complexity of the task and distractions.

**Mental demands:** how mental fatigue the surgical care provider experienced during the procedure.

**Physical demand**: a physical effort the surgical care provider used during the procedure.

**Temporal demand**: how hurriedness was the speed of the operation.

**Task complexity**: the effort a surgical care provider has to maintain in order to accomplish his goal. .

**Situational stress:** how the surgical care provider felt anxious during the task or operation.

**Distractions**: how the theater environment distracts the surgical care provider.

**The intra-operative workload:** the degree to which the surgical care provider involves his/her mental and physical demands required to perform a given task during an operative procedure.

**Workload threshold:** a workload score at which clinical task decline and clinical error become common. Using Surgery task load index; workload threshold is reached when score is or greater than 50 points.

**Surgical care providers:** were surgeons, resident in surgery, or surgical fellows who provide *care* in an operating theatre.

**Five ASA classes (I to V)**: **I**. Normal healthy patient, **II**.A patient with mild systemic disease, **III**. Patient with severe systemic disease, **IV**. Patient has incapacitating disease that is a constant threat to life, and **V**: a moribund patient who is not expected to survive.

## ABSTRACT

**Background:** The complexity of the operating room can generate a high mental and physical workload demand for operating team. Complex surgical techniques and technologies are continually evolving, increasing the mental demands and physical demands to the surgeons and their teams.

**Objectives:** This study aimed to assess the intra-operative workload of surgical care providers at the University Teaching Hospital of Kigali (CHUK).

**Methods:** This was a prospective cohort study. 39 surgical care providers have been followed performing 120 surgical procedures over the period of 3 months. The surgery task load index (TLX) tool was used to collect data on the six dimensions for surgery workload assessment: Mental demands, physical demands, temporal demands, task complexity, situational stress, and distractions.
SPSS version 22 was used for data analysis. Percentages and means have been used for descriptive statistics. For categorical variables with comparison groups not exceeding 2, Fischer's exact test was used; otherwise, chi-square test was used. A p –value of 0.05 or less was considered statistically significant. Odds ratio (OR) and 95% confidence interval (CI) was estimated using logistic regression analysis.

**Results:** 120 operative cases and 39 surgical care providers were included, 26 residents /fellows and 13 surgeons. Most surgical procedures were open technique (85%). 71% of surgical care providers had high intra-operative workload above midpoint of SURG-TLX scale, indicating high unsustainable high workload. Surgeons also surpassed midpoint on SURG-TLX subscale in 47.5% for mental demand, 37.5% for physical demand, 42.5% for temporal demand, 44.17% for task complexity, 32.5% for situational stress and 25.83% for distraction. Factors influencing intra-operative workload were duration of procedure (p=0.017) and surgeon experience (p=0.003). No statistically significant difference of intra-operative workload among different surgical specialties.

**Conclusion:** The majority of surgical care providers experienced high level of intra-operative workload at unsustainable level. Factors influencing intra-operative workload were procedure duration and surgeons experience. We would recommend introducing in-theater stress management program, targeted stretching micro-breaks to improve mental wellbeing of surgical providers.



**Key words**: Intra-operative work load, surgery task load index, surgical care providers

# CHAPTER I: INTRODUCTION

## I.1 Background

The complexity of the operating room can generate a soaring mental and physical workload on an operating surgical team (1). Complex surgical techniques and technologies are continually evolving, increasing the mental demands and physical demands to the surgeons and their teams (2).

Challenges suchlike complexness of procedures, temporal demands, distractions, peer evaluation and multitasking all possess the potency to impact on intra operative stress level (3). Different studies recommended that gaps between required workload and available capacity weaken performance and also may play a role in patients morbidity and mortality (4)(5).

According to Koh et al.;a surgical team member with high cognitive workload is less efficient at adjusting to unanticipated work such as intra operative complications and instrument malfunctions (6)(7). Repeated vulnerability to high intra-operative workload can alter surgical care provider's career longevity (8)(9). According to Law et al.the Workload is "a construct developed to explain the human cost to perform a task, this takes into consideration of mental and physical requirement necessary to accomplish a task"(10).

There are multiple tools used to assess the intra-operative workload. The far used measure of workload is the National Aeronautic and Space Administration task load index (NASA-TLX) and its validated surgery unique version as surgery task load index (SURG-TLX). SURG-TLX is multidimensional rating scale with six dimensions: "mental demands, physical demands, temporal demands, task complexity, situation stress and distraction"(11). Marzur et al.2014 found that intra-operative workload score at which clinical task decline and clinical error become common when score is or greater than 50 points over hundreds points.

Over the last two decades, Rwanda has seen a huge development in several sectors; economic, education and health. Several initiatives have been done to improve access to health care; this includes human resources development, building healthcare infrastructures, improving the referral system and access to healthcare insurance. As we improve access to surgical care, there

is a need to ensure safe surgery to all patients. Indeed, resources scarcity and variability have been identified to affect patient outcomes in Rwanda (14).

Most studies that assess the intra-operative workload were conducted in high income countries (HIC). Even if the effect of workload on surgical performance in low and middle-income countries (LMICs) may not be different from HICs, the factors affecting the cognitive workload on surgical care providers in LMICs may be different due to the fact that the complexity of operating rooms in HICs is different from that in LMICs. Understanding these factors will help surgical managers, educators and leaders to design interventions that optimize the workload of surgical care providers for improved patients' safety and satisfaction.

**I.2 Problem statement**

The global burden of surgical conditions requiring surgeries estimated to be 234 millions operation annually (15). Rose et al. reported that approximately 2 billion of people in LMICs lacks assess to essential surgical care with shortage of surgical care providers being the leading roadblock to safe surgery(15).

According to Shrime et al. revealed that, globally, we estimate 1 112 727 specialist surgeons. With low and middle income countries representing 48% of global population have 19% of all surgeons, 0.7 provider to 100 000 population in low income countries(16).

Surgical needs in Africa are immense. Numbers of surgical care providers per capita in most of African countries are still low(17). This is due to fewer trained surgeons and migration of health care providers to NGO and overseas with subsequent strains to surgical services and high workload to surgical care providers(17).

There is a high disparity of surgical workforce among HICs and LMICs (18). For example: In 2012, United Kingdom had 75 surgical providers density per 100 000 population (18) whereas Ethiopia had 0.12 surgeon per 100 000 population in 2012(19).

In Rwanda, study done by Petroze et al. in 2012, found that surgical providers density per 100 000 population was o.13 general surgeons,0.08 orthopedic surgeons,0.027 neurosurgeons,0.073 ENT surgeons, 0.027 urologist,0.009 pediatric surgeons,0.018 maxillofacial surgeons and 0.009

cardiothoracic surgeons(20). With this shortage of surgical providers and high burden of surgical condition, there is high workload for existing surgeons.

In Addition to shortage of surgical care providers, transition from open technique to minimally invasive surgery requires learning, processing new inputs. Such transformation of using advanced technique require considerable mental and physical cost to health care providers(21)

In Rwanda, roughly 6.4% of the population needs presently a surgical intervention (22). CHUK the largest referral hospital in the country possess catchment area of six millions and two hundreds thousands(6 200 000) population (22). With such high surgical needs, waiting list is huge. More consideration was put on quality care delivery and patient safety but little attention given to how surgical team and technology development interact and their effect on intra-operative workload.

Closing this gap is beneficial to both surgical care providers and decision maker with objective of better understand the implication of the evolving surgical procedures' technology and on surgeons-system interaction. Our study will measure intra-operative workload of surgical care providers using Surgery task load index and to identify factors influencing high intra-operative workload for further performance improvement at CHUK.

**I.3. Justification of the study**

Surgeons most often perceive their workload by surgical volume. As operation become more complex and requiring more technology, the surgical care providers' intra operative workload will presumably increase. Surgery task load index examines the cause of high intra-operative workload. In addition, it also helps to establish a scheme to reduce intra-operative workload with subsequent improve of quality of life for surgeons and patients' safety.

Our current intra-operative workload of surgical care providers is unknown. To understand if surgeons can stand out an extra workload or whether we need to balance our actual intra-operative workload, we must asses our current intra-operative workload and identify risk factors for high intra-operative workload.

Understanding the intra-operative workload of surgeons will help the surgical educators and leaders to design interventions that optimize the intra operative workload therefore improve patient safety and satisfactions.

### I.4. Study objective

#### I.4.1. General Objectives

To assess the intra-operative workload of surgical care providers

#### I.4.2. Specific objectives

1. To determine the intra-operative workload of surgical care providers at CHUK.
2. To identify factors influencing the intra-operative workload in surgical care providers at CHUK.
3. To compare intra-operative workload across different surgical specialty at CHUK.

#### I.4.3. Research question.

What is the intra-operative workload of surgical care providers at University Teaching Hospital of Kigali (CHUK)?

#### I.4.4. Hypothesis

We hypothesize that workload is high among surgical care providers with factors like level of expertise, type of procedure and specialty affect the level of workload.

# CHAPTER II: LITERATURE REVIEW

## II.1 Introduction

Over the recent years, many system organizations including health care sectors have been searching for a method to improve their working conditions with better use of their resources including human beings (23). Therefore, different concepts and tools have been adopted such as workload measures. Workload has been defined previously as "a construct that is used to describe the extent to which an operator has engaged the cognitive and physical resources required for a task performance"(24).

Sweller has established a theory that defines workload in three cognitive loads; "first, intrinsic cognitive load which refers to the load imposed by intrinsic nature of information being processed. Second, extraneous cognitive load induced by external factors such as work organizations, time pressure, background voices. Lastly, germane load which is defined as load imposed on working memory by a construction and automation of schemas"(25).

Many researchers and ergonomist have been trying to assess workload quantitatively by different techniques. Both subjective and physiological measures are the most popular workload measures(26).

## II.2 the objective (physiologic) measures of the workload

There are different objectives or physiologic measures of surgeons' workload. Ocular measures (pupil diameter, blink rate), cardiac measures (intra-operative heart rate variation), respiratory response (breath rate), and brain activity (EEG etc.).Although there are called objective measures, they are not direct measures as they base on presumed relationship between autonomic system and cognitive activity (27).

## II.3. Subjective measures of workload

It is the most direct indicator of workload as the workload is measured at the source. This makes the subjective tools to be more valid and reliable; intra-and inter- reliability of these subjective tools are high (28). Subjective measures are also flexible and portable as no special equipment needed. There also less costly and easy to analyze (28).

Subjective measures of workload are multi-dimension measures. They can investigate the origin of high workload. In the other hand, the important drawback of subjective measures of workload

is completed post a task, hence it can influence long task workload reliability. Despite, it has shown to be among the best measures of workload due to high sensitivity and diagnosticity (29).

Several subjective workload measures have been developed over the years: NASA task load index, with its derivative surgery task load index, Cooper-Hooper scale, workload profile (WP), Subjective workload assessment technique. The widely used NASA task load index because it can be used in multiple domains(11).

### II.3.1 Description of NASA TLX and its surgery specific tool SURGERY TLX

NASA task load index, the widely used tool was developed in 1980s in aviation and later used in others different domains(30).It consists of six subscales that measure independent dimension of workload including: mental demands, physical demands, temporal demands, effort, Performance and frustration(31).

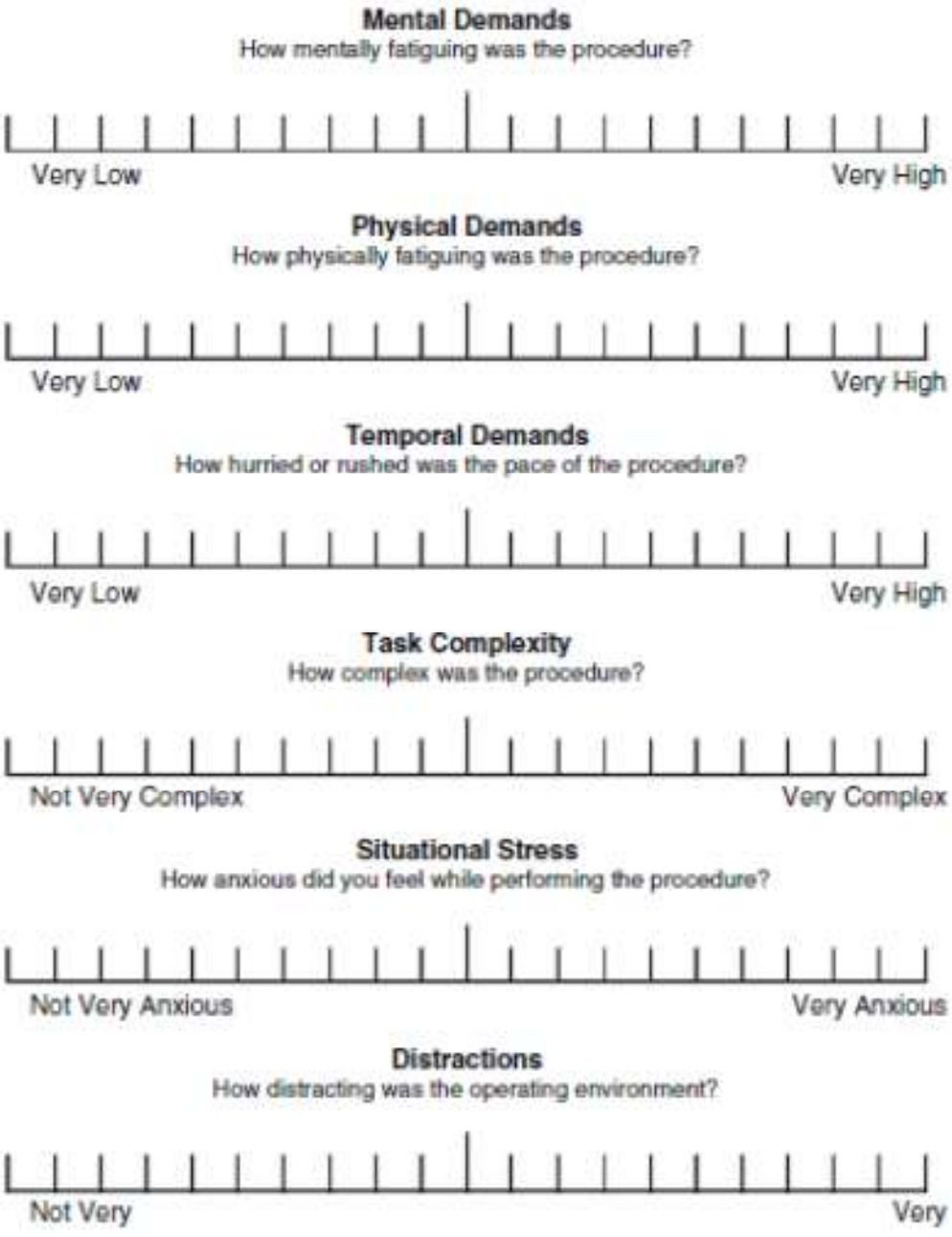
The surgery task load index (SURG-TLX) was introduced to measure workload of surgical care providers. Several researchers and ergonomics have been consulted to identify the main intra-operative stressors and the surgery specific tool was formulated as follows:

- Mental demands: how mental fatigue the surgical care provider experienced during the procedure.
- Physical demand: a physical effort the surgical care provider used during the procedure.
- Temporal demand: how hurriedness was the speed of the operation.
- Task complexity: the effort a surgical care provider has to maintain in order to accomplish his goal.
- Situational stress: how the surgical care provider felt anxious during the task or operation.
- Distractions: how the theater environment distracts the surgical care provider.

Both SURG-LX and NASA-TLX have a similarity except for three subscales which have substituted by the more applicable cognitive load dimensions to the field of surgery. Each dimension rated on a twenty step scale, TLX simply calculated as the mean of the six item ratings. When calculated in this way, TLX is sometimes referred to as raw TLX. The weighting is intended to tailor the TLX instrument to the task by emphasizing the most significant

dimensions of the task. However, the weighting procedure has been depreciated because it has been found to be ineffective(32)

*Figure 2 1* ***The surgery task load index scale.***




**Source:** wilson et al.(11)

### II.3.2.Reliability of NASA TLX and its surgery specific tool SURGERY TLX

There are two main concepts in psychometric measures like Surgery task load index. Those concepts are reliability and validity of the tool. The reliability is defined as the quality of being dependable or reliable: when measuring something at two different occasions resulting in the same outcomes. Test and retest method has been applied to prove reliability of NASA TLX tool and its derivatives including Surgery task load index (33).

Validity refers to the quality of effectiveness or content of measurements. Hart and Steveland constituted a content validity of NASA-TLX while developing NASA-TLX. Rubio et al reported a high convergent validity for NASA-TLX instrument. In laboratory study done, it was shown that NASA-TLX and its derivatives highly correlate with other instrument such as workload profile and workload assessment with 0.7 and 0.98 respectively(29). In summary, NASA-TLX and its variations are reliable and valid instrument than others.

### II.4. Workload in surgery

Workload of surgical care providers has received some considerable attention in literature. Katherine et al., on assessing workload in colorectal surgery showed mean surgeon perceived workload were highest for effort followed by mental demand and physical demand(30). Law et.al, found that significant difference in intra-operative workload were due to procedure type and surgical approaches(2).

Denny et al., in their study found that the intra-operative workload may vary depending on team role and procedure type (34). Lukasz et al. from a series of controlled experiences , reported that performance decreases when intra-operative workload score is equal or greater than fifty five(13).

## CHAPTER III: METHODOLOGY

### III.1 Study design

It was a prospective cohort study.

### III.2 Study site

This study was conducted at CHUK, a tertiary hospital located in Kigali and it has 519 beds. It covers 53% of referrals from district hospitals. The hospital has 6 general surgeons, 2 neurosurgeons, 1 plastic surgeon, 2 pediatric surgeon, 5 orthopedic surgeons3 ENT surgeons and a varying number of visiting surgeons. As a teaching hospital, CHUK also hosts a varying number of surgical trainees and medical/nursing students.

### III.3 Study population

The study population was surgical care providers: surgeons, senior residents in surgery and fellows in surgery at CHUK.

### III.4 Process for data collection

The eligible surgical care providers were given a Surgery task load questionnaire immediately after surgical procedure. The questionnaire was reliable and validated, in order to assure the questionnaire reliability, a pre-test was done on a sample size of 12 study cases. To ensure the reliability of the instrument, Cronbach's alpha scale reliability coefficient was calculated using SPSS version 22 and it was 0.811 (which is above 0.7), meaning that the instrument was reliable. A total of 39 surgical care providers have been followed performing 120 surgical procedures from 1$^{st}$ January 2021 to 31$^{st}$ march 2021.

### III.5.Variables to be measured

We collected data about the factors that may affect the workload: Specialty of the surgical care providers, level of training and experience of surgeon, diagnosis, procedure, surgical technique (open Vs laparoscopy) and ASA classification of the patient.

After the operation, the primary operator fills his/her Surgery task load questionnaire and individual score were recorded.

### III.5.1 Main outcomes

Our primary outcome was the SURG-TLX score of intra-operative workload of surgical care providers and secondary outcome was predictors of high workload.

### III.6 Selection of population

### III. 6.1 Inclusion criteria

Inclusion criteria of the surgical care providers were:

- Surgeons
- Senior Resident in surgery
- Surgical fellows

### III.6.2 Exclusion criteria

- No exclusion criteria

### III.7 Sampling

This study used convenience sampling method where all surgeons, surgical fellows and seniors' residents at CHUK were potential participants.

Finally, 39 participants accepted to be included in the study with 26(81%) of 32 residents and fellows, and 13(61.9%) of 21 surgeons.

### III.8 Data analysis

Data entry was done using Epi data, the analysis of data done by using SPSS statistical software version 22. (The descriptive analysis (univariate analysis) we reported in frequencies and percentages for categorical variables, for continuous variables descriptive analysis reported as medians and interquartile ranges. The multivariate performed therefore for categorical variables the chi-square test or Fisher exact test used and for continuous variables the Mann-Whitney U test or Student *t* test were be used.

### III.9 Ethical consideration

Confidentiality during data collection of care providers and patient's identification were maintained throughout and after data collection; every form had a code. Informed consent was voluntary presented to participant and signed by participant. Approval to conduct this study was

obtained from University of Rwanda, college of medicine and health sciences institutional review board (CMHS-IRB). Access to the surgical care providers were requested from CHUK research and ethic committee.

### III.10 Logistics

The principal investigator was coordinating all study activities. Literature search, discussion and selection were done by principal investigator.

## CHAPTER IV: RESEARCH FINDINGS AND DISCUSSION

### IV.1 Characteristic of respondents

Respondents' characteristics offer descriptive information on surgical care providers' gender, education level, level of training for residents and fellows, surgeons' working experience and surgical specialty. The clinical characteristics include case position per day, procedure duration (in Minutes), surgical technique, ASA grade and medical & surgical body systems. The patient's characteristics are age, gender.

***Table 4 1 Characteristic of surgical care providers.***

| Variables | Descriptions | Frequency | Percentage |
|---|---|---|---|
| **Gender** | Male | 35 | 89.74 |
| | Female | 4 | 10.26 |
| **Education level/position** | Resident or Fellows | 26 | 66.66 |
| | MMED | 10 | 25.64 |
| | MMED with other subspecialty | 3 | 7.7 |
| **Residents' level of training** | Year 3 | 10 | 43.47 |
| | Year 4 | 12 | 52.17 |
| | Year 5 | 1 | 4.37 |
| | Year 6 | 0 | 0 |
| **Fellows' level of training** | Year 2 | 3 | 100 |
| **Surgeons' working experience** | 0 to 2 years | 4 | 30.76 |
| | 3 to 5 years | 6 | 46.15 |
| | Greater than 5 years | 3 | 23.07 |
| **Surgical specialty** | ACS (acute care surgery) | 10 | 25.64 |
| | General surgery | 8 | 28.33 |
| | Urology | 3 | 7.69 |
| | Pediatric surgery | 3 | 7.69 |
| | Orthopedic surgery | 6 | 15.38 |
| | ENT (ear, nose and throat) | 5 | 12.8 |
| | Plastic surgery | 2 | 5.13 |
| | Neurosurgery | 2 | 5.13 |

**Source:** Primary data. n surgical care providers=39.

Table 4.1 shows a total of 39 surgical care providers participated in this study and the majority of surgical care provider respondents were male (89.74%), resident or fellows in surgery (66.66%), majority of them were in year 4 of study (41.15%).

*Table 4 2 Patients' sociodemographic and clinical characteristics*

| Variables | Descriptions | Frequency | Percentage |
|---|---|---|---|
| **Age** | 1 to 34 years old | 63 | 52.5 |
| | Greater than 34 years old | 57 | 47.5 |
| **Gender** | Male | 89 | 74.17 |
| | Female | 31 | 25.83 |
| **Patient ASA grade or patient physical status** | ASA I | 75 | 62.5 |
| | ASA II | 30 | 25 |
| | ASA III | 13 | 10.83 |
| | ASA IV | 2 | 1.67 |
| **Medical and Surgical Body Systems** | Heart and Great Vessels | 3 | 2.5 |
| | Upper limb | 2 | 1.67 |
| | Lymphatic and Hemic system | 1 | 0.83 |
| | Ear, Nose, Sinus | 5 | 4.17 |
| | Respiratory System | 3 | 2.5 |
| | Mouth and Throat | 2 | 1.67 |
| | Gastrointestinal System | 66 | 55 |
| | Hepatobiliary System and Pancreas | 2 | 1.67 |
| | Endocrine System | 2 | 1.67 |
| | Skin and Breast | 10 | 8.33 |
| | Subcutaneous Tissue and Fascia | 3 | 2.5 |
| | Lower limb Bones | 10 | 8.33 |
| | Female Reproductive System | 1 | 0.83 |
| | Male Reproductive System | 2 | 1.67 |
| | Anatomical Region, Upper extremities | 2 | 1.67 |
| | General trauma | 1 | 0.83 |
| | Anatomic Regions, Lower Extremities | 5 | 4.17 |
| **Case position** | $1^{St}$ to $2^{nd}$ position | 99 | 82.5 |
| | $3^{rd}$ to $4^{th}$ position | 21 | 17.5 |
| **Surgical technique** | Open procedure | 102 | 85 |
| | Minimally invasive | 18 | 15 |
| **Procedure duration (in Minutes)** | 15 to 60 Minutes | 49 | 40.83 |
| | 61 to 120 Minutes | 42 | 35 |
| | Greater than 120 Minutes | 29 | 24.17 |

**Source:** Primary data. *n=120*.

Table 4.2 shows that majority of patients were male (74.17%), were in young age (52.50%), and their physical status were completely healthy fit patient or ASA grade I (62.50%). The most concerned medical and surgical body systems were gastrointestinal system (55%). The most of patients were on position 1 or 2nd (82.50%)on operative schedule, they were applied an open procedure surgical technique on most of them (85%), and the procedure duration were in different range 15 to 60 Minutes (40.83%) and 61 to 120 Minutes (35%).

## IV.2 Quantification of the intra-operative workload across surgical care providers at CHUK

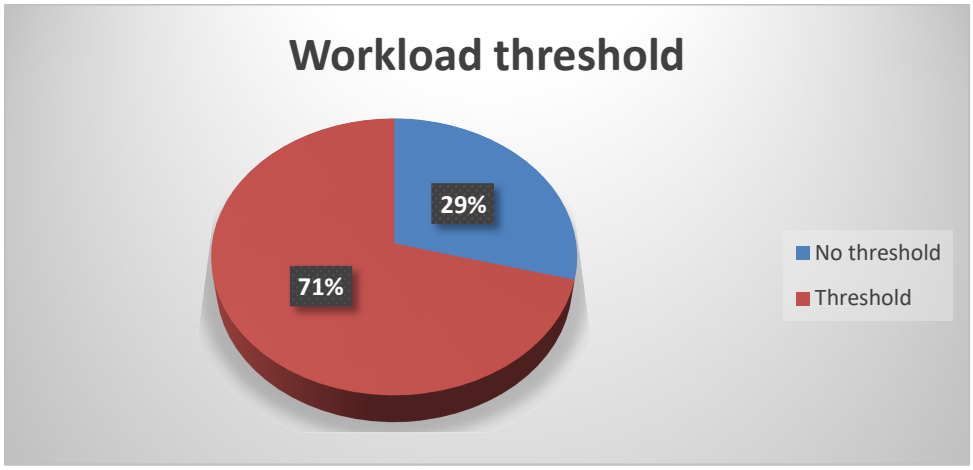
*Table 4 3* ***The intra-operative workload distributions among surgical care providers.***

| Workload variables | Descriptions | Frequency by case | Percentage |
|---|---|---|---|
| Mental demands | Low mental demands | 63 | 52.50 |
| | High mental demands | 57 | 47.50 |
| Physical demands | Low physical demands | 75 | 62.50 |
| | High physical demands | 45 | 37.50 |
| Temporal demands | Low temporal demands | 69 | 57.50 |
| | High temporal demands | 51 | 42.50 |
| Task complexity | Low task complexity | 67 | 55.83 |
| | High task complexity | 53 | 44.17 |
| Situational stress | Low situational stress | 81 | 67.50 |
| | High situational stress | 39 | 32.50 |
| Distractions | Low distractions | 89 | 74.17 |
| | High distractions | 31 | 25.83 |

**Source:** Primary data. n=120. *Low workload scale (0 to 9), High workload scale (10 to 20).*

Table 4.3 shows the intra-operative workload of surgical care providers. Surgical care providers had expressed high intra-operative workload above midpoint (threshold) of Surgery-TLX: 47.5% in mental demand, 37.5% in physical demand, 42.5% in temporal demand, 44.17% in task complexity, 32.5% in situational stress and 25.83% in distraction.

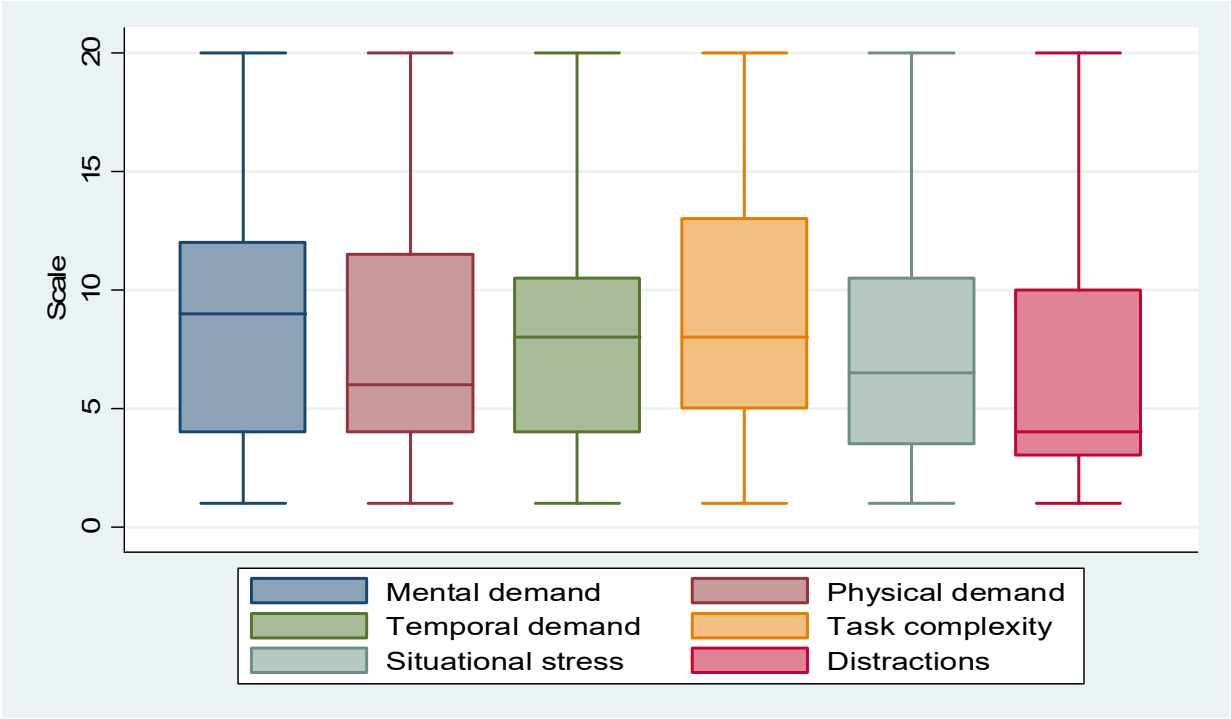
***Figure 4 1 Intra-operative workload thresholds in surgical care providers.***




**Source:** Primary data.

As Figure4.1 shown, 71% of surgical care providers had overall SURG-TLX score above 50(score from 0 to 100), the level at which clinical performance decreases.

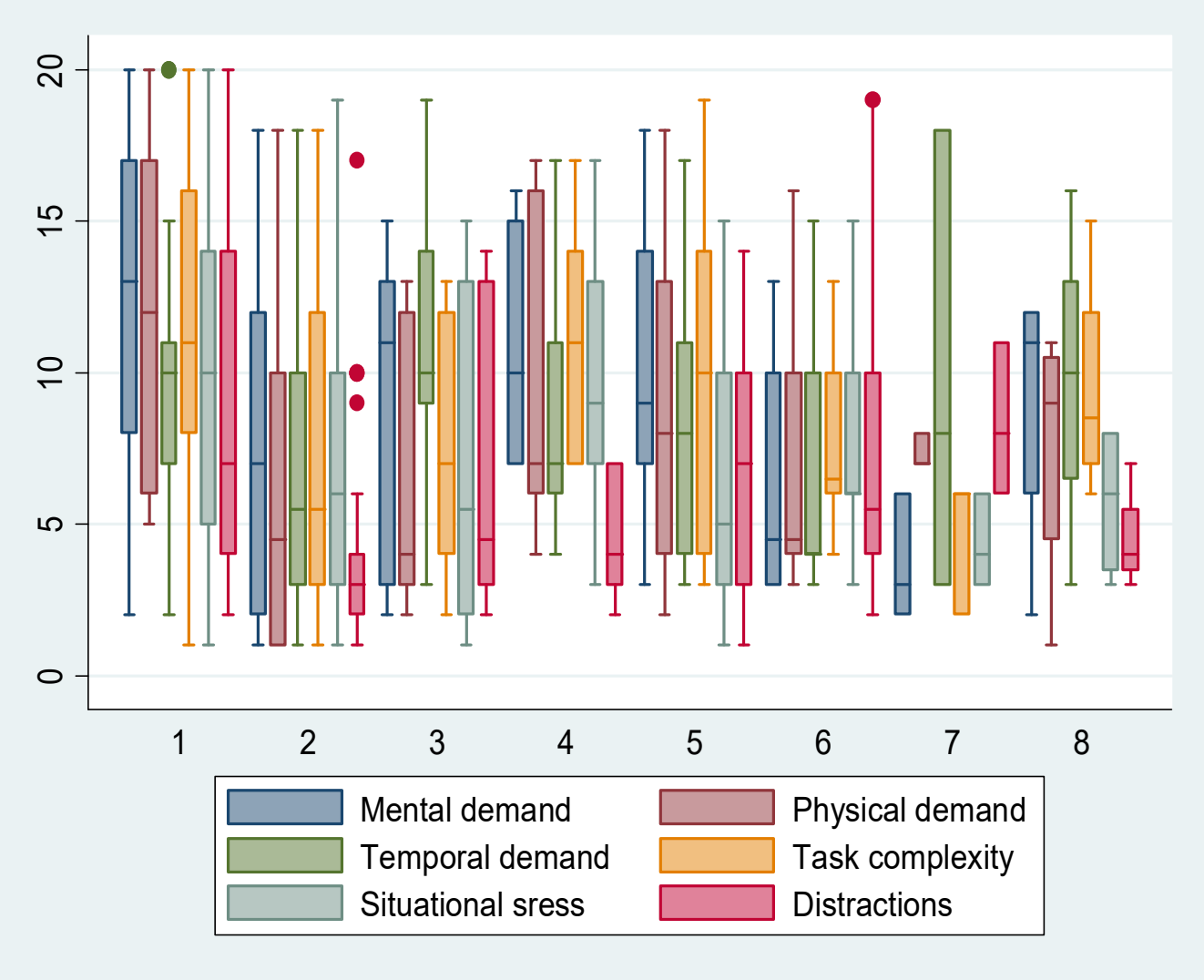
***Figure 4 2 Comparison of mean surgery task load subscales***




**Source:** Primary data.

Figure 4.2 represents the means of SURG-TLX subscales. Lower, upper and middle lines of boxes represent respectively the 25$^{th}$percentile, 75$^{th}$percentile and median value. The high mean workloads were observed on mental demands followed by temporal demands and task complexity.

***Figure 4 3 Surgery-TLX subscales by surgical specialty.***




**Source:** Primary data. *1: ACS, 2: general surgery, 3: urology, 4: pediatric surgery, 5: orthopedic, 6: ENT, 7: plastic surgery, 8: neurosurgery.*

Figure 4.3 shows distribution of SURG-TLX subscales by surgical specialties. Lower, upper and middle lines of boxes represent respectively the 25$^{th}$percentile, 75$^{th}$percentile and median value. The top and bottom whispers represent the 95$^{th}$ and 5$^{th}$ percentile respectively. Circles or dot represents outlier.

**IV.3 The factors influencing the intra-operative workload in surgical care providers at CHUK**

***Table 4 4 Bivariate analysis***

| Variables | Frequency | | Pearson Chi square | P value |
|---|---|---|---|---|
| | Low workload (n=35; 29.16%) | High Workload (n=85; 70.84 %) | | |
| Gender | | | 2.8161 | 0.093 |
| Male | 31 (27.43 %) | 82 (72.57%) | | |
| Female | 4 (57.14%) | 3 (42.86) | | |
| Education level | | | 0.7475 | 0.387 |
| Resident or fellow | 21(26.58%) | 58(73.42%) | | |
| Specialist surgeon | 14 (34.15%) | 27 (65.85) | | |
| Surgeons Experience | | | 8.5663 | 0.003 |
| 0 to 3 years | 12(18.18 %) | 54 (81.82%) | | |
| Greater than 3 years | 23 (42.59%) | 31 (57.41%) | | |
| Case position | | | 0.2139 | 0.644 |
| 1st to 2 nd cases | 28 (28.28 %) | 71 (71.72%) | | |
| Greater than 2nd | 7 (33.33%) | 14 (66.67%) | | |
| Patient age | | | 0.0227 | 0.88 |
| 1 to 34 years old | 18 (28.57 %) | 45 (71.43%) | | |
| Greater than 34 years old | 17(29.82 %) | 40 (70.18%) | | |
| Patient gender | | | 0.1933 | 0.66 |
| Male | 25 (28.09 %) | 64 (71.91%) | | |
| Female | 10 (32.26 %) | 21(67.74%) | | |
| Patient ASA grade | | | | |

| | | | |
|---|---|---|---|
| Grade I | 24 (32.0%) | 51 (68.00%) | 0.7771 | 0.378 |
| Grade II to V | 11 (24.44 %) | 34 (75.56%) | | |
| Surgical techniques | | | 0.1780 | 0.673 |
| Open procedure | 29 (28.43 %) | 73 (71.57%) | | |
| Minimally invasive | 6 (33.33 %) | 12 (66.67%) | | |
| Procedure duration | | | 5.6617 | 0.017 |
| 0 to 1h59 Minutes | 10 (12.66%) | 69 (87.34%) | | |
| ≥ 2 hour | 0(0.00 %) | 41 (100%) | | |

**Source:** Primary data.

As indicated in table 4.4, findings show a statically significant association between procedure workload and procedure duration (p=0.017) and with surgeons experience (0.003).Other variables did not show statically significant association with workload.

***Table 4 5 Multivariate analysis.***

| | Unadjusted model | | | Adjusted model | | |
|---|---|---|---|---|---|---|
| Variable | OR | p | 95%CI | AOR | p | 95% CI |
| Procedure duration | | | | | | |
| 1 to 119 Minutes | *Ref* | | | *Ref* | | |
| ≥ 2hour | 8.6 | 0.001 | 2.5-30.4 | 2.1 | 0.001 | 0.9-3.4 |
| Working experience | | | | | | |
| 0 to 3 Years | *Ref* | | | *Ref* | | |
| Greater than 3 Years | 0.3 | 0.004 | 0.1-0.7 | 1.2 | 0.004 | 0.4-2 |

**Source:** Primary data. *OR: odds ratio, CI: confidence interval, AOR: adjusted odds ratio, P: p-value.*

As shown in table 4.5, factors found to be significantly associated with intra-operational workload across surgical care providers in bivariate analysis, presented in table 4.4, were filtered

and then analysed using multivariate logistic regression analysis to adjust for possible confounders and calculate their adjusted odd ratio with their respective p-values and 95% confidence intervals. Multivariate analysis findings show that procedure duration greater than or equal to two hours was 2.1 times more likely to influence the intra-operative workload (AOR: 2.1 95% CI: 0.9-3.4, P=0.001) across surgical care providers. The working experience greater than 3 years was 1.2 times more likely to influence the intra-operative workload (AOR: 1.2 95% CI: 0.4-2, P=0.004).

### IV.4 The interaction between intra-operative workload and surgical specialties & surgical techniques

In this study we were interested in whether an individual's intra operative workload influenced by surgical specialties and surgical techniques (open VS laparoscopic). Therefore, the dependent variable was "intra operative workload", and the two independent variables were "surgical specialty" and " surgical techniques".

In addition, we wanted to know whether there was an interaction between surgical specialty and surgical techniques. Put another way, was the effect of level of surgical specialty on leading to intra operative workload in different surgical techniques (open and minimally invasive procedure).

Each surgical specialty represented by a number (1: ACS, 2: general surgery, 3: urology, 4: pediatric surgery, 5: orthopedic, 6: ENT, 7: plastic surgery, 8: neurosurgery) and surgical technique (1: open procedure and 2: minimally invasive procedure) where it is shown in column of degree of freedom.

***Figure 4 4 The two-way ANOVA***

```
                  Number of obs =       120     R-squared     =  0.1884
                  Root MSE      =   1.87628     Adj R-squared =  0.0974

      Source |  Partial SS    df       MS           F     Prob > F
-------------+----------------------------------------------------
       Model |  87.4409091    12  7.28674242        2.07     0.0249
             |
          ss |  29.2633122     7  4.18047317        1.19     0.3161
    stgroups |  1.14333372     1  1.14333372        0.32     0.5699
ss#stgroups |  23.5634064     4  5.89085161        1.67     0.1615
             |
    Residual |  376.684091   107  3.52041206
-------------+----------------------------------------------------
       Total |     464.125   119  3.90021008
```

The above two-way ANOVA result was interpret in table below.

***Table 4 6 The effect of surgical specialties and surgical techniques on the intra-operative workload.***

| Source of variations | SS | *df* | MS | F | p-value |
|---|---|---|---|---|---|
| Model | 0.9330357 | 12 | 0.07775298 | 1.01 | 0.4447 |
| SSp. | 0.0931938 | 7 | 0.0133134 | 0.17 | 0.9902 |
| ST | 0.0107252 | 1 | 0.01072521 | 0.14 | 0.7096 |
| SSp. * ST | 0.1693707 | 4 | 0.04234266 | 0.55 | 0.6992 |
| Residual | 8.233631 | 107 | 0.07694982 | | |
| Total | 9.1666667 | 119 | 0.07703081 | | |

**Source:** Primary data. *Number of obs. =120, R-squared =0.1884, Root MSE = 1.87628, Adj R-squared = 0.0974, SSp.: Surgical specialty, ST: Surgical technique, SS: Sum of squares; MS, mean squares.*

The table 4.6 show a two-way ANOVA was run on a sample of 120 questionnaires to examine the effect of surgical specialty and surgical approaches on impact of intra-operative workload across surgical care providers. There was no a significant interaction between the effects of surgical specialties and surgical techniques on impact of intra-operative workload among surgical care providers, $F$ (4, 107) = 0.55, $p$ = 0.699.

**IV.5.Discussion**

The study objectives were to determine the intra-operative workload, to identify factors influencing the intra-operative workload and to compare intra-operative workload across different surgical specialties of surgical care providers at CHUK. This section offers the discussion and also illustrates the relevance of these findings and relation with other studies carried out.

Findings from this study present the demography as that majority of surgical care provider respondents were male (89.74%), residents or fellows in surgery (66.66%). The study done by Miranda et al. they found that there were male predominance in surgical care providers with male female ration of 61:5. (35). This difference in gender may be due to gender related inequalities still existing in surgical specialties.

Study results showed that 71% of surgical care providers had high intra-operative workload score above 50 points on SURG-TLX score. Surgeons also surpassed midpoint on SURG-TLX subscale in 47.5% for mental demand, 37.5% for physical demand, 42.5% for temporal demand, 44.17% for task complexity, 32.5% for situational stress and 25.83% for distraction. These findings are in concordance with study done by Law et al where mental demand, physical demand and effort were the highest workload subscales. And Surgeons surpassed the midpoint on the NASA-TLX scale during 40% in mental demands and 34% in efforts (34).

Findings from this study show that procedure duration greater than or equal to two hours was 2.1 times more likely to influence the intra-operative workload (AOR: 2.1 95% CI: 0.9-3.4, P=0.001) across surgical care providers. This research was in line with the study done in USA by Denny Y. et al. where they found that the duration of surgery has a positive association ($p < 0.05$) with intra-operative workload (36).

Findings from this study shows that there is no statistically significant interaction between the effects of surgical specialties and surgical techniques on impact of intra-operational workload across surgical care providers $F$ (4, 107) = 0.55, $p$ = 0.699. A study done in USA by Niichel M.K. et al. was not in agreement with our study which revealed that there was a significant differences of workload scores among surgical (F(7,544)=3.622, p=0.001). Evidential interactions were discovered between surgical specialty and case number (F (20,534) =1.72, p=0.027) (37), therefore this study fail to compare impact of both surgical specialties and surgical techniques. In other hand we need a future study on intra-operative workload across multiples hospitals and specialties in order to set up a baseline workload.

From our study, the working experience greater than 3 years was 1.2 times more likely to influence the intra-operative workload (AOR: 1.2 95% CI: 0.4-2, P=0.004). Our study was in concordance with study done by Law et al.2020 which showed that early career surgeon with 0 to 5 years of experience after residence presented significant lower workload than career surgeons with more than 16 years of experience (34). The cause of high workload in long career surgeons may be due by patients' overload they might be taking care of and complex surgical procedure they perform compared to surgeons with little experience.

# CHAPTER V: CONCLUSIONS AND RECOMMENDATIONS

## V.1 Conclusions

The majority of surgical care providers experienced high level of intra-operative workload above midpoint of SURG-TLX scale indicating unsustainably high workload, surpassed midpoint on SURG-TLX subscale mainly for mental demand.

Duration of surgery and surgeons experiences has been found to be contributing factors to high intra-operative workload. No statistically significant difference seen in intra-operative workload among surgical specialties.

## V.2 Recommendations

In light of the study result, we would recommend:

To introduce in-theater stress management program, targeted stretching micro-breaks to improve mental wellbeing of surgical providers.

To improve surgical workflow and theater working environment to decrease waiting time for a better turnover and improved theater productivity.

In addition, a future study should be done to evaluate the impact of intra-operative workload on patient outcomes.

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# APPENDICES

## APPENDIX 1.DATA COLLECTION QUESTIONNAIRE

**THE INTRAOPERATIVE WORKLOAD ASSESSMENT USING SURGERY TASKLOAD INDEX AT UNIVERSITY TEACHING HOSPITAL OF KIGALI**

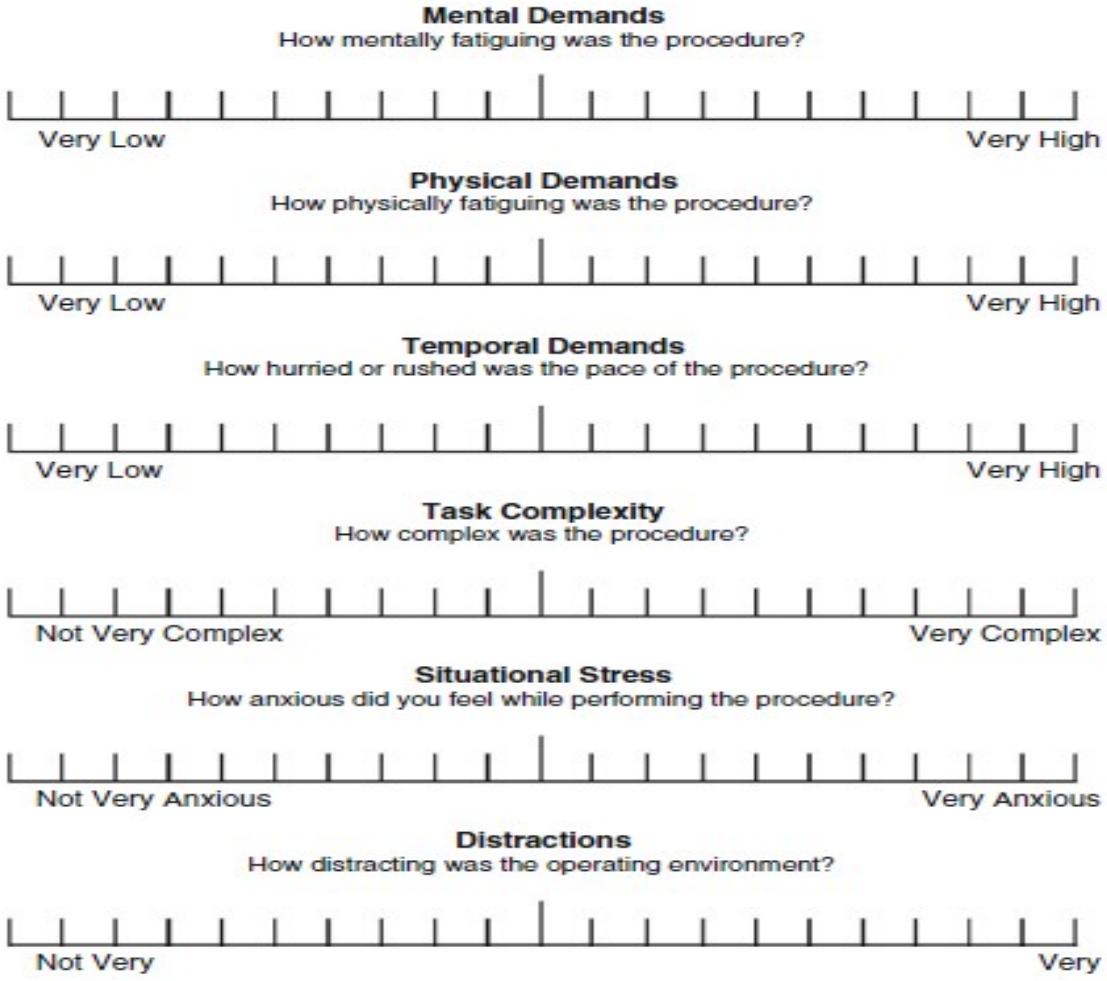
CARE PROVIDERS DEMOGRAPHY

| | | |
|---|---|---|
| 1. Identification | initials | |
| 2. Care providers Age | How old are you ( years in numbers) | |
| 3. Sex | Choose sex of surgical care provider | Male ☐<br>Female ☐ |
| 4. Education position | Surgical provider level of training | Resident ☐<br>Fellow ☐<br>MMED ☐<br>MMED + subspeciali ☐ |
| 5. Level of training for resident or fellow | Year of study for resident and fellows | |
| 6. Experience | Number of years surgical care providers has been practicing ( in numbers) | |
| 7. Surgical specialty | Surgical specialty of operator | ACS ☐<br>General surgery, ☐<br>Urology ☐<br>Pediatric surger ☐<br>Orthopedy ☐<br>ENT ☐<br>Plastic surgery ☐<br>Maxillofacial surger ☐ |

SURGERY TASKLOAD INDEX SCORE

1. Weighted rating

These subscales are mean to evaluate your experience during the procedure. Please evaluate your procedure by marking X



2. Pair wise comparison

These are sets of titles listed into boxes. Please choose title you deem applicable to your experience in the previous surgery

| | | |
|---|---|---|
| **Task Complexity**<br>**Or**<br>**Mental Demand** | **Distractions**<br>**Or**<br>**Situational Stress** | **Task Complexity**<br>**Or**<br>**Distractions** |
| **Task Complexity**<br>**Or**<br>**Temporal demand** | **Mental demand**<br>**Or**<br>**Situational Stress** | **Physical Demand**<br>**Or**<br>**Distractions** |
| **Mental demand**<br>**Or**<br>**Physical demand** | **Situational Stress**<br>**Or**<br>**Physical demand** | **Situational Stress**<br>**Or**<br>**Task Complexity** |
| **Temporal demand**<br>**Or**<br>**Mental demand** | **Distractions**<br>**Or**<br>**Mental demand** | **Temporal demand**<br>**Or**<br>**Distractions** |
| **Physical demand**<br>**Or**<br>**Temporal demand** | **Physical demand**<br>**Or**<br>**Task Complexity** | **Temporal demand**<br>**Or**<br>**Situational Stress** |

QUESTION ABOUT THE PROCEDURES

| | | |
|---|---|---|
| 1. Case number | Number the position of your case on your day schedule | |
| 2. Patient age | How old is the patient( months or years) | …. Years or<br>……Months. Or<br>……..Days |
| 3. Patient sex | Male or female | |
| 4. Patient ASA grade | American society of anesthesiologist category | |
| 5. Patient diagnosis | Post operative diagnosis | |
| 6. Procedure | Name of procedure done | |
| 7. Surgical techniques | Which surgical techniques has been used | Open procedure ☐<br>Minimally invasive procedure ☐ |
| 8. Procedure duration | Incision time to closure time ( in hours) | |

## APPENDIX 2. STUDY PARTICIPATION CONSENT FORM

Please read this consent agreement before you participate in this study.

I'm **DR UWASE Clement,** Resident in General Surgery doing this study on workload of surgical care providers.

Title of the study**: THE INTRAOPERATIVE WORKLOAD ASSESSMENT USING SURGERY TASKLOAD INDEX AT UNIVERSITY TEACHING HOSPITAL OF KIGALI**

**The aim** of this study is to quantify workload of surgical care providers working at CHUK using surgery task load index, to determine factors affecting the workload of surgical care providers and to compare workload across different techniques and specialty.

This is not to evaluate or criticize you, so please do not feel pressured to give a specific response and do not feel shy if you do not know the answer to a question. I am not expecting you give a specific answer; I would like you to answer questions honestly. Feel free to answer questions at your own pace.

**Benefits for participation**: No direct incentives or other financial benefits for participating in this study. The long-term benefits will be to have local evidence based data that might help in improving our practice.

**Right to withdrawal**: you have the full right to stop your participation in the study at any step and anytime.

**Agreement**

I hereby, agree to participate in the research study described above.

signature: ……..

Date: