ADEQUACY OF ANALGESIC PRACTICES AMONG ADULT PATIENTS UNDERGOING LAPAROTOMY AT MOI TEACHING AND REFERRAL HOSPITAL, ELDORET, KENYA.

BY

GLADYS KEZZIAH M NJUE

THIS IS A THESIS SUBMITTED TO THE SCHOOL OF MEDICINE IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF MEDICINE IN ANESTHESIOLOGY AND CRITICAL CARE MEDICINE AT MOI UNIVERSITY, KENYA.

DECLARATION

Student Declaration

I declare that this research is my original work and has not been presented in any other university or institution for the award of the degree or any academic credit. The views expressed herein are my own unless otherwise stated and in such a case, the reference has been cited.

Dr. Gladys. Kezziah M Njue
MS/ACC/5677/21
Department of Surgery and Anesthesiology, Moi University, School of Medicine.

Signature: _____Date: _____

Supervisor Declaration

This thesis has been submitted to Moi University for consideration with our approval as university supervisors.

Dr Kennedy Imbaya,
Consultant Anesthesiologist,
Department of Surgery and Anesthesiology, Moi University.

Signature: _____Date: _____

Dr Seno Saruni
Directorate of Surgery, Moi Teaching and Referral Hospital.

Signature: _____Date: _____

Dr Obadiah Samoei,
Directorate of Anesthesia, Moi Teaching and Referral Hospital.

Signature: _____Date: _____

DEDICATION

I dedicate my work to my parents, *Patrick,* and *Eva*, for unrelenting support, to the department of surgery and anesthesia without whom this undertaking would not have been possible and to the patients who have chosen to give their precious time and attention during recuperation. May this study be a gateway to the much-needed breakthrough in management of acute pain that we so much seek.

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I am deeply indebted to my supervisors *Dr Kennedy Imbaya, Dr Seno Saruni, Dr Obadiah Samoei* for the mentorship. I also acknowledge faculty members and my colleagues in the department of surgery and anesthesia for offering great insight into my study.

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LIST OF ABBREVIATIONS

ACS - NSQIP	American College of Surgeons, National Surgical Improvement Program
ANZA	Australia, New Zealand, and Asia
APS	American Pain Society
ASRA	American Society of Regional Anesthesia
EPSA	European Society for Pediatric Anesthesiologists
ERAS	Enhanced Recovery After Surgery
ESRA	European Society of Regional Anesthesia and pain therapy
FPS-R	Faces Pain Scale - Revised
HICs	High Income Countries
IASP	International Association for the Study of Pain
IREC	Institutional Research and Ethic Committee
LMIC	Low- and Middle-Income Countries
MTRH	Moi Teaching and Referral Hospital
NACOSTI	National Commission for Science Technology and Innovation
NELA	National Emergency Laparotomy Audit
NRS	Numeric Rating Scale
NSAIDs	Non-Steroidal Anti-inflammatory Drugs
PACU	Post Anesthesia Care Unit
PCA	Patient Controlled Analgesia
PQIP	Perioperative Quality Improvement Program

PROSPECT	PROcedure SPEcific pain managemenT
UK	United Kingdom
VAS	Visual Analogue pain Scale
VRS	Verbal Rating Scale
WHO	World Health Organization

OPERATIONAL DEFINATION OF TERMS

Acute pain - A sensory or emotional response to tissue injury or an illness, lasting a few minutes to twelve weeks (or resolves once the underlying cause is managed).

Acute pain service - A specialized healthcare interdisciplinary team, focused on managing acute pain using multimodal approach.

Acute postoperative period - The immediate recovery phase following surgery, typically lasting up to 80 days, depending on the type of surgical procedure.

Adequate analgesia - Relief of pain sufficient to allow patient to function and to recover without excessive discomfort, generally considered when visual analogue scale is ≤ to 3.

Analgesia - Reduced sensibility to pain without loss of consciousness

Analgesic practices - Techniques, methods and protocols used to relieve pain without causing loss of consciousness

Analgesics - Medication or agents given to relieve or prevent pain.

Anesthesiologist - A physician with specialized training in giving medicine or other agents to relieve or prevent pain during surgical procedures. He or she is also trained in critical, intensive, and emergency care.

Anesthetist - A clinical officer trained in giving medication during surgical procedures.

Immediate postoperative period - The first 24 to 48 hours following surgery (varies depending on surgical procedure) when patients are closely monitored to avoid immediate postoperative complications. Period of highest risk of moderate to severe postoperative pain.

Laparotomy - An abdominal procedure performed by making an incision into the abdominal wall to gain access to the abdominal organs with either a therapeutic or diagnostic intent. This is also known as celiotomy.

Multimodal analgesia - A pain management strategy that combines multiple analgesics, techniques and/ or interventions that target different pain pathways.

Patient controlled analgesia - Method of pain relief in which a patient controls the amount of pain medicine used through use of a programmable pump.

Pre-emptive analgesia - Administration of analgesic before introduction of painful stimulus to obtain better pain relief compared with when the analgesic intervention is used after the stimuli.

ABSTRACT

Background: The prevalence of moderate to severe postoperative pain is estimated to be up to 100% in sub-Saharan Africa. Undertreatment is associated with physiological and psychological complications which can prolong recovery, lengthen hospitalization and add economic strain to patients and health care system. Adequate analgesia following surgery is generally considered when the visual analogue pain score (VAS) is ≤ 3. Faced with rising laparotomy rate at MTRH, lack of published data and absence of a procedure specific pain management guideline, the magnitude of acute postoperative pain and adequacy of analgesia practices remained unknown.

Objective: To determine the adequacy of analgesia practices used in management of acute postoperative pain among adult patients who undergo laparotomy at MTRH, Eldoret, Kenya by establishing acute pain severity, identifying and evaluating the adequacy of pain-relieving modalities.

Methods: The descriptive study was conducted among 241 participants who underwent laparotomy during the study period. The sample size was 241 people enrolled systematically. Participants were followed at different intervals including, at the postanesthetic care unit (PACU), at 24- and 48-hours. Data was collected through patients' interviews, review of anesthetic charts and treatment sheets, to complete a structured questionnaire. The independent variables were demographic and clinical data (Elective/Emergency), types of analgesics and techniques of administration. The dependent variable of interest was pain severity. STATA version 16 software was used for analysis. Categorical data was summarized and findings presented in figures, corresponding percentages and tables. The study was conducted at 0.05 α level of significance. Pertinent ethical approvals were obtained.

Results: The mean age of participants was 45.4 years with a female predominance. Majority of laparotomies were performed emergently (97.1%), with most common abdominal procedure being, exploratory laparotomy (41.9%). The proportion of patients with moderate or severe pain at PACU, 24 hours and 48 hours intervals, was 56%, 17% and 6.2%, respectively. The Conchran – Armitage test showed a statistically significant ($P < 0.001$) linear trend in pain score across the assessment periods. Paracetamol and tramadol were the most used combination at both 24 (31.1%) and 48 (28.9%) hours intervals.

Conclusion: Postoperative pain management at MTRH is inadequate, as evidenced by many patients experiencing acute moderate to severe pain. A narrow range of opioid based systemic analgesics are used.

Recommendation: Incorporation of additional interventions (such as adjuvant analgesics) and techniques (such as nerve blocks, epidural analgesia, cognitive behavioral therapy) with the goal of achieving VAS ≤ 3 post-operatively. Further research is needed to explore factors influencing post-operative pain management (comorbidities, anesthesia used, health care provider or system related factors).

CHAPTER ONE. INTRODUCTION

1.1 Background of study

Pain is a subjective experience that is characterized by sensory or emotional distress that is linked to factual or potential tissue damage. The International Association for the Study of Pain (IASP) defines acute pain as an abrupt, intense sensation, resulting from a surgical procedure, trauma, or illness. This sensation lasts between a few minutes to 3 months or the expected healing time, after which it is presumed chronic. Post-operative pain is therefore considered a form of acute pain due to inflammatory and neuronal reaction to surgical insult, (Raja SN, 2020).

The overall prevalence of moderate to severe postoperative pain vary depending on geographic location with rates ranging from 48-77% across the United Kingdom, 13 - 75% in the USA and 58.7% in a China, (Horn R, 2024; Small & Laycock, 2020; Zhang, 2023). These rates are higher in low and middle income countries where studies show prevalence ranging from 40 - 100%, (Ndebea et al., 2020).

The disparity is attributed to the high burden of disease in low middle income countries, with limited resources such as equipment and essential analgesics. Poor prioritization of pain relief at multiple levels (such as government, hospital, and individual patient care levels), stemming from insufficient policies, poor human resource distribution, and perceived attitudes of health care givers on pain, further exacerbate under treatment of pain, (Calia Morais, 2022; Morriss & Roques, 2018).

The growing recognition of the importance of pain management in high- and middle-income countries has led to a rise in the formation of acute pain service. Acute pain service is a specialized health care interdisciplinary team focused on managing acute pain using strategies that combine multiple systemic analgesics,

techniques or procedural interventions that target different pathways. The acute pain service follows established guidelines and best practices for acute pain management ensuring safety and efficacy of treatment and monitors the effectiveness of therapies and techniques used, adjusting treatment as needed. Its structure varies across institutions.

A sizable portion of both emergent and elective surgical workload worldwide entail abdominal surgeries. The National Emergency Laparotomy Audit (NELA), from 1st December 2021 to March 2023, reported a total of 27,863 (a rise from 22,132) emergency laparotomies across 173 hospitals in the UK. American College of Surgeons National Surgical Quality Improvement Program (ACS - NSQIP) estimates that 175,000 emergency laparotomies are done annually in the USA, (Anand et al., 2024; Seid Adem A, 2021). Multiple studies have shown significant surgical disease burden in sub-Saharan Africa as well, (Eyob A, n.d.; Kiswezi, 2014; Ndebea AS, 2020).

Data from surgical registry from MTRH shows that in 2020 and 2021 a total of 695 and 729 abdominal surgeries were done, respectively. The data on caesarean sections was excluded as it is a distinct entity in research and is not comparable to a laparotomy in terms technique, risks, potential outcome, and underlying conditions. Therefore, inclusion into the study would potentially introduce a bias and confound the results. Furthermore, there is an existing protocol in place at MTRH which aids in management of acute postoperative pain following caesarian sections. The rising trajectory poses a unique challenge as the magnitude of postoperative pain at MTRH remains unknown and in consequence, the scope of development on this subject matter is undefined. Therefore, there was a need for this gap to be explored

especially in the East African population where there is an information gap and compare the findings to other regions across the world.

Adequate postoperative pain control is underpinned by proper pain assessment, regular reassessment, and prompt response. The Visual Analogue Pain Scale (VAS) is preferred mode of evaluating acute postoperative pain due to its strong sensitivity and reliability across different population groups and its ease of use. It's usually rated from 0 to 10 where 0 suggests no pain, 1-3 mild pain, 4-6 moderate, 7-9 severe pain and 10 -worst pain possible. The 2016 post operative pain guideline considers a target pain score of ≤ 3 on VAS with no significant functional impairment, as adequate, (Chou et al., 2016).

The 2016 postoperative pain guidelines by American Pain Society, the American Society of Regional Anesthesia and Pain Medicine, and the American Society of Anesthesiologists strongly recommend that a facility in which surgery is performed should use multimodal approach, have access to pain specialist (where Nurse - Based, Anesthesiologist supervised APS model has shown to have the highest potential for optimal pain relieve) and have a structure for policy development and implementation to ensure safe and effective postoperative pain management, (Chou et al., 2016) Furthermore, for open laparotomy, the guideline recommends preemptive use of gabapentin (or pregabalin), intraoperative use of NSAIDs, acetaminophen, transversus abdominis plane block (where epidural analgesia is contraindicated) and/or local wound infiltration. During the immediate postoperative period, the use of opioid boluses where indicated, has been shown to provide rapid pain relief and allow for analgesic titration. Parenteral patient-controlled analgesia (PCA) should also be considered for patients with sufficient cognitive function (to understand device safety and its

limitations) who require parenteral analgesics for a few hours post operatively and who may not benefit from epidural or regional nerve blocks. Intravenous lidocaine can also be used as it reduces opioid consumption and has demonstrated prolonged analgesic effects by decreasing inflammation. Ketamine can be considered in opioids tolerance. Non- pharmacological methods such as cognitive behavioral therapy and transcutaneous electrical nerve stimulation should also be considered as adjunctive to pharmacological treatment, (Chou et al., 2016; Pirie, 2022).

This was therefore a novel study in this region which was aimed at identifying the current analgesics and modalities used in management of acute post-operative pain following laparotomy and assessing their adequacy.

1.2 Statement of the problem

Kenya has a significant laparotomy procedure burden with only 52% of surgically equipped hospitals capable of performing this procedure. The current surgical volume is estimated to be 252 - 11,110 procedures per 100,000 population, (Hugh et al, 2022). There is lack of published data in Kenya on proportion of patients who experience acute postoperative pain. However, some studies from some African countries report a high prevalence, (Eyob A, n.d.; Kiswezi, 2014; Ndebea et al., 2020).

Studies also show patients undergoing laparotomy face a higher risk of significant acute postoperative pain, which, if insufficiently managed can lead to adverse physiological, psychological, and ultimately, economic outcomes, (Chou et al., 2016).

MTRH is a high-volume center with laparotomy accounting for 52% of all major surgeries. Despite the large numbers, there is no documented evidence at MTRH or nationally in Kenya, on the magnitude of postoperative pain following laparotomy. There are no local guidelines for acute postoperative pain management specific to our

setting. World Health Organization (WHO) ladder is typically used but it's liable to variable applications based on available resources, provider experience, cadre, preference or ease of use, (Pirie K et al., 2022). This highlights a significant knowledge gap that impedes evidence-based planning.

1.4 Study Justification

MTRH serves patients from multiple counties across Kenya, making this study relevant to a wide demographic. Laparotomy is among the most common procedures globally and at MTRH. However, no previous study has evaluated pain severity or adequacy of pain management techniques following laparotomy. The study sought to quantify the burden of acute postoperative pain, therefore addressing a critical knowledge gap and highlighting the need to strengthen acute postoperative care. It also helped to contribute valuable evidence within African context and inform future comprehensive research in this field.

1.5 Research questions

1. What is the severity of acute postoperative pain among adult patients who undergo laparotomy at MTRH?
2. What are the analgesia techniques in use among adult patients who undergo laparotomy at MTRH?
3. What is the adequacy of analgesia practices among adult patients undergoing laparotomy at MTRH?

1.6 Objectives of the Study

1.6.1 Broad objective

To determine the adequacy of postoperative analgesic practices among adult patients who undergo laparotomy at MTRH.

1.6.2 Specific objective

1. To establish acute postoperative pain severity among adult patients who undergo laparotomy at MTRH.
2. To identify the pain-relieving modalities in use among adult patients who undergo laparotomy at MTRH.
3. To establish the adequacy of pain-relieving modalities in use among adult patients who undergo laparotomy at MTRH.

CHAPTER TWO: LITERATURE REVIEW

Pain is one of the most ancient healthcare conundrums. To curb the pain burden, American Pain Society (APS) launched the "pain as the 5th vital sign" campaign in 1996, which was later adopted in the United Kingdom. The World Health Organization (WHO) and the International Association for the Study of Pain (IASP), in 2016, also emphasized the importance of pain management and declared pain relief a fundamental human right, (Chou et al., 2016). In the past four decades studies on pain and pain management have exponentially increased and this has paved the way for major advancement in pain control. Multimodal approach to pain and interventional pain management techniques, guided by diagnosis or specific procedures, have also gained traction in the recent past. That said, pain remains a significant burden especially in resource constrained countries, (Gao et al., 2023; Paladini A et al., 2023). A study conducted at Mulago hospital in Uganda found that the prevalence of postoperative pain was 100%. In Tanzania, Ndebeaa et al carried out a prospective cohort study with 281 patients and reported a postoperative pain prevalence of 73%, (Kiswezi, 2014; Ndebea et al., 2020).

The term laparotomy is changeably used with the term celiotomy. This is a surgical opening made through the abdominal wall, to gain access to the peritoneal cavity with either a therapeutic or diagnostic intent. With the emergence of minimally invasive laparoscopic surgeries, the indications for laparotomy have markedly reduced. Nonetheless, this surgical procedure remains pivotal in both emergency and elective setup where the risks of minimal access outweigh the benefits. Indications for laparotomy encompass but are not limited to abdominal trauma (both blunt and penetrating), suspected intraabdominal bleeding, biopsy or debulking in cases of abdominal or pelvic malignancy, suspected intestinal obstruction, and

abdominal organ transplant surgeries, among others. Emergency laparotomy is a commonly done procedure with about 30,000-50,000 annual cases reported in the United Kingdom,(Raja SN, 2020). A study conducted over six months in 2015 across all public regional and tertiary hospitals in KwaZulu province, South Africa revealed a significant surgical disease burden. A total of 13,282 surgical procedures were performed, of which 5,630 were emergency abdominal surgeries. A retrospective study from Ethiopia in 2020 examined outcomes and associated factors among patients who had undergone laparotomy, showed that emergency laparotomy accounted for 23% of all surgeries performed, (Seid Adem A, 2021). Studies also indicate that the prevalence of acute moderate to severe postoperative pain vary depending on the postoperative day. Pain is typically marked on the day of surgery and tends to dissipate over time based on the treatment provided. A prospective study done in Ethiopia involving 1,490 participants managed under acute pain protocol found moderate to severe pain prevalences of 41%,30% and 19% on post operative day 0, 1 and 2 respectively, affirming these observations, (Sommer M et al., 2008).

Despite the introduction of evidence-based recommendations, through ERAS pathways, acute postoperative pain management often remains inadequate. Some of the barriers to adequate pain control include health care providers' beliefs regarding analgesics such as opioids leading to underutilization or reliance on less effective medication. These concerns stem from anticipated adverse effects including sedation, nausea, vomiting, respiratory depression, or dependency. Additionally, the level of expertise among healthcare professionals in pain assessment and alternative analgesic options significantly impacts the selection of appropriate pain management strategies. Anxiety and depression in patients are linked to moderate to

severe postoperative pain. Providing patient centered education before surgery (covering the procedure, expected outcomes and pain management options) can reduce anxiety and set realistic expectations. This approach promotes collaboration in pain management between patients, families and clinicians, (Akbar & Teo, 2019).

Local barriers such as lack of quality indicators such as tailored multidisciplinary pain management guidelines and assessment tools can contribute to poor postoperative pain management. This is especially prevalent in sub-Saharan countries, possibly due to insufficient research. Such guidelines help standardize clinical practice. System based challenges such as lack of resources, inconsistent medication availability, insufficient drug administration equipment (such as pumps, nerve block needles, epidural catheters, ultrasound for performing nerve blocks) and inadequate postoperative monitoring due to staff shortage, can impede improvement in postoperative care, particularly in resource limited countries. As a result, health care practitioners rely on what is readily available, which might not sufficiently control pain, (Gao et al., 2023).

The 2016 postoperative pain guidelines recommend establishing an acute pain service to enhance post operative pain outcomes. The structure of acute pain service varies across institutions and include, NBAS – APS (Nurse based anesthesiologist supervised, acute pain service), NBASS – APS (Nurse – based, anesthesiologist, specialist supervised, acute pain service), conventional APS (C- APS) and PMDT (Pain management multidisciplinary team). In the NBAS – APS model, the anesthesiologist is responsible for prescribing post-operative analgesics while the nurse guides post operative pain scoring and reports the findings to the anesthesiologist. The NBASS – APS model incorporated pain specialist guidance

into NBAS – APS framework highlighting the role of specialist supervision. Therefore, this model is a nurse based, anesthesiologist guided, and specialist supervised approach. Among various APS models, the NBASS-APS demonstrates the highest potential for achieving optimal pain relief followed by the NBAS-APS. It also has the highest potential for saving health care costs. The PMDT model emphasizes the development and implementation of comprehensive perioperative treatment strategies requiring multidisciplinary participants (surgeons, anesthesiologists, nurses) to create pain management plans and facilitate regular discussions while the C-APS involves establishing a professional team to provide acute pain services but lacks details specifications. Studies have shown that APS models are more effective in relieving pain compared to the conventional ward doctor- nurse model, where a nurse assesses and manages pain under the guidance of a ward doctor, (Kishore et al., 2011; Mahyar et al., 2024; Mojica et al., 2023). There is no established acute pain service model in use at MTRH.

A range of factors influence the effectiveness of specific management models in providing optimal postoperative pain relief. Pain is a subjective phenomenon with its characteristics such as intensity and duration influenced by preoperative status, (such as anxiety, chronic pain, American Society of Anesthesiologists status), patients' sex (with females typically reporting greater pain severity compared to males), type and duration of surgical procedure as well as analgesic regimen and mode of administration. Laparotomy carries a significant risk of severe acute postoperative pain, (Chou et al., 2016; Ezra E et al., 2022). A rigorous preoperative assessment helps identify risk factors which affect the intensity of postoperative pain and informs the development of analgesic regimen, customized to patients' needs.

MTRH is a national hospital located in Eldoret town, Uasin Gishu county. It serves twenty-four counties in Kenya, parts of Eastern Uganda, South Sudan and Democratic republic of Congo and offers outpatient, inpatient, and specialized health care services. The hospital acts as a teaching hospital for Moi University College of Health Sciences that trains both undergraduate medical students and postgraduate students in several medicine specialist programs. Other medical training institutions also use the facility. MTRH serves many patients across different specialties annually and laparotomy is one of the most performed surgical procedures, (MTRH, 2026). Data obtained from the MTRH surgical registry shows that in 2022, despite the COVID pandemic, 1,608 surgeries were performed of which, 52% (836) were laparotomies. Despite these stupendous numbers, there are multifarious views, general lack of research and absence of a protocol on how best to manage acute postoperative pain following laparotomy especially in a resource constrained country such as Kenya, in the backdrop of this continuously and rapidly evolving subject matter globally.

Self-report is one of the most accurate forms of pain assessment. Visual analogue pain scale is preferred mode of evaluation due to its strong sensitivity and reliability across different population groups and its ease of use. Pain assessment and reassessment help determine the effectiveness as well as the adverse effects of analgesics used and decide whether added interventions are required. The VAS is rated from 0 to 10 where 0 suggests no pain, 1-3 mild pain, 4-6 moderate, 7-9 severe pain and 10 -worst pain possible. There is inadequate data to inform firm recommendations on best timing of patients' reassessment. However, this is usually guided by type of intervention done and time to achieve peak effects, typically 15 to 30minutes after parenteral drug therapy or 1 to 2 hours after use of oral analgesic. Other factors that

affect assessment frequency include surgical procedure done, presence of comorbidities, adequacy of initial pain relief, presence of side effects and changes in clinical status. This is geared to not only ensure adequate pain relief but to also detect early adverse effects and continuously monitor patients' progress towards functional goals, (Baamer et al., 2022; Chou et al., 2016)

Enhanced recovery after surgery (ERAS) advocates for proper assessment of postoperative pain and encourages the use of multimodal strategies. Multimodal analgesia strategies entail combination of both pharmacological and non-pharmacological interventions aimed at different pain pathways. The regimen should be customized based on patients' comorbidities, type of surgery, expected duration of therapy, drug dosage and timing. The combinations have not only reduced opioid consumption but also exhibit superior pain control with fewer side effects. Despite these benefits, multimodal opioid sparing analgesia is yet to be universally embraced, predisposing patients to avertable pain, (Mogianos K et al., 2025). Traditionally, opioid based analgesic therapy served as the main stay of treatment for acute postoperative pain. However, the opioid crisis led to increasing demand for more investigative effort into developing newer pain treatment strategies that emphasize utilization of opioid sparing multi-modal approach. PROcedure-SPECific Pain managemenT (PROSPECT), a collaboration of anesthesiologists and surgeons in 2017 updates, emphasized on the significance of evidence-based studies, in the context of multimodal analgesic strategies, considering the risks and benefits of interventions in these specific surgical procedures. Limited data has been published on PROcedure- SPECific Pain Management (PROSPECT) in low- and middle-income countries, such as Kenya, suggesting a gap between evidence-based findings and practice. Therefore, the need

for evidence based, procedure specific strategies has never been greater. Insufficient pain education among health care givers has led to perceived limited pain treatment options, dissimilarity in pain assessment and eventually, suboptimal pain control. There is also slow adoption of advanced pain management modalities such as nerve blocks, epidural analgesia, and use of patient-controlled analgesia (PCA). Lack of specialized pain management services, where adjuvant therapies such as preemptive analgesia can be employed and perioperative pain strategies monitored and adjusted according, result in less effective postoperative pain control, (Calia Morais, 2022; Morriss & Roques, 2018).

The implementation of region-specific solutions to promote pain management will go a long way in curbing the physical and psychological trauma that patients experience following surgery and consequently improving the quality of life.

2.2 Classification and physiology of pain

Pain is a multi-layered interaction of sensory, emotional, and behavioral factors. It is classified into physiological or pathophysiological pain. Physiological pain results from activation of pain receptors in response to stimuli while pathophysiological pain includes inflammatory response resulting from tissue or nerve damage. Acute physiological pain is sudden in onset, sharp and localized at the site of tissue injury or illness. It lasts for a few minutes to weeks (< 12 weeks) and relates to identifiable cause (resolve when the underlying cause is treated or managed). Chronic physiological pain is a continuum of acute pain. It is persistent or recurrent, outlasts the normal healing process and usually continues for more than 12 weeks. Pathophysiological pain is also known as clinical pain. It outlasts the stimulus and spreads to non-damaged areas, leading to primary hyperalgesia. Peripheral sensitization may also result from inflammatory response leading to pain from non-

noxious stimuli such as touch, (Chen J et al., 2026; Gore, 2022; Shuang L & Leigh K, 2022; Yao D et al., 2023).

2.2.1 Physiology of pain

Nociceptors are free nerve endings which respond to either mechanical, chemical or thermal noxious stimuli. They are located on the skin, joints, muscles, viscera, or bone and respond to actual or possible threats, transmitting signals in form of action potential to the spinal cord and brain (central nervous system). Perception of pain is regulated at the spinal cord and eventually interpreted by the brain cortex resulting in varying degrees of discomfort. The process of transmission is referred to as nociception. Nociceptor fibers are structurally classified into type A, B and C with type A further classified into alpha, beta, and delta. Type A delta and C are primarily responsible for pain transmission. Type A delta fibers, which respond to mechanical or thermal stimuli, are medium sized, myelinated and transmit well localized, sharp pain at a speed of 12-30m/s. Conversely, type C fibers are small, unmyelinated and transmit poorly localized pain at a slow speed of 0.5-2m/s in response to mechanical, thermal or chemical stimuli, (Yao D et al., 2023).

Once cellular damage occurs, chemical mediators are released such as potassium (released from damaged cells), histamine (released from mast cells near site of tissue injury), bradykinin, leukotrienes and prostaglandins (released from tissue inflammation) and serotonin (in response to vascular injury), initiating an action potential, through the fibers, to the central nervous system. Type A myelinated delta fibers transmit well localized, sharp pain (first pain) in response to mechanical or thermal stimuli, while type C fibers transmit dull, poorly localized pain at a slow speed, in response to mechanical, thermal and chemical stimuli. Mechanical trauma such as surgery usually activates both the type A delta and C fibers. The initial sharp

pain, in response to high intensity mechanical stimulation of nociceptors through skin penetration, is transmitted by the A delta fibers while the later deep ache, which is due to release of chemical mediators of inflammation, secondary to initial injury, is transmitted by type C fibers, (Chen J et al., 2026; Yao D et al., 2023)

2.2.2 Ascending pain pathway

Following tissue insult, the afferent nociceptive fibers located in the periphery (first order neurons), relay action potentials from the nociceptor to the cells on the dorsal horn of spinal cord, which are divided into physiologically distinct layers, known as laminae. A delta fibers synapse in rexed laminae I (marginal nucleus) and V (reticular nucleus) and C fibers synapse in rexed laminae II (substantia gelatinosa) and III (nucleus proprius) into a second order neuron, using substance P as the neurotransmitter. The synaptic junction between first order neuron and dorsal horn cells in the spinal cord is referred to as a ‘gate’ due to its considerable plasticity. Painful impulses are therefore “gated” or modified at this region. The second order neurons then decussate at the anterior white commissure, to the contralateral side and send signals via the spinothalamic tract to the thalamus, reticular formation (in medulla), nucleus raphe magnus (in medulla) and peri-aqueductal grey matter (in the midbrain), where they synapse with the third order neurons. The spinothalamic tract is classified into neo (lateral) and paleo (medial) spinothalamic tract based on its location. The third order neurons are in the thalamus and transmit nociceptive action signals to the somatosensory cortex areas 2 and 1 in the posterior central gyrus and superior wall of the sylvian fissure, where perception and discrete localization of pain take place. Some fibers project to cingulate gyrus and mediate the emotional aspects of pain. (Venugopal K, 2015).

2.2.3 Descending pathway

The descending pathway modulates the ascending pathway, controlling pain perception. Signals are transmitted from somatosensory cortex to the hypothalamus. They are then conveyed to the periaqueductal grey area of the midbrain or periventricular nucleus which in turn stimulates nucleus raphe magnus and nucleus reticularis gigantocellularis in the medulla. This then stimulates the substantia gelatinosa in the dorsal horn through the second order adrenergic and serotonergic neurons leading to release of serotonin and adrenaline respectively. (Venugopal K, 2015). The release of serotonin and adrenaline leads to inhibition of substance P from pre-synaptic cleft of first order neuron and stimulates inhibitory interneurons to secrete endorphins and enkephalins (opioids), which inhibit transmission of signals between 1st and 2nd order neurons. The para-aqueductal grey matter also contains opioid receptor where exogenous opioids exert their actions.

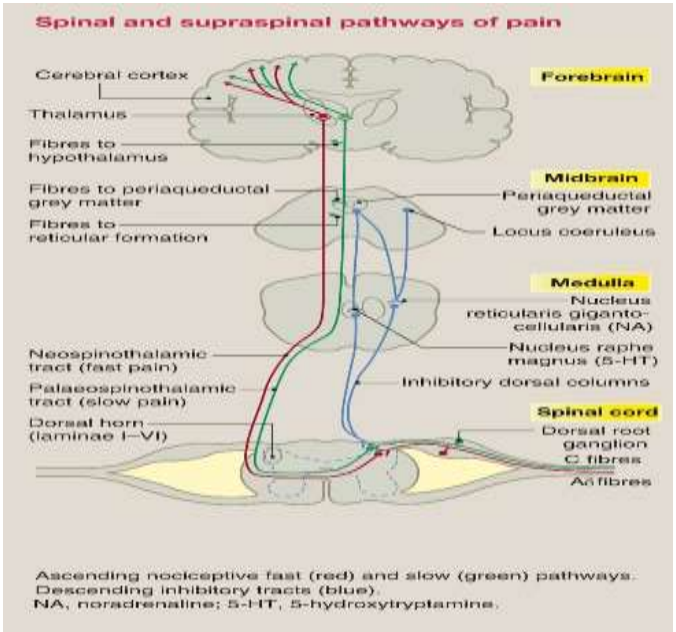


Figure 1: Pain pathways, (Colvin L, 2012).

Neural impulses from the peripheral nervous system are modulated in the spinal cord by a gate-like process before transmission to the central nervous system. Activation of type A beta fibers through deep touch, activate inhibitory interneurons which interrupt the transmission of signals from 1st to second order neurons providing localized analgesic effect, (Gore, 2022; Shuang L & Leigh K, 2022).

2.2.4 Role of autonomic nervous system in pain transmission.

While not in the primary pain pathway, the autonomic nervous system plays a significant role in pain transmission and modulation, influencing both the experience and perception of pain. Activation of sympathetic nervous system either during stress or in response to injury can exacerbate pain through direct activation of pain pathways or sensitizing pain receptors. Conversely, the parasympathetics nervous system, mainly through the vagus nerve plays an inhibitory role by reducing inflammation, modulating pain transmission and influencing pain perception. Dysfunction of autonomic nervous system is frequently observed in chronic pain conditions with sympathetic nervous system implicated in potentiation and facilitation of pain,(Chen J et al., 2026; Yao D et al., 2023).

2.3 Psychological aspects of acute pain.

Pain is an individual biopsychosocial phenomenon that is largely influenced by previous pain experience, individual culture and the ability to cope. Preoperative psychological conditions such as depression and anxiety are associated with higher levels of postoperative pain. Fear regarding intra and postoperative experience, pain beliefs and catastrophizing, can heighten pain perception by directing more attention to the painful stimuli. This creates a feedback loop where pain is amplified, leading to further deteriorating mood and ultimately results in depressive episodes. Recurrence of this cycle can contribute to chronic pain syndromes. Cultural norms

and individual coping methods (such as relaxation, seeking social support) may also affect how pain is perceived and expressed. Thus, preoperative evaluation should include counseling regarding the planned procedure and setting reasonable postoperative expectations regarding pain management, (Chen J et al., 2026; Chou et al., 2016).

2.4 Impact of inadequately managed pain.

Acute pain triggers multisystem physiological changes. Effective management aims to not only alleviate pain, but also to mitigate the risk of stress-induced multisystem side effects. Inadequate management of acute pain following surgery can adversely affect both physiological and psychological aspects of patient's life wellbeing, potentially diminishing quality of life, or in severe cases, resulting in mortality. Poor pain management may lead to pulmonary infection and atelectasis attributable to shallow breathing, suppressed coughing and secretion retention, all of which reduce functional residual capacity. Elevated blood pressure and tachycardia due to heightened sympathetic nervous system activity and release of catecholamines may predispose individuals to ischemic heart disease. Additionally, immune suppression and impaired inflammatory responses can delay wound healing and promote new infections. Inadequate pain control also impedes mobility, resulting in blood stasis and heightened risk for deep venous thrombosis and related thromboembolic events such as pulmonary embolism, which may be fatal, (Chen J et al., 2026; Colvin L, 2012; Gore, 2022). Studies have also shown that pain can disrupt sleep and hinder activities of daily living which raise the risk of postoperative pain syndromes, anxiety and depression. These effects can delay recovery, lengthen hospitalization and create financial burden to patients and the health care system,(Gan J, 2017).

2.5 Standard treatment modalities for post operative pain

Acute postoperative pain management involves both pharmacological and non-pharmacological approaches. Though pharmacological interventions remain the cornerstone, non-pharmacologic therapies such as cognitive modalities, physical therapy and transcutaneous electrical nerve stimulation, serve as important adjuncts in optimizing acute pain control and have been endorsed by the American Society of Regional Anesthesia and Pain Medicine, (Horn R, 2024). Opioid based and epidural analgesia has been linked to superior postoperative pain control, but these benefits do not consistently result in reduced morbidity and mortality,(Small & Laycock, 2020a). The Enhanced Recovery After Surgery (ERAS) pathway following major abdominal surgeries recommend the employment of multimodal analgesia. Multimodal analgesia entails the use of synergistic pharmacological and non-pharmacological techniques that target different mechanisms of action in the peripheral and/or central nervous system. Round-the-clock multimodal techniques have shown more effective pain relief compared with single modality interventions. Side effect profiles for each analgesic medication and technique used should be weighed against the benefits and anticipated monitoring following intervention. Systemic opioids should be used sparingly due to increased likelihood of attendant risks such as dependance, tolerance and development of chronic pain syndromes. Integration of techniques such as nerve blocks, neuraxial techniques and use of N-methyl- D- aspartate receptor antagonist such as ketamine, alpha 2 agonist such as clonidine or anticonvulsants such as pregabalin, is recommended based on indications. Therefore, the regimen should be customized to patients' needs based on comorbidities, surgical procedure, anticipated duration of therapy and anticipated postoperative monitoring,(Chou et al., 2016; Shuang L & Leigh K, 2022; Small &

Laycock, 2020a). Cognitive behavioral modalities such as guided imagery techniques, relaxation methods with music and hypnosis, are used as adjuncts in patients who undergo surgery. These are offered by psychologists, psychotherapists, nurses, physicians or social workers. Although considered generally safe, studies show inconsistencies in terms of benefits on outcomes related to post operative pain. There is insufficient evidence to recommend one specific cognitive behavioral modality over another, or to recommend specific techniques. There is also insufficient evidence to recommend against cognitive behavioral modalities therefore, administration should be based on patient's need, (Shuang L & Leigh K, 2022; Steeds, 2016).

The WHO analgesic ladder is widely used as a guide in management of acute pain. It was originally coined for use among cancer patients but has since undergone modification and is widely adopted in management of noncancer pain as well. It was a three-tier approach which involves use of Nonsteroidal anti-inflammatory drugs (NSAIDs), opioids, acetaminophen with or without adjuvants. The original ladder mainly consists of;

Step 1- Mild pain, use NSAIDs or acetaminophen with or without adjuvant.

Step 2- Moderate pain, use weak opioids (tramadol, codeine), with or without non-opioid analgesics and with or without adjuvants.

Step 3- Severe or persistent pain, use potent opioids (morphine, fentanyl) with or without non-opioid analgesics and with or without adjuvants.

(Jenkinson H & Abd-Elsayed A, 2023).

The original analgesic ladder focused on escalation of pain management with exclusion of neuraxial and regional analgesia techniques. Non-pharmacological approaches were also not included. A fourth step was later added to incorporate

techniques such as epidural analgesia, nerve blocks as well as non-pharmacological methods such as transcutaneous electrical nerve stimulation (TENS) and cognitive behavioral therapy as adjuvants. The revised WHO ladder allows for both escalation and de-escalation of pain treatment as needed, (Jenkinson H & Abd-Elsayed A, 2023).

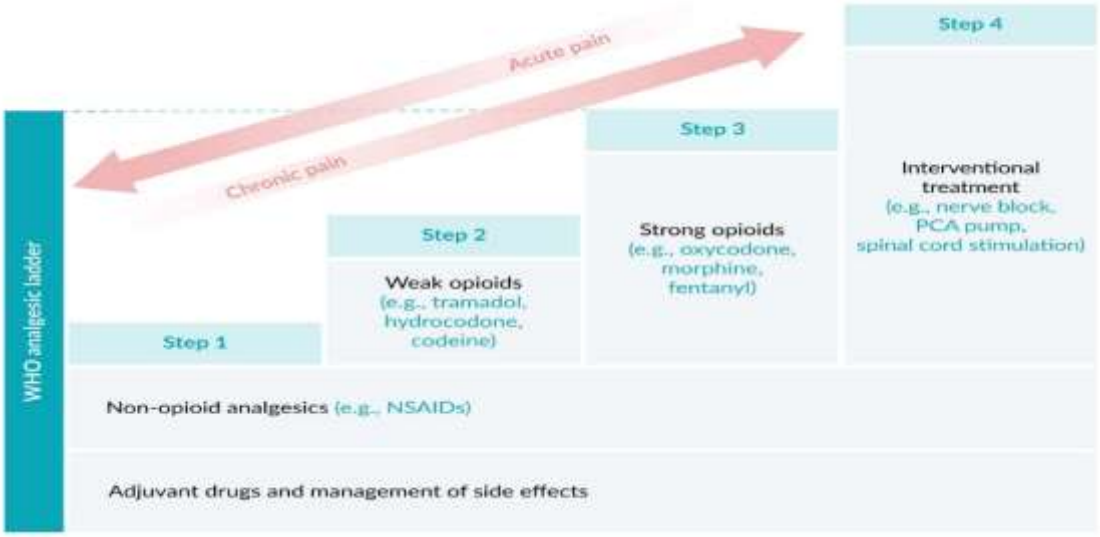


Figure 2: Modified WHO pain ladder, (Jenkinson H & Abd-Elsayed A, 2023).

Despite the update on the WHO pain ladder, the IASP found the ladder approach to pain management to be one dimensional, focusing more on the physical aspect of pain. This led to recommendation on adoption of therapeutic approaches that focus on cause of pain and its physiology and the mechanism of action of drugs used to treat the pain, (Anekar A et al., 2023) ERAS currently advocates multimodal analgesia and encourages the use of opiate sparing techniques as this has been shown to improve recovery and reduce morbidity. The American Pain Society, the American Society of Regional Anesthesia and Pain Medicine and American Society of Anesthesiologists committee on regional Anesthesia recommend customization

of postoperative analgesics to enable seamless and early transition to oral medication postoperatively, while decreasing chances of developing side effects.

2.6 Systemic pharmacological methods

2.6.1 Opioids

Opioids were conventionally considered the mainstay in management of acute moderate to severe postoperative pain for a considerable length of time. They act pre-synaptically by blocking calcium channels on nociceptive afferent nerves to inhibit the release of substance P and glutamate. They exert their analgesic action post-synaptically by activating descending inputs from the periaqueductal gray and rostral ventromedial medulla by opening potassium channels, which hyperpolarize cell membranes, increasing the required action potential to generate nociceptive transmission. Tramadol, oxycodone, fentanyl, methadone, dextromethorphan, meperidine, codeine, and buprenorphine inhibit serotonin reuptake and increase the release of intrasynaptic serotonin through inhibition of gamma-aminobutyric acidergic presynaptic inhibitory neuron on serotonin neurons. Methadone binds to the NMDA receptor and antagonizes the effect of glutamate, (Alorfi N, 2023; Cohen B et al., 2026).

Opioids are typically administered intravenously, intramuscularly, subcutaneously, intra-nasally, trans-dermally or orally. The route choice depends on type of pain, (location and severity), desired drug speed of onset and duration of action, clinicians ease of use and monitoring modalities available, (Cheung K et al., 2022). Intravenous opioids are more useful in management of acute pain due to rapid onset. The APS, ASRA and ASA in the current postoperative pain management guideline, strongly recommend intravenous, PCA in patients who have adequate cognitive functions, who require analgesia post operatively. Studies have shown that this modality is highly

effective with higher patient satisfaction rates. Use of intramuscular opioids is discouraged due to pain at injection sites, erratic absorption resulting in inadequate early analgesia and late drug absorption, especially in patients who are hypovolemic or in shock. Besides, intramuscular route has not shown any advantages over other routes of administration. Patients on systemic opioids should be adequately monitored for possible adverse effects associated with opioids use which include cognitive and fine motor impairment, respiratory depression, nausea, vomiting, pruritus, among others, (Chou et al., 2016).

Preoperative opioid use has been linked to moderate to severe postoperative pain and severe adverse effects (such as sedation and respiratory depression), in the immediate postoperative phase. Post operative opioid dependance and overdose has been shown to affect 2 per 1000 opioid naïve surgical patients who received opioids during perioperative period and followed up for about 5 years, (Wylie J et al., 2022). Mitigation strategies to the opioid related acute and chronic adverse effects should be initiated in the peri operative period and include use of opioid sparing multimodal analgesics and de-escalation of medication using reverse analgesic ladder, (Small & Laycock, 2020).

2.6.2 Acetaminophen and NSAIDs

Acetaminophen, also known as paracetamol, acts centrally by activating a descending serotonergic pathway. Studies have shown a marked reduction in 24-hour opioid consumption compared to placebo when used as part of multimodal analgesia. Route of administration includes intravenous, oral, or rectal. Intravenous route is preferred in immediate postoperative period due to the rapid onset while prophylactic administration has been linked to decreased nausea and vomiting. Some of the associated side effects include hepato-renal toxicity, although highly unlikely at therapeutic doses, (Chetty S et al., 2022; Chou et al., 2016). NSAIDs act by inhibiting prostaglandin synthesis. They are classified into cyclooxygenase 1 and

2 inhibitors (diclofenac, ketorolac, ibuprofen, indomethacin) and selective cyclooxygenase 2 inhibitors (celecoxib) and routinely used as part of multimodal analgesic strategy via different routes (intravenous, intramuscular, rectal, or oral). Intravenous route is preferred in immediate postoperative period due to the rapid onset. They are associated with adverse effects such as renal damage (especially in hypovolemia or shock), hepatic failure, platelet impairment (increasing risk of bleeding) and gastric erosion. Therefore, caution should be exercised while considering administration to patients with renal or hepatic impairment or those with increased risk of gastrointestinal hemorrhage, thromboembolic or cardiac events. Gastrointestinal risks are reportedly lower with cyclooxygenase-2 selective NSAIDs. NSAIDs use has also been associated with risk of impaired wound healing, anastomotic leaks and possible exacerbation of asthma. Evidence by numerous studies is however inconclusive,(Chetty S et al., 2022; Cheung K et al., 2022; Small & Laycock, 2020).

The combination of acetaminophen and NSAIDs has been shown to offer better postoperative pain control than either drug alone as well as decrease post operative opioids requirement, (Cheung K et al., 2022).

2.6.3 Local and peripheral regional pharmacological therapies

Local anesthetics are broadly classified into short acting (e.g., lignocaine) and long acting (e.g., bupivacaine). They exert the analgesic effect by inhibiting neural excitation, conduction and transmission of impulses to the central nervous system as well as suppression of inflammatory response to noxious stimuli. The main modalities employed perioperatively include local infiltration of the wound, peripheral nerve blocks and neuraxial techniques, (Mingxu Z et al., 2024). The use of local anesthetics as part of multimodal strategies has gained traction over the

years especially with adoption of ultrasonography. Studies have shown reduced opioids consumption, early mobilization and better recovery as a result. However, employment of these modalities requires proper expertise to avoid nerve damage or inadvertent vascular drug placement. Monitoring and timely management in case of development of local anesthetic systemic toxicity is also essential, (Mingxu Z et al., 2024).

The use of long-acting local anesthetics such as bupivacaine for wound infiltration can provide effective analgesia for several hours. However, this is not routinely recommended due to current mixed evidence. Surgical site-specific regional blocks are used to provide selective pain control by providing blockade of plexus or peripheral nerves. Common nerve blocks used during abdominal surgeries include, transversus abdominis plane (TAP) and internal oblique muscle block. These nerve blocks are strongly recommended as part of the ERAS program. The single injection peripheral neural blockade prolongs the duration of analgesia and potentially reduces the need for a continuous infusion, (Cheung K et al., 2022).

2.6.4 Neuraxial Therapies

Epidural or spinal analgesia is strongly recommended for major thoracic and abdominal procedures, especially in patients with a substantial risk for myocardial infarction, venous thrombo-embolism, pneumonia, respiratory depression, or prolonged ileus. These modalities are associated with lower postoperative pain scores and are recommended as part of procedure specific guidelines. Most recent systemic reviews however show conflicting results stating marginal benefits of neuraxial modalities compared to peripheral nerve blocks. Epidural analgesia has been linked to prolonged hospital stay due to lack of early mobilization. The waning popularity is due to paucity of data showing improved mortality benefits of epidural

analgesics compared to other non-invasive modalities such as peripheral nerve blocks, (Chou et al., 2016; Katrina P et al., 2022).

2.6.5 Preemptive analgesia

Preemptive analgesia entails administration of analgesics prior to acute pain stimuli, to minimize central sensitization and inflammation. Different analgesic techniques are used such as systemic analgesic, epidural and local anesthetics. This modality has steadily gained traction in recent years with benefits such as reduced analgesic consumption. A meta-analysis of 188 studies done in which 19 preemptive analgesic techniques were compared showed that preemptive analgesia is associated with low pain scores, decreased opioid cumulative consumption, and improved time to first rescue analgesia, (Yan W et al., 2022).

Preemptive analgesia with celecoxib, gabapentin, pregabalin, 30minutes to 2 hours preoperatively is associated with reduced opioid need after surgery and lower postoperative pain scores. Celecoxib is, however, contraindicated in patients who have cardiac disease or those who undergo coronary artery bypass graft surgery, due to increased risk of cardiovascular events. Both gabapentin and pregabalin are associated with adverse effects such as sedation, in higher doses. One of the drawbacks of these medications is they are only available in oral form, which may restrict their use during the immediate postoperative period, (Chou et al., 2016; Yan W et al., 2022).

Ketamine is a dissociative anesthetic, commonly used for induction of anesthesia. Recent studies have shown that preoperative intravenous ketamine was associated with decreased postoperative pain scores and decreased opioid consumption in the first 24 and 48 hours postoperatively. It can also be administered intra and post operatively with other analgesics such as acetaminophen as this has shown

increased synergism. It's however associated with dose dependent adverse effects such as increased risk of hallucinations, nightmares, hypersalivation, nausea and vomiting therefore not recommended as routine part of ERAS postoperative strategies, (Small & Laycock, 2020).

Preemptive epidural analgesia showed the longest time to first rescue analgesia followed by gabapentinoids. Local anesthetics are, however, discouraged as a form of preemptive analgesia as they have shown no benefits, (Yan W et al., 2022).

2.6.6 Nonpharmacological therapies

These techniques do not require medication and should only be used alongside, and not instead of, pharmacotherapy. They are typically safe, inexpensive, and can reduce the need for analgesic and potential side effects. They are usually categorized into physical and psychological approaches. The physical interventions include transcutaneous electrical nerve stimulation, acupuncture and massage. Transcutaneous Electrical Nerve Stimulation (TENS) delivers low voltage electrical currents through pads placed on painful areas, using portable a device to activate opioids receptors via inhibitory pathways and decrease central excitability. Acupuncture uses needles at specific points to boost blood flow, aid healing and modulate pain and analgesia. Massage involves superficial application of cold or warm compress on the surface of the skin with or without compression resulting in reduced edema and local analgesia. Psychological interventions like cognitive behavioral therapy aim to modify pain related behaviors and build coping skills to improve mental functioning. Techniques such as structured relaxation techniques and arranged enjoyable activities can reduce analgesic use and postoperative anxiety as part of multimodal approach. However, evidence of their effectiveness on post

operative pain outcomes is mixed,(Chetty S et al., 2022; Chou et al., 2016).

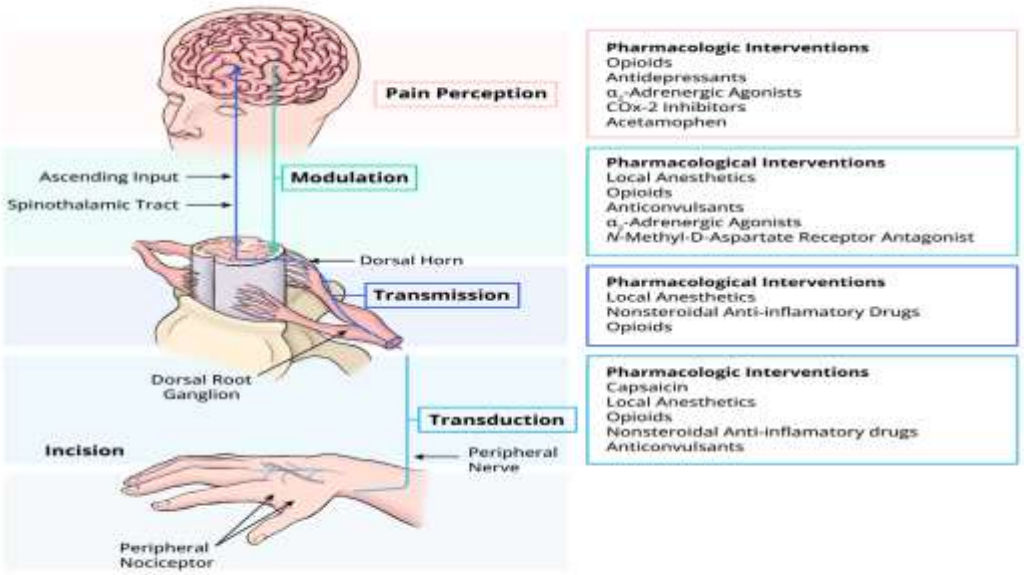


Figure 3: Summary of systemic multimodal analgesics,(Preetma K & Margaret H, 2024).

2.7 Standard tools for pain assessment in adults

Effective acute pain assessment is essential for safe pain management. It begins preoperatively with a review of medical history, current pain details, physical exam and evaluation of any functional impairment, to develop an appropriate perioperative pain plan. Accurate use of pain assessment tools and documenting baselines scores enable meaningful comparison after interventions. Ongoing assessment and reassessment are necessary to guide further treatment and monitor adverse effects. Self-reporting is the primary method for pain assessment; however, behavioral assessment tools can be used in circumstances where communication is impaired such as in patients with cognitive disability. ASA with input from APS recommend that reassessment after an intervention should consider the time to peak effect, (typically 15 to 30 minutes after parenteral drug therapy or 1 to 2 hours after oral analgesic), surgical procedures type, comorbidities, clinical status and potential

side effects. There is currently insufficient evidence to determine how often patients should be reassessed after surgery, (Chetty S et al., 2022; Chou et al., 2016).

Several self-report assessment tools are currently utilized in clinical practice. VAS is popularly used due to its simplistic design, ease of administration and minimal translation. However, it's unsuitable for individuals with visual impairment or cognitive disabilities. VAS is typically 10cm horizontal line marked from 0 (no pain) to 10 (worst pain possible), often accompanied by five colored emoticon faces representing different pain levels, with corresponding VAS scores. The scale has been shown to be sensitive and reliable. It's widely validated among various categories of patients, and it's more meaningful when used on the same patient over time.

(Chetty S et al., 2022; Chou et al., 2016; Ezra E et al., 2022).

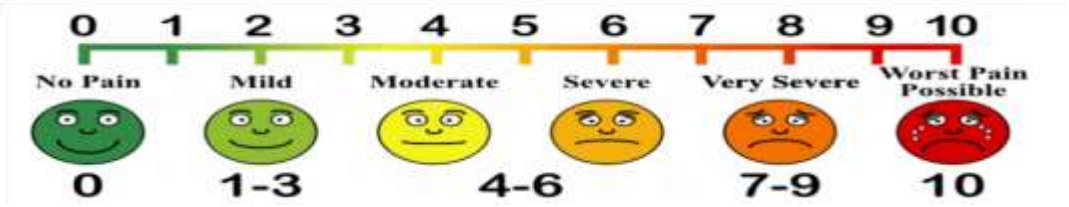


Figure 3: Visual Analogue pain Scale, (Small & Laycock, 2020).

ASA emphasizes that postoperative pain assessment should also involve further investigation to rule out a new medical condition, surgical complications, and potential opioid tolerance. The effects of pain on both functional and psychological status should also be assessed and potential pain management barriers such as language barriers, cognitive dysfunction and patients or health workers attitude towards pain, identified. Pain relief can also be measured using reverse visual analogue scale where 10 represents complete relief and 0 representing no relief. Pain interpretation is influenced by perception, experience and gender, with

different genders defining “worst pain experience”, differently. While pain rating scales help assess postoperative analgesia, lower scores do not always mean better patient experience. Current guidelines recommend adjusting analgesia to achieve a visual analogue score below 4 or 3 when using patient-controlled analgesia, (Adeboye A et al., 2021; Chetty S et al., 2022).

2.8 Pain management at PACU

Post operative pain care is a continuum and PACU serves as a critical transition point from operating theatre to the inpatient wards. Comprehensive management of postoperative pain extends beyond hospital discharge to ensure optimal patient outcome. PACU is an extraordinarily complex environment that presents both medical and ethical challenges, particularly due to patients altered neurological status resulting from anesthesia, sedation or underlying comorbidities. In such circumstances, patients may have an impaired ability to communicate, comprehend, or reason, making the process of obtaining informed consent suboptimal for many individuals. Nevertheless, informed consent can be obtained at PACU under emergency conditions or when performing interventions outside standard care. In research, informed consent at the PACU can be obtained when the study involves collection of non-routine data related to immediate postoperative care such as pain assessments, monitoring for complications, or other activities that might disrupt standard patient care. In this context, patients are typically present in a research related setting and thorough documentation is essential. It is critical to verify that the patient is alert, coherent, and capable of comprehending the information provided. Consent should be obtained in accordance with the key principles of autonomy, beneficence, non-maleficence, disclosure, competence, and voluntariness, (Michelle B, 2018; Sara M & Amelia L, 2018) To that effect, we

ensured only participants with a modified Aldrete score of ≥9 with a Glasgow Coma scale of 15, were approached.

Modified Aldrete score assesses readiness for discharge from PACU based on limb activity, respiration, circulation, consciousness and oxygen saturation, rated from 0 to 2 (with 2 as the ideal). Activity is linked to the ability to move limbs voluntarily or on demand. A score of 1 is assigned when the patient moves two limbs while a score of 2 represents movement of four limbs. In respiration, recognized dyspnea is given 0 points while deep breathing with ability to cough represents a score of 2, blood pressure less than 20%, 20-50% and more than 50% of pre-anesthetic value is scored 0,1 and 2, respectively. The consciousness level is scored 0,1 and 2 for non-responsive, arousable, and fully conscious respectively and oxygen saturation is graded as 0,1,2 for oxygen saturation less than 90% (with supplemental oxygen), greater than 90% (with supplemental oxygen) and greater than 92% in room air. These scores are summed up and determined the status of a patient informing the decision to discharge from PACU for management in the ward or for continued recovery at home for ambulatory patients, (El Aoufy K et al., 2024).

2.9 Summary of best practice and new advances

The 2016 postoperative pain guidelines by APS, ASA, ASRA and pain medicine strongly recommend that, a facility in which major surgery is performed should use multimodal approach, have access to pain specialist where, Nurse- Based Anesthesiologist - Supervised, Acute Pain Service model, has shown to have the highest potential for optimal pain relieve. The facility should also have a structure for policy development and implementation, to ensure safe, effective postoperative pain management. Titration of analgesics to a target pain score ≤ 3 (VAS), with no

significant functional impairment is also considered optimal, (Bicket C et al., 2025; Chen X et al., 2025; El-Boghdadly K et al., 2024).

Artificial intelligence using machine learning may contribute to perioperative pain management by analyzing diverse data sets and algorithms to identify potential risk factors related to acute postoperative pain to suggest targeted pain management strategies. Further research is required to determine the reliability and safety of machines learning based on approaches prior to their integration into perioperative pain management strategy, (Agrawal S et al., 2025; Sajdeya R & Narouze S, 2024).

At MTRH, laparotomy accounted for 52% of surgeries in 2022, Despite the surgical burden, the magnitude of acute postoperative pain and adequacy analgesic practices remained unknown. There is also no standard multidisciplinary protocol for managing postoperative pain following laparotomy, instead, health care providers rely on the general WHO pain ladder, which is inconsistently applied depending on available resources and provider preferences. Additionally, despite the presence of consultant anesthesiologists and pain specialists, traditional acute pain service models are still in use at MTRH.

This study highlighted the need for a standardized multidisciplinary postoperative protocol customized to our setting and accentuates the need for continued education on perioperative pain care among healthcare practitioners. It also underscores the importance of transition towards nurse-led, anesthesiologist-based, specialist-supervised acute pain service model. Further, the study will serve as a baseline for future research and enable comparison with institutional and regional data.

CHAPTER THREE: MATERIALS AND METHODS

3.1 Study design

This was a cross-sectional prospective study aimed at identifying analgesics and pain management modalities utilized for management of acute postoperative pain in adult patients who undergo laparotomy at MTRH, Eldoret. The research further evaluated the adequacy of these modalities by tracking pain scores during the first 48 hours following surgery. The study design offered a cost-efficient approach for measuring pain management outcomes.

3.2 Study area and period

The study was conducted at the department of Obstetrics and Gynecology (gynecology ward) and the department of Surgery and Anesthesia (post-anesthetic care unit in theatre, male surgical ward, female surgical wards) at MTRH Eldoret, between March and December 2023. The participants were followed up from the post anesthetic care unit (PACU) to the wards for 2 days post operatively and data collected at three intervals.

MTRH is an internationally recognized hospital with a total capacity of 1,000. The gynecological ward has 32 beds, whereas male and female general surgical wards accommodate 42 and 48 beds, respectively. The facility includes 12 operating theatres, 1 primarily designed for obstetrics emergency and 3 predominantly utilized for general emergencies. General emergency surgeries are conducted daily as needed, while elective gynecological surgeries are performed biweekly and elective general surgical procedures are performed three times per week. Surgical interventions are performed by surgical registrar under supervision of a consultant general surgeon. Anesthesia is administered by an anesthesiologist consultant, a supervised anesthesiologist registrar, anesthetist or anesthetist student.

3.3 Study Population

The study population comprised of adult patients, (above the age of 18 years), who underwent laparotomy at MTRH within the study period.

3.4 Eligibility criteria

3.4.1 Inclusion criteria

All consented adult patients, (above the age of 18 years), who underwent laparotomy at MTRH during the study period. Pediatric patients were not included in the study because both pain assessment methods and drug metabolism differ greatly compared to those in adults. This is due to inability to adequately self-report pain and underdeveloped metabolic pathways and clearance mechanisms.

3.4.2 Exclusion criteria

1. Patients who had mental and cognitive disabilities (as indicated on patients file), who were scheduled to undergo laparotomy at MTRH during the study period.
2. Patients who underwent laparotomy and other surgical procedures concurrently, at MTRH during the study period.
3. Patients who were admitted to the intensive care unit following laparotomy during the study period.

Patients with documented mental and cognitive disabilities scheduled for laparotomy were excluded from the study as they are unable to reliably recall and self-report pain. Due to the subjective nature of pain assessment and an increased risk of disorientation from surgical stress, a specialized behavioral tool is often required for accurate pain evaluation in this group. Those participants who underwent other concurrent procedures were also eliminated since they fell outside scope of the study. Peri operative pain management in the intensive care unit (ICU) setting is unique due to altered pain expression and restricted treatment options due to comorbidities such as

sepsis or organ failure. Additionally, pain assessment tools differ from other patients. Consequently, individuals requiring ICU care after laparotomy were excluded from the study, (Chou et al., 2016; Czernicki M et al., 2019).

3.5 Sample size determination

A similar study at Bugando Medical Centre, Mwanza, Tanzania on prevalence of postoperative pain following laparotomy showed a pain prevalence of 94%, (Isaya M, 2024). Sample size was determined, assuming a confidence interval of 95% with a 5% margin of error and a prevalence of 94%. The Fischer's formula shown below was therefore used to calculate the sample size.

$$N= Z^2 pq /d^2$$

Where N is sample size, Z is the standard normal distribution =1.96, P is the proportion of patients reported to have adequate pain management based on a similar study =0.94 (94%), q is proportion equivalent to = 1-p and d is the precision or margin of error = 0.03

z =1.96 for 95% confidence interval

p = is 94%

q =1-p

d = is 0.05, the precision or margin error.

Therefore, N, which is the estimated sample size is equivalent to= 1.96*1.96*0.94 (1-0.94)/0.03*0.03 =241

Therefore, the final sample size was 241 participants.

3.6 Sampling technique

The systematic sampling technique was used. The first patient was randomly selected from the theatre lists, while subsequent participants were selected at fixed periodic intervals of 3. Eligible participants were enrolled until the desired sample size was achieved. The sampling interval was calculated by dividing the population size (N) with the desired sample size (n).

$$K = N/n$$

Eligible participants were those who met the inclusion criteria and the desired sample size calculated was 241. According to the Moi Teaching and Referral hospital Surgical registry of the year 2020, 2021 and 2022 a total of 595, 629, 736 underwent celiotomy, respectively. Therefore, the average number of patients who were admitted for laparotomy was calculated as below,

$$695 + 729 + 836 = 2{,}260$$

$$2{,}260 / 3 = 753.33$$

The population size was therefore 753.33.

The sampling interval was calculated as below,

$$753.33(N) / 241(n) = 3.1$$

The sampling interval was therefore 3.

3.7 Study procedure

3.7.1 Data collection procedure

Recruitment of two research assistants was done by the principal researcher on the significance of the study, procedure for obtaining informed consent and proper completion of the structured questionnaires. Eligible participants were identified pre-operatively by reviewing theatre lists and patient's files.

In the post-anesthetic care unit (PACU), participants who were fully alert and had attained a Modified Aldrete score of 9 or above were approached by the researcher or an assistant. The study objectives and procedures were explained prior to obtaining written informed consent. This approach was designed with consideration for the urgency often associated with laparotomies during the study period, as well as the frequent preoperative instability observed in participants, ensuring that patient interests remained paramount. The same approach was used for all participants undergoing elective laparotomy to maintain consistency and reduce information bias.

Participants' information was collected using a structured questionnaire and included biodata (age and sex), intraoperative information such as procedure done, intraoperative analgesic administered and postoperative data such as postoperative analgesics administered. This was collected at 3 intervals. The initial data was collected at PACU while the subsequent data was obtained 24 and 48 hours while the participants were in the wards. During these intervals, the participants were asked to grade the pain severity using the visual analogue pain scale. Over the entire study period, a total of 726 laparotomies were done, 3 patients were excluded since they required admission to the intensive care unit during data collection. Therefore, 723 patients were available for sampling.

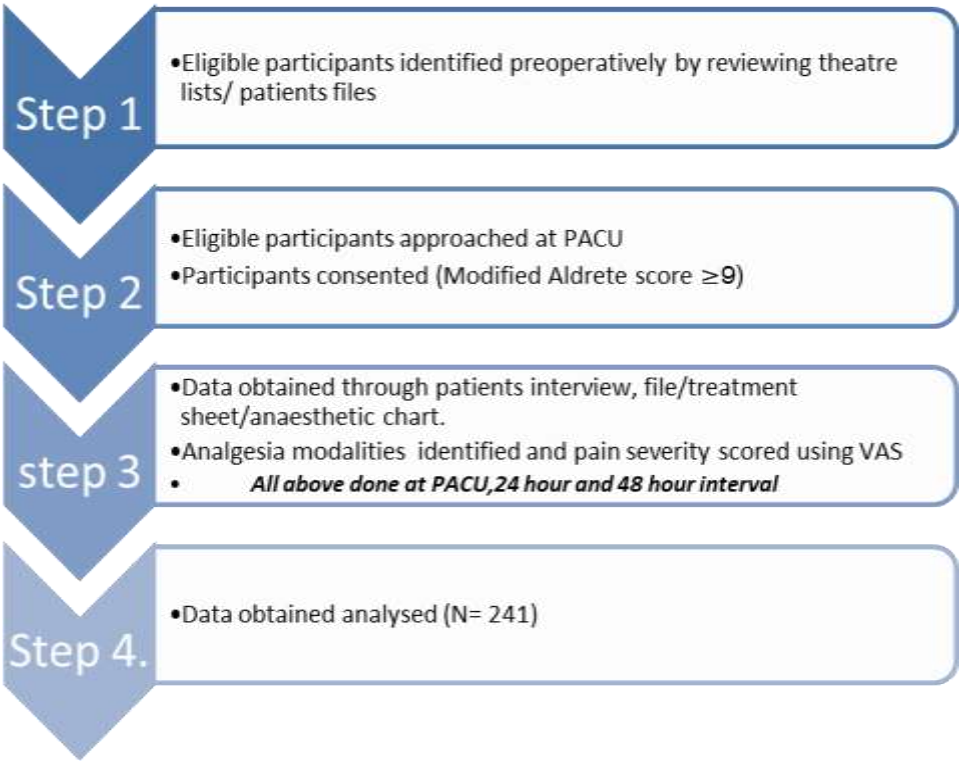


Figure 4: Study flow chart

3.7.2 Data Collection Methods

Structured questionnaire

The questionnaire was based on a previous questionnaire developed by Idvall et al to assess the quality of postoperative pain management, which was validated for its reliability in Turkey by Vatansever et al in 2014 as part of establishing strategic and clinical quality indicators in post operative pain management, (Vatansever & Akansel, 2014).The interview based questionnaire was composed of 5 sections (A-D)

Section A:

This section helped in obtaining information such as socio-demographic data, diagnosis, and urgency of surgery (elective or emergency). This information was largely obtained from the patients' file. This was done to minimize errors from entering incorrect data, especially in patients who might not be well versed with their medical history. It helped to understand the characteristics of study population.

Section B

This section involved gathering intraoperative details such, intraoperative analgesics used, and use of other alternative modalities such as intraoperative local analgesia (wound infiltration) neuraxial and regional techniques such as nerve blocks or epidural analgesia. This information was obtained from an anesthetic chart and surgeons notes since patients are generally not conscious during general anesthesia.

Section C

This section entailed assessment prescribing practices following laparotomy and evaluating other alternative modalities used for pain control. This information was also obtained from patient's treatment sheets anesthetic chart.

Section D

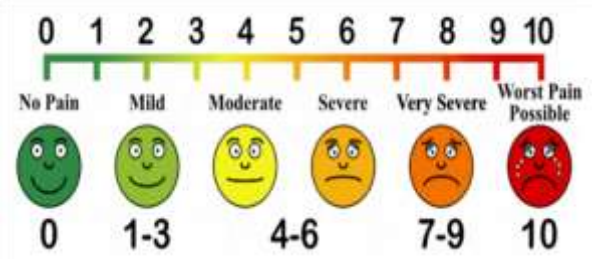
This part of the questionnaire obtained information determining the adequacy of the analgesics used and various modalities. This was established using the visual analogue pain scale which rates pain from 0 (no pain),1-3 (mild pain), 4-6 (moderate pain) to 7-9 (severe pain) to 10 (worst pain possible). This is a well validated tool to evaluate acute postoperative pain. Different analgesic combinations were also compared against degree of pain control.

Table 3.1: Questionnaire: Adequacy of analgesic practices among adult patients undergoing laparotomy at MTRH, Eldoret, Kenya.

A) SOCIO-DEMOGRAPHICS			
Name	Age:		
In Patient Number			
Ward	Date:		
Sex: F/M	Study no:		
B) INTRA-OPERATIVE DETAILS			
Diagnosis:	Analgesics	Route &dosage	
Urgency: Emergency/ Elective			
Duration of surgery:			
	Fentanyl		
	Morphine		
	Paracetamol		
	Ketorolac/Diclofenac		
	Others		
Intra-operative local analgesia given?	Y/N		
	If yes, type		
C) POST-OPERATIVE ANALGESIA			
PACU	Analgesics	Route & dosage	
	Morphine		
	Tramadol		
	Ketorolac/Diclofenac		
	Paracetamol		
	Others		
Day 1	Morphine		
	Tramadol		
	Ketorolac/Diclofenac		
	Paracetamol		
	Others		
Day 2	Morphine		
	Tramadol		
	Ketorolac/ Diclofenac		
	Others		
Pain score	Tramadol + Paracetamol	Morphine + Paracetamol	Others (Indicate)
At 24 hours			
None			
Mild			
Moderate			
Severe			
Worst pain possible			
At 48 hours			
None			
Mild			
Moderate			
Severe			

Worst pain possible

D) POSTOPERATIVE PAIN ASSESSMENT

Using the pain scale below, how best would you describe the pain you are experiencing now? Visual analogue scale.	PACU	Day 1	Day 2
	0 1 2 3 4 5 6 7 8 9 10		
Key: ***0-No pain Mild-1-3 Moderate 3-5 Severe 5-7 Very severe 7-9 Worst pain possible 10***			
Researcher: Gladys Kezziah Njue	**Signature:**		

3.8 Data management and analysis

Data obtained from both the questionnaires and patients' files was inspected for completeness and consistency continuously during the study by the principal investigator to ensure quality data. It was thereafter coded and entered in an excel sheet. Data cleaning was done and exported to STATA version 16.

(Stata Corp. 2019.Stata Statistical Software: Release 16. College Station, TX: Stata Corp LLC), for analysis. After the completion of data entry, the questionnaires were stored safely. Analysis was done per each objective as summarized in the table below.

Table 3.2: Data analysis.

Objective	Variables	Summary statistics
1.To establish the severity of acute postoperative pain among patients who undergo laparotomy at MTRH.	Pain score – Categorical variable.	Frequency and percentages.
2.To identify the pain-relieving modalities in use among patients who undergo laparotomy at MTRH.	Analgesics given – Categorical variable.	Frequency and percentages.
3.To establish the adequacy of pain relief by different modalities in use, following celiotomy at MTRH.	Pain relief – Categorical variable.	Frequency and percentages.

The study findings were presented using figures, their corresponding percentages and in tables. The study was conducted at 0.05 α-level of significance.

3.9 Ethical consideration

Approval was sought and granted from the Institutional Research and Ethics Committee (IREC) of Moi University, approval number 0004376 (appendix 5), the CEO Moi Teaching and Referral Hospital, reference number ELD/MTRH/R&P/10/2/V.2/2010 (appendix 6) and National Commission for Science, Technology and Innovation (NACOSTI), reference number, NACOSTI/P/24/34089 (appendix 7).

Written informed consent (appendix 3) was obtained from each participant recruited into the study. The study procedure and its importance were fully explained in a language understandable to them. All participants were treated equally whether they

agreed to be enrolled in the study or not and no incentives were offered to those who consented. The participants were allowed to leave the study at any stage with no repercussions. The researcher had no conflict of interest, and the study was not externally funded. All resources used in this study were solely provided by the researcher. The information collected was treated with utmost confidentiality and the anonymity of participants was guaranteed through unique identifiers and computers for data entry and analysis was secured with passwords only accessible to the principal researcher. Printed research documents are kept under lock and Key. There was no compensation from the study to participants. Disposal of the patient's information will be done as per IREC guidelines.

3.10 Dissemination of information.

The findings of this study were disseminated to colleagues in the department of Surgery and Anesthesiology as well as those in the Department of Obstetrics and Gynecology through continuous medical education, seminars, and conferences. A book will be presented to Moi University School of medicine library, for easy public access. Objective one has been accepted for publication by the East African Medical Journal; Volume 102, 11 November 2025 issue "*adequacy of current analgesia practices among adult patients who undergo laparotomy at MTRH, Eldoret, Kenya"*. An abstract has also been submitted to the European Journal of Medical and Health Research through peer review.

CHAPTER FOUR: RESULTS

4.1 Socio demographic characteristics

A total of 241 participants were recruited. Of these, 58.1% (140) were females while 41.9% (101) were male. The age range was between 21 to 67 years with a mean age of 35.29 ± 6.5, (Table 4.1).

Table 4.1: Socio-demographic characteristics of participants.

Variable	N=241
Gender	
Female	58.1% (140)
Male	41.9% (101)
Age in years	
<30	51% (123)
30-41	24.1% (58)
42-50	3.3% (8)
51-60	11.6% (28)
>60	10.0% (24)

4.2 Operative characteristics

Both emergency and elective abdominal laparotomies were done at MTRH during the study period. The emergency laparotomies accounted for 97.1% (234) while elective laparotomies were performed in 2.9% (7) of the participants. The leading indication for emergency laparotomy was acute abdomen requiring exploration comprising of 41.9% (101) followed by intestinal obstruction at 31.1% (75), perforated gut with peritonitis at 6.2% (15). Among elective procedures, the most common indications were pelvic mass and ovarian cyst each representing 0.8%, (Table 4.2).

Table 4.2: Operative characteristics

Variable	Patient characteristics	N-241
Indication for surgery	Electives	2.9% (7)
	Emergency	97.1% (234)
Emergency surgical interventions	Acute abdomen	41.9% (101)
	Intestinal Obstruction	31.1% (75)
	Perforated gut	6.2% (15)
	Blunt abdominal trauma	4.1% (10)
	Sigmoid volvulus	3.7% (9)
	Penetrating abdominal trauma	2.9% (7)
	Appendectomy, appendicular mass	2.5% (6)
	Hysterectomy	1.2% (3)
	Ovarian torsion	1.2% (3)
	Burst abdomen	0.8% (2)
	Incarcerated umbilical hernia	0.8% (2)
	Abdominal pregnancy	0.4% (1)
Elective surgical interventions	Pelvic mass	0.8% (2)
	Ovarian cyst	0.8% (2)
	Ca cervix	0.4% (1)
	Colon mass	0.4% (1)
	Pancreatic pseudo cyst	0.4% (1)

4.3 Pain severity among the participants

The study participants were followed up at three intervals. At PACU, patients who were fully awake with a GCS of 15, were scored for pain using the VAS and followed up at 24 and 48hours intervals. A score of 0 suggested no pain while that 1 to 3 suggested mild pain. Moderate pain was rated between 4 and 6, and a score of 7-9 suggested severe pain, and 10 represented worst pain possible. Majority of participants, 44% (106) reported mild pain while 56% (135)) reported moderate to severe pain while at PACU. Vast majority of patients reported a VAS pain score of 0-3 in 24 hours and 48 hours while 17% (41) and 6.2% (15) reported a VAS score of 4-9 at 24 and 48 hours respectively, (Table 4.3). The Conchran-Armitage test showed a statistically significant ($P< 0.001$) linear trend in pain score across the assessment periods.

Table 4.3: Acute postoperative pain severity

Pain score (VAS)	PACU (n=241)	24 hours (n= 241)	48 hours (n= 241)
0 (No pain)	0	0	0.4% (1)
1-3 (Mild)	44% (106)	83% (200)	93% (225)
4-6 (Moderate)	42.3% (102)	16.6% (40)	6.2% (15)
7-9 (Severe)	13.7 % (33)	0.4% (1)	0
10 (Worst pain possible)	0	0	0

4.4 Pain management modalities used.

Results obtained showed that only systemic pharmacological pain management modalities were used. These analgesics were administered as monotherapy or in combination. The most preferred analgesic combination at both 24- and 48-hours interval were tramadol and paracetamol at 31.1% and 28.2%, respectively. Paracetamol and morphine combination was often used in the intra operatively. Surprisingly, no other analgesic modalities such as abdominal wall blocks, incision site infiltration or epidural analgesia were offered to participants during the study period, (Table 4.4).

Table 4.4: Intra and postoperative analgesic combinations

Intraoperative		
Fentanyl + Paracetamol	68 (28.2%)	
Morphine + Paracetamol	89(36.9%)	
Tramadol +Paracetamol	62 (25.7%)	
Fentanyl + Paracetamol + Morphine	22 (9.1%)	
Post operative	**24-hour interval**	**48-hour interval**
Morphine + Paracetamol	64 (26.5%)	27 (11.2%)
Tramadol + Paracetamol	75 (31.1%)	68 (28.2%)
Diclofenac + Paracetamol	2 (0.83%0	10 (4.1%)
Ketorolac + Paracetamol	2 (0.83%)	-
Paracetamol only	94 (39%)	67 (27.8%)
Zulu (Aceclofenac + paracetamol)	2 (0.83%)	2 (0.82%)
Betapyn (paracetamol + caffeine anhydrous + codein phosphate + doxylamine succinate)		2 (0.82%)
Kettesse (dexketoprofen trometamol) and paracetamol	2 (0.83%)	65 (26.9%)

4.5 Adequacy of pain management modalities used.

Using the Chi-square test (p = 0.001) tramadol/paracetamol combination showed superior pain control, with only 12.5% of participants experiencing moderate to severe pain, compared to 36% in the morphine/paracetamol group. At 48 hours, tramadol/paracetamol and morphine/paracetamol were used in 28.2% and 11.2% of cases, respectively. Fisher's Exact test (p=0.336) showed that 7.4% of participants on tramadol/paracetamol reported moderate to severe pain, versus 17.6% on morphine/paracetamol. This finding is atypical given the pharmacodynamic mechanism of both medications. Additionally, 48% and 25% of participants reported a VAS score of 4-9 at 24 and 48 hours respectively which is above the recommended threshold of ≤3.

Table 4.5: Comparison of pain control at 24 and 48 hours between those using tramadol/paracetamol and morphine paracetamol.

Pain score	Tramadol/Paracetamol	Morphine/Paracetamol	P-value
At 24 hours			**0.001** [c]
No/ Mild pain	**56 (87.5%)**	**48 (64%)**	
Moderate/ severe pain	**8 (12.5%)**	**27 (36%)**	
At 48 hours			**0.336** [f]
No/Mild pain	**25 (92.6%)**	**56 (82.4%)**	
Moderate/Severe	**2 (7.4%)**	**12 (17.6%)**	

CHAPTER FIVE: DISCUSSION

5.1 Introduction

The burden of acute postoperative pain remains high. There's limited data on procedure specific guidelines on pain treatment among patients who have undergone laparotomy, more so, in resource constrained regions. A study done in 2022, in Mwanza, Tanzania on adequacy of postoperative pain among patients undergoing laparotomy, reported moderate to severe postoperative pain prevalence of 92.2% within the first 24 hours, reaffirming the same, (Isaya M, 2024). Analgesia practices encompass multimodal approaches that incorporate both pharmacological methods (utilizing various techniques and routes) and non-pharmacological strategies to achieve effective pain management.

This study aimed at identifying various analgesics and modalities commonly used among adult patients who undergo laparotomy at MTRH and determining the adequacy of pain control using the visual analogue pain scale.

5.1 Socio-demographic characteristics

A total of 241 participants were enrolled and observed throughout the study duration. Results show that the mean participants' age was 35.29 ±6.5 years. Females accounted for 58.1% of group whereas males represented 41.9% yielding a female to male ratio of 1.4:1.

The female preponderance is consistent with findings from the National Emergency Laparotomy Audit 2021-2023 across the UK which reported a female predominance of 51.2%, predominantly among individuals over 60 years of age, (Anand et al., 2024). The observed difference in age distribution may be attributed to distinct regional health burden. In East Africa, a greater proportion of surgical interventions

are required among younger populations often linked to infectious diseases, trauma and complications related to childbirth. In contrast, the UK exhibits a higher demand for surgical procedures among older adults, primarily driven by age related conditions and enhanced access to health care services, (Fowler A J et al., 2019; Swarbrick C et al., 2025). Studies in Sub-Saharan Africa and India show mixed findings on gender predominance, with both males and females reported as dominant. Participants in this study ranged from 20 to 88 years old, (Eshete et al., 2019; Nithya T & Rajagopalan S, 2021; Rancesca G, 2019). Gender and age disparities in low- and middle-income countries are influenced by changing health-seeking behaviors, which are shaped by socio-demographic, cultural, psychological, and provider factors. Disparities often relate to culture, healthcare costs, age, and proximity to hospitals. In Uasin Gishu county, Eldoret, health-seeking beliefs involve a mix of traditional and modern practices, with an increasing trend toward hospital care due to improved access to quality services, (Ombok, 2024).

5.3 Operative characteristics

Both emergency and elective laparotomies remain integral to the surgical management of gastrointestinal pathologies. Emergency laparotomy is performed frequently across the globe, with 27,863 operations annually in England and Wales, a notable increase from 22,132 according to NELA 2021- 2023, and approximately 175,000 procedures each year in the US, as reported by the American College of Surgeons National Quality Improvement Program. In the UK, leading indications include small bowel obstruction necessitating exploration (36%) and gastrointestinal perforation (25%), (Anand et al., 2024). While the rate of elective laparotomy is gradually declining due to the growing adoption of minimally invasive laparoscopic procedures, which offer reduced complication rates, open laparotomies retain their

importance, particularly when the risks associated with minimal access techniques outweigh their potential benefits.

The study findings indicated that laparotomies were performed emergently in 97.1% (234) of participants, while elective procedures accounted for 2.9% (7). The predominant indication was exploratory laparotomy for acute abdomen, representing 41.9% of cases, where the underlying gastrointestinal pathology was undetermined prior to surgery. Additionally, 31.1% of participants presented with intestinal obstruction, and 6.28% had a perforated gut accompanied by peritonitis. Higher rates of emergency laparotomies compared to elective procedures have been documented in previous studies from Tanzania (55.5%) and Ethiopia (43.3%), respectively, (Eshete et al., 2019; Kiswezi, 2014). The variation in the prevalence of elective versus emergency laparotomy, as well as their indications, may be attributed to differences in disease patterns across geographical regions, the types of hospitals where the studies were conducted, and variations in case complexity. Nevertheless, there remains a paucity of data on this subject in both developed and developing countries. The increasing adoption of elective laparoscopic surgeries in our setting may further contribute to the observed variability.

At MTRH, laparoscopic procedures are steadily becoming more common, particularly among individuals with gynecological conditions. Laparoscopy can serve both elective and emergency surgical needs for diagnostic and therapeutic purposes. Although traditional surgical methods are well established, determining the optimal management approach (open versus laparoscopic surgery), especially in emergencies, remains under debate due to a lack of studies with standard outcome measures. Most existing research consists of case reports or series. While these offer promising

results, the scarcity of trial-based evidence means specific recommendations cannot yet be made. Laparoscopic surgeries generally result in smaller incisions, less postoperative discomfort, shorter recovery periods, and may enhance surgical safety and precision. Nevertheless, this technique requires specialized skills and equipment, therefore, patient selection should consider the surgeon's experience and available resources. Additionally, the potential need to convert from laparoscopic to open surgery should always be anticipated, (Cui et al., 2020; Madhusudanan G & Girijavallabhan P, 2024).

5.4 Pain severity among participants

The immediate postoperative period, generally considered to be the first 24 to 48 hours after surgery, plays a vital role in patient care. During this phase, postoperative pain tends to be at its peak and requires careful management to avoid complications. Patients are monitored closely for any issues related to surgery or anesthesia.

Research indicates that pain treatment during this time is frequently insufficient, and achieving optimal pain control depends on regular reassessment of treatment effectiveness. This is why the study focused on the first 48 hours after surgery. The perioperative pain management plan should remain adaptable, allowing adjustments when pain control is inadequate and tapering analgesics as pain improves.

Routine observations should incorporate proper assessment, as this process provides essential information for individualized therapy. In this study, VAS was used to evaluate pain severity due to its high sensitivity and reliability among postoperative patients. Pain was scored on a scale from 0 to 10; 0 indicating no pain, 1 to 3 mild pain, 4 to 6 moderate pain, 7 to 9 severe pain, and 10 representing the worst pain possible, (Delgado A., 2018).

In this study, participants were first evaluated in the PACU, an environment that requires careful consideration of both medical and ethical factors due to altered neurological states resulting from anesthesia or pre-existing comorbidities. Therefore, some patients may experience impaired communication, comprehension, or reasoning abilities compared to their baseline condition. To mitigate this concern, only those participants who achieved a modified Aldrete score of ≥9 and a Glasgow Coma Scale of 15 were approached. This ensured all participants were alert, coherent, and fully capable of understanding the information provided. The modified Aldrete score assesses readiness for discharge from PACU based on five key parameters. Motor function, consciousness level, respiratory status, oxygen saturation, and cardiovascular stability. Each parameter is scored from 0 to 2, with a maximum total score of 10. Due to its reliability, accuracy, and comprehensiveness, this scoring system is widely used to evaluate patients' recovery following general anesthesia or deep sedation, (Prachi P & Chakole V, 2024).

The results from the study showed that at the initial review in the PACU, 56% of patients experienced moderate to severe pain and required additional painkillers, while 44% reported only mild pain. At the 24-hour follow-up (second review), 17% of patients still had moderate to severe pain, but most (83%) reported mild pain. By the 48-hour mark (third review), just 6.2% of participants had moderate pain, with the vast majority, 93.4%, experiencing mild pain. Only 0.4% of participants were completely pain free, registering a pain score of zero. Notably, no patient reported the highest possible pain during the study period. The pain score served both to measure pain severity and as a baseline for subsequent comparison. The Cochran-Armitage test revealed a significant ($P < 0.001$) linear trend in pain scores over time, with pain highest in the PACU and decreasing within 24 to 48 hours.

The findings of this study differ from those of a prospective longitudinal study done in 2022 in Bulago Tanzania on adequacy of postoperative pain among patients undergoing laparotomy, where 92.2% and 47% of participants reported moderate to severe pain at 24 hours and 48 hours, respectively. A separate study done in Mulago hospital in Uganda, reported pain prevalence of 100% and 97% at 6 and 24 hours, respectively. However, the pain intensity was not documented. Additionally, a cross-sectional study done in two referral hospitals in Addis Ababa, Ethiopia, reported a moderate-severe pain prevalence of 73.1% at 24 hours post operatively. (Isaya M, 2024), (Kiswezi, 2014) (Amberbir W. D, 2021). The findings suggest post-operative pain is relatively well managed in relation to other comparable regions in East Africa.

This study findings contrast with earlier research; in Bulago, Tanzania (2022), 92.2% and 47% of laparotomy patients had moderate to severe pain at 24 and 48 hours postoperatively. In Mulago Hospital, Uganda, pain prevalence was 100% and 97% at 6 and 24 hours (intensity not documented) and in Addis Ababa, Ethiopia, 73.1% reported moderate to severe pain at 24 hours, (Amberbir W et al., 2023; Isaya M, 2024; Kiswezi, 2014). Overall, the severity of acute postoperative pain is observed to be marginally lower in this study region relative to other areas of East Africa.

The differences observed among these studies may be due to variations in analgesic regimens and techniques used for acute postoperative pain management in different regions. Additionally, the lack of standardized protocols for managing postoperative pain, as noted in the reference studies above, could contribute to these discrepancies. Notably, our study assessed postoperative pain only while patients were at rest, whereas other studies evaluated pain both during rest and movement, which may explain higher pain scores reported elsewhere. Currently, there are no published

studies with results that align or compare with our findings globally and regionally, highlighting the need for further research in our context. Effective pain management encourages early mobility, quicker recovery of normal functions, and shorter postoperative hospital stays.

5.5 Pharmacological interventions

This study observed that systemic analgesics were exclusively utilized during the research period, administered either as monotherapy or in combination. The predominant methods of administration were intravenous and intramuscular, with oral medications subsequently introduced in the ward.

The APS, ASRA, and ASA guidelines recommend preemptive administration of gabapentin (or pregabalin), NSAIDs, or acetaminophen for open laparotomy procedures. Intraoperatively, combination of systemic analgesics with regional or neuraxial techniques where clinically appropriate is encouraged while postoperative use of systemic analgesics is advised. Use of postoperative opioid boluses has been shown to provide rapid pain relief and facilitate titration when indicated. Parenteral PCA is also encouraged for patients with adequate cognitive function who require parenteral analgesics for several hours postoperatively and may not benefit from epidural or regional nerve blocks. Additionally, transversus abdominis plane block has demonstrated improvement in early pain control, reduction in opioid consumption, and enhanced patient satisfaction, while epidural analgesia is associated with lower pain scores and accelerated bowel function recovery. Nonpharmacological approaches, including cognitive behavioral therapy and transcutaneous electrical nerve stimulation, may serve as useful adjuncts to medication, (Chou et al., 2016; Katrina P et al., 2022)

All participants received paracetamol intraoperatively, while fentanyl and morphine were administered to 28.2% and 36.7%, respectively. NSAIDs were not used during surgery, despite their analgesic and opioid sparing benefits, largely due to concerns on potential adverse effects such as postoperative anastomotic leaks, bleeding, and ulceration. Evidence regarding these risks is conflicting and of low quality, warranting further research. NSAIDs are however contraindicated in patients with renal risk factors, risk of gastrointestinal bleeding, or acute cardiovascular disease due to an elevated risk of both intra and postoperative complications, (Joshi & Girish P, 2024).

Due to elevated pain scores (moderate to severe) recorded on the VAS, some patients required rescue analgesics at PACU. Morphine was administered to 34.8% of participants, while tramadol and dexketoprofen trometamol (Kettesse) were utilized in 32% and 30.5% of cases, respectively. The use of morphine decreased steadily throughout the study, declining from 36.9% during intraoperative administration to 11.2% at the third follow up, as pain intensity gradually diminished.

The most common combinations used intraoperatively were morphine/paracetamol in 36.9% of participants and fentanyl/paracetamol in 28.2% of participants. Fentanyl/Paracetamol/ morphine combination was used in 9.1% of participants. During the second and third reviews at 24- and 48-hours intervals, tramadol/paracetamol were the most used combination by 31.1% and 28.2% of participants, respectively. Oral combinations such as Zulu (aceclofenac and thiocolchicoside) and betapyn (paracetamol and codeine) were introduced 24-hour postoperatively, most probably after bowel movements were confirmed and oral sips were introduced. Paracetamol was used as monotherapy in 39% of participants at 24-

hour interval and 27.8% of participants at 48 hours interval. This results contrast with studies done in Tanzania and Ethiopia, where paracetamol combined with pethidine and diclofenac combined with tramadol were most used for management of acute moderate to severe postoperative pain, (Ezra E, Bizuneh Y, Fentie Y, et al., 2022; Isaya Munisi et al., 2024) The variation in prescription patterns observed across different studies may be due to systemic factors such as resource availability, levels of training among healthcare practitioners, and staffing levels, which can impact the ability to monitor patients. Limited access to certain analgesics, lack of equipment like pumps or ultrasounds for regional block administration, and insufficient staff for patient monitoring may restrict the use of specific techniques or medications.

These findings therefore highlight the need for a standard protocol tailored to the specific context. ERAS guidelines recommend combination of medication with synergistic effects, targeting various parts of pain pathway for adequate management of acute postoperative pain, (Rodriguez G et al., 2024).

Statistical analysis using the Chi-square test ($p = 0.001$) indicated that the tramadol/paracetamol combination provided superior pain control, with only 12.5% of participants experiencing moderate to severe pain, compared to 36% in the morphine/paracetamol group. At 48 hours, tramadol/paracetamol and morphine/paracetamol were used in 28.2% and 11.2% of cases, respectively. Fisher's Exact test ($p=0.336$) indicated that 7.4% of participants on tramadol/paracetamol reported moderate to severe pain, versus 17.6% on morphine/paracetamol.

These results were unexpected since morphine is a potent mu-opioid agonist, while tramadol mainly inhibits serotonin and norepinephrine reuptake as a weaker opioid. Factors such as dosage relative to patient weight and potential opioid resistance may

have influenced the outcomes. There is limited and inconsistent research comparing low dose morphine plus paracetamol with high dose tramadol plus paracetamol for pain management. Some studies indicate that low doses of morphine combined with paracetamol are often less effective than high doses of tramadol and paracetamol for managing moderate pain, since tramadol's dual action offers a broader and more consistent range of relief. However, other studies suggest the opposite (Chatterjee S, 2019; Grond & Stefan, 1999). Opioids in pain management necessitate meticulous dose escalation and empirical adjustments based on clinical response, observed side effects, and potential drug interactions. Opioid resistance frequently occurs among patients utilizing opioids for chronic pain management. This resistance is a physiological adaptation wherein the body becomes less responsive to the therapeutic effects of opioids. Therefore, further investigation in this area is necessary.

The pethidine/paracetamol and tramadol/diclofenac used in Tanzania and Ethiopia also did not demonstrate adequate control in postoperative pain, as pain prevalence was observed to be 97.7% at 12 hours and 92.2% at 48 hours post operatively. This was attributed to poor utilization of multimodal analgesics, (Amberbir W et al., 2023; Isaya Munisi et al., 2024). A prospective analysis on postoperative pain management in elective laparotomies conducted at a tertiary hospital in India indicated that using both epidural analgesia and tramadol resulted in improved pain outcomes when compared to monotherapy, (Nithya T & Rajagopalan S, 2021).

5.6 Pain control adequacy

Adequate pain management plays a significant role in recovery after surgery, particularly as global surgical rates are anticipated to increase by 3.4% per year until 2028. Pain perception differs among individuals, adding complexity to its management. Achieving adequate pain relief requires balancing efficacy with the

minimization of side effects to support functional recovery. When pain exceeds an individual's threshold, it may interfere with daily activities. Recommendations from ASRA, ASA recommend maintaining postoperative pain at a VAS score of ≤3 at rest and ≤4 during activity for the initial 2–3 days following surgery. This level of pain control is regarded as sufficient to support daily functional activities, (Chou et al., 2016).

In this study, pain control adequacy was assessed by comparing pain intensity across two intervals: the 24-hour measurement versus that recorded in the PACU and the 48-hour measurement compared to that at 24 hours. Pain relief was evaluated using the VAS score. The Conchran – Armitage test for trend confirms that there was statistically significant ($P< 0.001$) linear trend in pain score across the assessment periods. This suggested there was a linear relationship between the pain scores and the time of assessment. The findings indicate that several patients continued to experience moderate or severe pain at 48 hours post operation, underscoring the necessity for routine pain assessment and the establishment of a comprehensive pain management protocol at MTRH to enhance postoperative pain management and patient outcomes.

The proportion of patients with moderate or severe pain at 24 hours and 48 hours post operatively ranges from 11-75% in the developed countries. The incidence is anticipated to be significantly higher in developing countries, particularly within Sub-Saharan Africa, (Chou et al., 2016). The variability in the proportions of patients with moderate or severe pain across all studies is attributed to different health care systems, availability and allocation of resources, and presence or absence of acute pain service organization models. This highlights the importance of developing suitable clinical guidelines for postoperative pain management, as patients require adequate care

following surgery regardless of the country in which the procedure is performed. Studies have also shown that training of health care providers, who are directly involved in the management of postoperative pain and implementation of guidelines, can greatly improve the effectiveness of post-operative pain management. Variation in research methodologies across studies may have contributed to differing results. This study was also conducted at a single center, whereas other studies used national surveys or multicenter analyses. The patients were followed up for 48 hours post operatively while in previous studies participants were followed up for 6 to 72 hours. Additionally, the current study assessed pain severity while at rest while previous studies assessed pain severity while at rest, during movement or both.

Evidence suggests that patients who receive thorough preoperative counseling on available treatment options, intraoperative procedures, and post-operative care, including pain relief, provide more accurate feedback during post-operative pain assessments. Accordingly, it is recommended that preoperative counseling be strengthened to improve the effectiveness of post-operative pain management.

No similar findings were reported on the adequacy of postoperative pain management by comparison of differences between PACU versus 24hrs and 24hours versus 48 hours.

5.7 Strengths and limitations

The reliance on data collected via self-report questionnaires, which may introduce respondent and recall bias. To address this, the questions were designed to be neutral, direct, and non-leading and information was collected at three intervals at PACU, 24 and 48 hours. The study was limited to laparotomy procedures conducted at a single hospital, restricting the generalizability of the results. Future studies should consider including a range of surgical procedures across multiple centers and a larger sample

size to improve transferability of findings. Additionally, pain was only assessed at a single point in time, when at rest which might predispose to lower pain scores. Further studies should consider including assessing pain at both rest and in motion.

The strength of study is to the best of our knowledge, this is the first study assessing post operative pain adequacy among patients who have undergone laparotomy at MTRH, and this will form a baseline for further research.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

1. Moderate to severe pain was documented in 56% of patients in the PACU, decreasing to 17% at 24 hours and 6.2% at 48 hours postoperatively. Overall, the intensity of acute postoperative pain observed in this study region is slightly lower compared to other areas within East Africa.

2. A limited range of opioid based systemic analgesics is used, with tramadol and paracetamol representing the most administered postoperative combination. Other modalities such as neuraxial analgesia (epidural or spinal analgesia), truncal nerve blocks, wound infiltration, or transdermal patches are not used. Pharmacological adjuvants, including massage and cognitive therapy, were also not utilized.

3. Although patients experienced less acute postoperative pain than those in other parts of East Africa, many still report VAS scores above 3, surpassing the international guideline threshold. This indicates that post operative pain management at MTRH is inadequate.

6.2 Recommendations

1. The level of acute postoperative pain recorded in this study region is marginally lower than in other parts of East Africa. Additional research is warranted to investigate factors influencing these reduced pain scores, including provider, patient, or systemic elements, relative to those observed elsewhere.
2. Practice and policy: Incorporation of additional interventions such as neuraxial analgesia (epidural or spinal), truncal nerve blocks, wound infiltration or transdermal patches and adjuncts such as cognitive behavioral therapy with the aim of achieving a postoperative VAS score of ≤3. Creation and implementation of acute pain service model ideal for our setting.

3. Further research: Additional studies should be conducted too.

    a) Examine the relationships between various patient factors such as types of incision, anesthesia method, gender, and psychosocial considerations and pain outcomes.

    b) Examine acute postoperative pain control in relation to analgesic selection, dosage, route of administration, and frequency.

REFERENCES

Adeboye, A., Hart, R., Senapathi, S. H., Ali, N., Holman, L., Thomas, H. W., ... & Senapathi, H. (2021). Assessment of functional pain score by comparing to traditional pain scores. *Cureus*, *13*(8).

Agrawal, S., Rupavath, R. V. S. S. B., Jalaja, P. P., Ushmani, A., Mishra, A., Bodapati, N. V. S. B., & BODAPATI, N. V. S. B. (2025). Artificial intelligence (AI)-driven approaches to manage postoperative pain, anxiety, and psychological outcomes in surgical patients: a systematic review. *Cureus*, *17*(5).

Akbar, N., & Teo, S. (2019). Barriers and Solutions for Improving Pain Management Practices in Acute Hospital Settings: Perspectives of Healthcare Practitioners for a Pain-Free Hospital Initiative. *Annals of Geriatric Medicine and Research*, 23(4), 190–196.

Alorfi, N. M. (2023). Pharmacological methods of pain management: narrative review of medication used. *International journal of general medicine*, 3247-3256.

Amberbir, W. D., Bayable, S. D., & Fetene, M. B. (2023). The prevalence and factors associated with acute postoperative pain in elective gynecologic surgical patients at two referral hospitals in Addis Abeba, Ethiopia, 2021: a cross-sectional study. *Annals of Medicine and Surgery*, *85*(6), 2506-2511.

Anand, E., Rahman, S. A., Tomlinson, C., Mercer, S. J., & Pucher, P. H. (2024). Comparison of major abdominal emergency surgery outcomes across organizational models of emergency surgical care: Analysis of the UK NELA national database. *Journal of Trauma and Acute Care Surgery*, 96(2), 305–312.

Anekar A, Hendrick J, & Cascella M. (2023). WHO analgesic ladder. Scientific Research, (8).

Baamer, R. M., Iqbal, A., Lobo, D. N., Knaggs, R. D., Levy, N. A., & Toh, L. S. (2022). Utility of unidimensional and functional pain assessment tools in adult postoperative patients: a systematic review. *British journal of anaesthesia*, *128*(5), 874-888.

Bekele, E. A., Tulu, T. B., Bulto, Y. A., Azibte, G. T., & Birhanu, W. (2024). Prevalence and associated factors of acute postoperative pain in adult surgical patients: a prospective study. *Surgery in Practice and Science*, *19*, 100262.

Bicket C, Ladha K, Haroutounian S, McFarlin K, Neff M, McDuffie R, Brummet C, & Li, Y. (2025). Comparing Analgesic Regimen Effectiveness and Safety after Surgery (CARES): protocol for a pragmatic, international multicentre randomised trial. BMJ Open, 15(4), e099925.

Biros, M. (2018). Capacity, vulnerability, and informed consent for research. *The Journal of Law, Medicine & Ethics*, *46*(1), 72-78.

Chatterjee S. (2019). Low-Dose Morphine versus High-Dose Tramadol for management of moderate cancer pain: a comparative study. *Journal of Medical Science and Clinical Research*, 7(6).

Chen J, Kandle P, & Murray I. (2026). Physiology, Pain.

Chen X, Chu Q, Peng Y, Chen Y, Kaye A, Liu H, Yang J, Wang T, & Yu W. (2025). Clinical practice guidelines for postoperative pain management in adults (2024 edition). *Journal of Anesthesia and Translational Medicine*, 4(3), 161–185.

Chetty S, Eric H, Analee M, Anthony T, & Cecile van R. (2022). South African Society Of Anaesthesiologists (SASA). ublished by Medpharm Publications for *The South African Society of Anaesthesiologists* (SASA).

Cheung, C. K., Adeola, J. O., Beutler, S. S., & Urman, R. D. (2022). Postoperative pain management in enhanced recovery pathways. *Journal of Pain Research*, 123-135.

Chou, R., Gordon, D. B., de Leon-Casasola, O. A., Rosenberg, J. M., Bickler, S., Brennan, T., ... & Wu, C. L. (2016). Management of Postoperative Pain: a clinical practice guideline from the American pain society, the American Society of Regional Anesthesia and Pain Medicine, and the American Society of Anesthesiologists' committee on regional anesthesia, executive committee, and administrative council. *The journal of pain*, *17*(2), 131-157.

Colvin L. (2012). Anatomy and physiology of pain. In Principles and Practice of Regional Anaesthesia (pp. 9–18). Oxford University Press.

Cui, N., Liu, J., & Tan, H. (2020). Comparison of laparoscopic surgery versus traditional laparotomy for the treatment of emergency patients. *Journal of International Medical Research*, 48(3).

Czernicki, M., Kunnumpurath, S., Park, W., Kunnumpurath, A., Kodumudi, G., Tao, J., ... & Urman, R. D. (2019). Perioperative pain management in the critically ill patient. *Current pain and headache reports*, *23*(5), 34.

Delgado, D. A., Lambert, B. S., Boutris, N., McCulloch, P. C., Robbins, A. B., Moreno, M. R., & Harris, J. D. (2018). Validation of digital visual analog scale pain scoring with a traditional paper-based visual analog scale in adults. *JAAOS Global Research & Reviews*, *2*(3), e088.

Deshmukh, P. P., Chakole, V., & DESHMUKH, D. P. P. (2024). Post-anesthesia recovery: a comprehensive review of sampe, modified aldrete, and white scoring systems. *Cureus*, *16*(10).

El-Boghdadly, K., Levy, N. A., Fawcett, W. J., Knaggs, R. D., Laycock, H., Baird, E., ... & Lobo, D. N. (2024). Peri-operative pain management in adults: a multidisciplinary consensus statement from the Association of Anaesthetists and the British Pain Society. *Anaesthesia*, *79*(11), 1220-1236.

Eshete, M. T., Baeumler, P. I., Siebeck, M., Tesfaye, M., Haileamlak, A., Michael, G. G., ... & Irnich, D. (2019). Quality of postoperative pain management in Ethiopia: a prospective longitudinal study. *PloS one*, *14*(5), e0215563.

Fowler, A. J., Abbott, T. E. F., Prowle, J., & Pearse, R. M. (2019). Age of patients undergoing surgery. *Journal of British Surgery*, *106*(8), 1012-1018.

Gan, T. J. (2017). Poorly controlled postoperative pain: prevalence, consequences, and prevention. *Journal of pain research*, 2287-2298.

Gao, L., Mu, H., Lin, Y., Wen, Q., & Gao, P. (2023). Review of the current situation of postoperative pain and causes of inadequate pain management in Africa. *Journal of Pain Research*, 1767-1778.

Gore, D. G. (2022). The anatomy of pain. *Anaesthesia & Intensive Care Medicine*, *23*(7), 355-359.

Grond, & Stefan. (1999). High-Dose Tramadol in Comparison to Low-Dose Morphine for Cancer Pain Relief. *Journal of Pain and Symptom Management*, 18(3).

Horn R. (2024, January 30). *Postoperative pain control. StatPearls.*. StatPearls Publishing.

Isaya Munisi, Erick Muhumba, Peter Kibunto, & Rebecca Shinja. (2024). Adequacy of Postoperative Pain Management among patients undergoing Laparotomy at Bugando Medical Centre, Mwaza, Tanazania. *East African Scholars Journal of Medicine and Surger*y, 6(6), 199–207.

Jenkinson H, & Abd-Elsayed A. (2023). World Health Organization (WHO) Analgesic Ladder. In A. Abd-Elsayed (Ed.), Advanced Anesthesia Review (pp. 561–564). Oxford University PressNew York.

Joshi, G. P., Kehlet, H., & Lobo, D. N. (2025). Nonsteroidal anti-inflammatory drugs in the perioperative period: current controversies and concerns. *British Journal of Anaesthesia*, *134*(2), 294-296.

Kaye, A. D., Roberts, C. J., Green, A. M., Hollande, A. V., Nguyen, A., Shekoohi, S., & Kaye, A. M. (2026). Opioid agonist and antagonist pharmacology: A comprehensive overview for clinicians and scientists. *New Opioid Receptor Modulators and Agonists*, 23-30.

Kishore, K., Agarwal, A., & Gaur, A. (2011). Acute pain service. *Saudi Journal of Anaesthesia*, *5*(2), 123-124.

Kiswezi, A. K., Masiira, N. M., & Mugisa, D. (2014). Evaluation of Postoperative Pain Control Following major Surgery at Mulago Hospital. *East and Central African Journal of Surgery*, *19*(2).

Liu, S., & Kelliher, L. (2022). Physiology of pain—a narrative review on the pain pathway and its application in the pain management. *Digestive Medicine Research*, *5*.

Madhusudanan Pillai, G., & Girijavallabhan Nair, P. (2024). 166 A Retrospective Observational Study on Laparoscopic and Open Hernia Repairs at a Single Centre. *British Journal of Surgery*, *111*(Supplement_6), znae163-132.

Mahyar, L., Missair, A., Buys, M. J., Kou, A., Benedetti de Marrero, E., Sandbrink, F., ... & Veterans Affairs Acute Pain Medicine Committee. (2024). National review of acute pain service utilization, models of care, and clinical practices within the Veterans Health Administration. *Regional Anesthesia & Pain Medicine*, *49*(2), 117-121.

Manti, S., & Licari, A. (2018). How to obtain informed consent for research. *Breathe*, *14*(2), 145-152.

Mehari, E. E., Bizuneh, Y. B., Fentie, D. Y., & Arefayne, N. R. (2022). Prevalence and factors associated with acute postoperative pain after emergency abdominal surgery. *The Open Pain Journal*, *15*.

Mingxu Z, Zhou M, Lu P, Wang Y, Zeng R, Liu L, Zhu S, Kong L, & Zhang J. (2024). Local anesthetic delivery systems for the management of postoperative pain. Acta Biomaterialia, 181, 1–18.

Mogianos, K., Åkeson, J., & Persson, A. K. (2025). Systematic review of methods for individual prediction of postoperative pain. *Pain Research and Management*, *2025*(1), 1331412.

Mojica, J., Washek, S., & Schwenk, E. (2023). Setting Up A Modern Acute Pain Service (APS). In J. Li (Ed.), *Regional Anesthesia and Acute Pain Medicine* (pp. 37–48). Oxford University PressNew York.

Morais, C., Moyano, J., Belton, J., & Moyo, N. (2022). Global inequities in pain treatment: how future research can address this better. *International Association for the Study of Pain (IASP): IASP*.

Morriss, W. W., & Roques, C. J. (2018). Pain management in low-and middle-income countries. *BJA education*, *18*(9), 265-270.

MTRH. (2026). Moi Teaching and Referral Hospital - Eldoret.

Ndebea, A. S., van den Heuvel, S. A., Temu, R., Kaino, M. M., van Boekel, R. L., & Steegers, M. A. (2020). Prevalence and risk factors for acute postoperative pain after elective orthopedic and general surgery at a tertiary referral hospital in Tanzania. *Journal of Pain Research*, 3005-3011.

Nithya T, & Rajagopalan S. (2021). Prospective analysis of post-operative pain management in elective laparotomies in a tertiary care centre. *International Surgery Journal*, 8(11), 3291.

Ombok, C. A. (2024). Influence of Cultural Perspectives on Caregivers' Approaches to Seeking Health Care for Mentally Ill Patients in Uasin Gishu County, Kenya. *Disease and Health Research: New Insights Vol. 11*, 1-26.

Oumer, K. E., Ahmed, S. A., Tawuye, H. Y., & Ferede, Y. A. (2021). Outcomes and associated factors among patients undergone emergency laparotomy: a retrospective study. *International Journal of Surgery Open*, *36*, 100413.

Paladini, A., Rawal, N., Martinez, M. C., Trifa, M., Montero, A., Pergolizzi Jr, J., ... & Tamayo Sr, M. A. N. (2023). Advances in the management of acute postsurgical pain: a review. *Cureus*, *15*(8).

Pirie K, Traer E, Finniss D, Myles P., & Riedel B. (2022). Current approaches to acute postoperative pain management after major abdominal surgery: a narrative review and future directions. *British Journal of Anaesthesia,* 129(3), 378–393.

Pirie, K., Traer, E., Finniss, D., Myles, P. S., & Riedel, B. (2022). Current approaches to acute postoperative pain management after major abdominal surgery: a narrative review and future directions. *British journal of anaesthesia*, *129*(3), 378-393.

Preetma K, & Margaret H. (2024). Multimodal Analgesia Summary. Open Anesthesia - *International Anesthesia Research Society.*

Raja, S. N., Carr, D. B., Cohen, M., Finnerup, N. B., Flor, H., Gibson, S., ... & Vader, K. (2020). The revised International Association for the Study of Pain definition of pain: concepts, challenges, and compromises. *Pain*, *161*(9), 1976-1982.

Rancesca G, S. M. A. (2019). Post-Laparotomy Pain: How to Achieve Satisfactory Control. Clinics of Surgery, 4, 2673.

Rodriguez, G., Whiting, E., & Lee, J. (2023). ERAS protocols and multimodal pain management in surgery. In *Pain Management-From Acute to Chronic and Beyond*. IntechOpen.

Sajdeya, R., & Narouze, S. (2024). Harnessing artificial intelligence for predicting and managing postoperative pain: a narrative literature review. *Current Opinion in Anesthesiology*, *37*(5), 604-615.

Shirley, H., & Wamai, R. (2022). A narrative review of Kenya's surgical capacity using the Lancet Commission on Global Surgery's indicator framework. *Global Health: Science and Practice*, *10*(1).

Small, C., & Laycock, H. J. J. O. B. S. (2020). Acute postoperative pain management. *Journal of British Surgery*, *107*(2), e70-e80.

Sommer, M., De Rijke, J. M., Van Kleef, M., Kessels, A. G. H., Peters, M. L., Geurts, J. W. J. M., ... & Marcus, M. A. E. (2008). The prevalence of postoperative pain in a sample of 1490 surgical inpatients. *European journal of anaesthesiology*, *25*(4), 267-274.

Steeds, C. E. (2009). The anatomy and physiology of pain. *Surgery (Oxford)*, *27*(12), 507-511.

Swarbrick, C. J., Williams, K., Evans, B., Blake, H. A., Poulton, T., Nava, S., ... & Moppett, I. K. (2025). Characteristics of older patients undergoing surgery in the UK: SNAP-3, a snapshot observational study. *British Journal of Anaesthesia*, *134*(2), 328-340.

Vatansever, N. A., & Akansel, N. (2014). Validation study of the strategic and clinical quality indicators in postoperative pain management questionnaire in Turkish surgery patients. *Pain Management Nursing*, *15*(4), 871-880.

Wylie, J. A., Kong, L., & Barth Jr, R. J. (2022). Opioid dependence and overdose after surgery: rate, risk factors, and reasons. *Annals of surgery*, *276*(3), e192-e198.

Xuan, C., Yan, W., Wang, D., Li, C., Ma, H., Mueller, A., ... & Wang, J. (2022). Efficacy of preemptive analgesia treatments for the management of postoperative pain: a network meta-analysis. *British Journal of Anaesthesia*, *129*(6), 946-958.

Yao, D., Chen, Y., & Chen, G. (2023). The role of pain modulation pathway and related brain regions in pain. *Reviews in the Neurosciences*, *34*(8), 899-914.

Zhang, Y. E., Xu, X., & Gong, R. (2023). Postoperative pain management outcomes at a Chinese hospital: a cross-sectional survey. *Journal of Perianesthesia Nursing*, *38*(3), 434-439.

Zhao, M., Zhou, M., Lu, P., Wang, Y., Zeng, R., Liu, L., ... & Zhang, J. (2024). Local anesthetic delivery systems for the management of postoperative pain. *Acta biomaterialia*, *181*, 1-18.

APPENDICES

Appendix 1: WORK PLAN

ACTIVITY	DURATION
Proposal writing	June- 2022
Presentation to ethical review committee	December- 2022
Data collection	February 2023- December 2023
Data analysis and report writing	January 2024- December 2024
Thesis submission	January – May 2025
Thesis mock defense	June 2025
Thesis presentation and defense	February 2026

Appendix 2: BUDGET

ITEM	*UNIT COST*	*NUMBER OF UNITS*	*COST*
Stationery and equipment			
Printing	500 per ream	10	5000
papers Black	2000	3	6000
Cartridges	560	1 packet	560
Pens	250	2	500
Files	100	4	400
Document Wallets			
Personnel			
Biostatician	60,000	1	40,000
Research Assistant	15,000	3	45,000
Internet	10,000	-	10,000
Proposal development			
Printing drafts and final proposal	500	5	5,000
Photocopies of final proposal	600	6	600
Binding of copies of proposal	150	5	750
Thesis development			
Printing of drafts of final thesis	900	10	900
Photocopy of final thesis	250	6	1500
Binding of final thesis	400	6	2400
Publication	20,000	1	20,000
Total			**138,610**
Miscellaneous			20,000
Grand Total			**178,610**

This study will not be funded by an external source.

Appendix 3: Consent Form

Study Title: "ADEQUACY OF ANALGESIC PRACTICES AMONG ADULT PATIENTS UNDERGOING LAPAROTOMY AT MOI TEACHING AND REFERRAL HOSPITAL, ELDORET, KENYA"

Name of Principal Investigator: Dr. Gladys Kezziah Njue (Moi University).

Name of Organization: Moi University. P.O Box 4606-030100, Eldoret, Kenya.
Telephone 254 53 2061562, 254 53 2060958/9

Name of Sponsor: None.

Informed Consent Form for: Adult patients who are hospitalized at Moi Teaching and Referral Hospital scheduled to undergo celiotomy between 1st February 2023 and 30th October 2023.

This Informed Consent Form has two parts:

- Information Sheet (to share information about the research with you).
- Certificate of Consent (for signatures if you choose to take part in the study).
- Statement of the researcher (for signature of researcher after sharing information).

You will be given a copy of the signed Informed Consent Form.

Part I: Information Sheet Introduction.

You are invited to take part in a study. Once information about the study is provided, you will be allowed to seek clarification from us in the form of questions. Participation in the study is voluntary, and you are free to withdraw from the study at any stage without any consequences. If you choose to volunteer to take part in the study, you will be provided with a copy of this consent form for your records.

Purpose of the study.

Pain control after surgery is extremely important in aiding patient's successful recovery. Current emphasis is on development postoperative pain guidelines that are tailor made to be procedures specific.

The purpose of this study is to evaluate the effectiveness of the analgesic practices among adult patients undergoing laparotomy at Moi Teaching and Referral Hospital, Eldoret, Kenya, with the aim of enhancing patients care by developing a procedure specific guideline based on best practice.

Type of Research Project/Intervention.

The study is a hospital based prospective study which involves following you from when you fully emerge from anesthesia by taking you through semi structured questionnaires to score the severity of your pain and assess the adequacy of the pain control interventions.

Why have I been identified to take part in this study?

The study population includes all adult patients admitted for laparotomy at Moi Teaching and Referral hospital during the study period.

You have been systematically enrolled as part of the 241 participants in the study based on the procedure that you have undergone (laparotomy).

How long will the study last?

The study duration is approximately 6-10 months depending on the time when the sample size will be obtained, from 1st of February 2023.

Your participation in answering our questions will be approximately 10 minutes.

What will happen to me during the study?

1. If you agree to take part in this study, you will be asked questions by the data collector to assess the severity of your pain postoperatively and assess if the interventions are adequate and prompt. Information obtained will be secured and will remain confidential.
2. The questionnaire will have four sections of semi structured questions.

The main themes that will be assessed will include sociodemographic characteristics (Gender, age), adequacy of analgesic practices post laparotomy. Pain will be scored using the visual analogue pain scale which is rated from 0 to 10;0 stands for no pain, 1 -3 stands for Mild pain, 4-6 stands for moderate pain, 7-9 stands for severe pain, and 10 stands for worst pain possible. Type, route, frequency of analgesics will also be assessed against pain control. This will help evaluate the effectiveness of the current medication administered post- operatively. Finally, we will ask about the overall pain satisfaction during the first 48 hours after surgery.

What side effects or risks can I expect from being in the study?

There are no risks associated with your participation in this study.

Are there benefits to taking part in the study?

The outcome of this study will help improve current analgesia practices. The

information obtained will also help in developing procedure specific guidelines that will inform improvement in post-operative pain management following celiotomy.

Reimbursements.

You will not be reimbursed or payment for participation in this study.

Whom do I call if I have questions about the study?

If you have any questions about the study, please contact the principal investigator: Dr Gladys Kezziah Njue, Mobile no: 0718548005

If you have questions about your rights as a research subject, you may contact the Institutional Review Ethics Committee (IREC) at 053 33471 Ext.3008. IREC is a group of people that reviews studies for safety and protects the rights of study subjects.

Will the information I provide be kept private?

All possible efforts will be made to keep information obtained private and confidential. Using or sharing such information must follow National privacy guidelines. By signing the consent, you are giving permission to let the research team use and share your Protected Information with The Institutional Review and Ethics Committee who have their guidelines to make sure all personal information is kept private and confidential.

Unless stipulated otherwise, the permission to use or share your Personal Information does not cease. If you decide to withdraw your consent, we ask that you contact Dr Kezziah Njue, most preferably in writing and let her know that you are withdrawing your permission. The mailing address is Moi University. P.O Box 4606-030100, Eldoret, Kenya. We will therefore stop further collection of information about you, however information collected prior to revoking the consent may continue to be used for reporting and research quality.

You will have the right to access your personal information related to the study as long as the principal researcher and institution holds this information. Your treatment will not be affected if you decide to enroll in this study. Once you give the consent by signing, you will receive a copy of this document.

Part II: Consent of Subject

I have read or have had read to me the description of the research study. The investigator or his/her representative has explained the study to me and has answered all the questions I have currently. I have been told of the potential risks, discomforts,

and side effects as well as the possible benefits (if any) of the study. I freely volunteer to take part in this study.

Name of Participant: ……....

Signature of participant/thumbprint: …….....

Name of person obtaining consent…….

Signature…….

Date…….

Witness if the participant is unable to write or print.

I have seen the investigator, or her representative read and explain the description of the research study to the participant. The investigator or her representative has explained the study to the participant and has answered all the questions the participant has currently. The participant has been told of the potential risks, discomforts, and side effects as well as the possible benefits (if any) of the study. The participant freely volunteers to take part in this study.

Name of Participant: ……....

Name of witness and relationship to participant: ……

Signature/print of witness: ...……. ……

Name of person obtaining consent…….

Signature…….

Date……

Part three: Statement by researcher.

I have accurately read out the information shared to the participant and to the best of my ability answered questions brought forward by the participant. I confirm that the consent has been given freely and voluntarily.

Name of person obtaining consent. …….

Signature……

Date…….

Kiswahili

Fomu ya makubaliano ya kujiunga na utafiti

Nimesoma ama nimeelezewa utafiti huu kwa kina na mtafiti mkuu ama msaidizi wake. Nimepata wakati wa kuuliza maswali na nimeelewa kuwa iwapo nina maswali zaidi, ninaweza kumuliza mtafiti mkuu au msaizidi wake. Nimekubali kushiriki utafiti huu kwa hiari yangu

Jina la mshiriki. ……

Sahihi/alama ya kidole…….

Tarehe……

Kwa wasioweza kusoma na kuandika

Nimeshuhudia usomaji na maelezo ya utafiti huu kwa mshiriki. Mshiriki amepewa fursa ya kuuliza maswali na amepata maelezo kwa kina.

Ninathibitisha ya kwamba mshiriki alipeana ruhusa ya kushiriki bila ya kulazimishwa

Jina la shahidi na uhusiano wa shahidi na mshiriki……

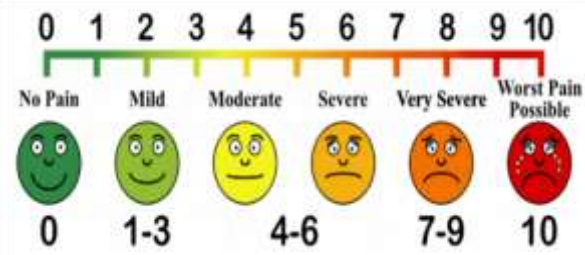
Shahidi la shahidi…….

Tarehe…….

Appendix 4: Questionnaire

Adequacy of analgesic practices among adult patients undergoing laparotomy at MTRH, Eldoret, Kenya.

A) SOCIO-DEMOGRAPHICS			
Name **In Patient Number**	Age:		
Ward	Date:		
Sex: F/M	Study no:		
B) INTRA-OPERATIVE DETAILS			
Diagnosis: **Urgency: Emergency/ Elective** **Duration of surgery:**	Analgesics	Route &dosage	
	Fentanyl		
	Morphine		
	Paracetamol		
	Ketorolac/Diclofenac		
	Others		
Intra-operative local analgesia given?	Y/N If yes, type		
C) POST-OPERATIVE ANALGESIA			
PACU	Analgesics	Route & dosage	
	Morphine		
	Tramadol		
	Ketorolac/Diclofenac		
	Paracetamol		
	Others		
Day 1	Morphine		
	Tramadol		
	Ketorolac/Diclofenac		
	Paracetamol		
	Others		
Day 2	Morphine		
	Tramadol		
	Ketorolac/ Diclofenac		
	Others		
Pain score	Tramadol + Paracetamol	Morphine + Paracetamol	Others (Indicate)
At 24 hours **None** **Mild** **Moderate**			

Severe **Worst pain possible**			
At 48 hours **None** **Mild** **Moderate** **Severe** **Worst pain possible**			
D) POSTOPERATIVE PAIN ASSESSMENT			
Using the pain scale below, how best would you describe the pain you are experiencing now? Visual analogue scale.	PACU	Day 1	Day 2
	0		
	1		
	2		
	3		
	4 5		
	6		
	7		
	8		
	9		
Key: ***0-No pain Mild-1-3 Moderate 3-5 Severe 5-7 Very severe 7-9 Worst pain possible 10***	10		
Researcher: Gladys Kezziah Njue	**Signature:**		

Appendix 5: IREC Approval

MTRH/MU-INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

MOI TEACHING AND REFERRAL HOSPITAL
P.O. BOX 3
ELDORET
Tel: 33471/2/3

MOI UNIVERSITY
COLLEGE OF HEALTH SCIENCES
P.O. BOX 4606
ELDORET
Tel: 33471/2/3

Reference: IREC/386/2023
Approval Number: 0004376

23rd March, 2023

Dr. Gladys Kezziah Njue,
Moi University,
School of Medicine,
P.O. Box 4606-30100,
ELDORET-KENYA.

Dear Dr. Njue,

EFFECTIVENESS OF CURRENT ANALGESIA PRACTICES FOLLOWING CELIOTOMY AT MOI TEACHING AND REFERRAL HOSPITAL, ELDORET, KENYA

This is to inform you that ***MTRH/MU-IREC*** has reviewed and approved the above referenced research proposal. Your application approval number is ***FAN: 0004376***. The approval period is **23rd March, *2023- 22nd March, 2024***.
This approval is subject to compliance with the following requirements;

i. Only approved documents including (informed consents, study instruments, Material Transfer Agreements (MTA) will be used.
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by ***MTRH/MU-IREC***.
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to ***MTRH/MU-IREC*** within 72 hours of notification.
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to ***MTRH/MU-IREC*** within 72 hours.
v. Clearance for export of biological specimens must be obtained from ***MOH at the recommendation of NACOSTI*** for each batch of shipment.
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days upon completion of the study to ***MTRH/ MU-IREC.***

Prior to commencing your study; you will be required to obtain a research license from the National Commission for Science, Technology and Innovation (NACOSTI) https://oris.nacosti.go.ke and other relevant clearances from study sites including a written approval from the CEO-MTRH which is mandatory for studies to be undertaken within the jurisdiction of Moi Teaching & Referral Hospital (MTRH) and its satellites sites.

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
23 MAR 2023
APPROVED
P. O. Box 4606-30100 ELDORET

Sincerely,

PROF. E. WERE
CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc CEO - MTRH Dean - SOP Dean - SOM
Principal - CHS Dean - SON Dean - SOD

Appendix 6: MTRH CEO Approval

An ISO 9001:2015 Certified Hospital

MOI TEACHING AND REFERRAL HOSPITAL

Telephone: (+254)-0532033471/2/3/4
Fax: 0532061749
Email: ceo@mtrh.go.ke/ceosoffice@mtrh.go.ke

NANDI ROAD
P.O. BOX 3-30100
ELDORET,KENYA

Ref: ELD/MTRH/R&P/10/2/V.2/2010

27th March, 2023

Dr. Gladys Kezziah Njue,
Moi University,
School of Medicine,
P.O. Box 4606-30100,
ELDORET-KENYA.

EFFECTIVENESS OF CURRENT ANALGESIA PRACTICES FOLLOWING CELIOTOMY AT MOI TEACHING AND REFERRAL HOSPITAL, ELDORET, KENYA

You have been authorised to conduct research within the jurisdiction of Moi Teaching and Referral Hospital (MTRH) and its satellites sites. You are required to strictly adhere to the regulations stated below in order to safeguard the safety and well-being of staff, patients and study participants seen at MTRH.

1. The study shall be under Moi Teaching and Referral Hospital regulation.
2. A copy of MTRH/MU-IREC approval shall be a prerequisite to conducting the study.
3. Studies intending to export human bio-specimens must provide a permit from MOH at the recommendation of NACOSTI for each shipment.
4. No data collection will be allowed without an approved consent form(s) to participants unless waiver of written consent has been granted by MTRH/MU-IREC.
5. Take note that **data** collected must be treated with due confidentiality and anonymity.

The continued permission to conduct research shall only be sustained subject to fulfilling all the requirements stated above.

The approval period is **27th March, 2023 – 26th March, 2024.**

27/03/2023

DR. WILSON K. ARUASA, *MBS, EBS*
CHIEF EXECUTIVE OFFICER

MOI TEACHING AND REFERRAL HOSPITAL
CEO
APPROVED
27 MAR 2023
SIGN.....
P. O. Box 3-30100, ELDORET

c.c. - Senior Director, Clinical Services
- Director, Nursing Services
- HOD, HRISM

Appendix 7: NACOSTI Approval

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **866796**

Date of Issue: **19/March/2024**

RESEARCH LICENSE

This is to Certify that Ms.. GLADYS GLADYS NJUE of Moi University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Elgeyo-Marakwet on the topic: Effectiveness of current analgesia practices following celiotomy at Moi Teaching and Referral Hospital for the period ending : 19/March/2025.

License No: **NACOSTI/P/24/34089**

866796

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

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See overleaf for conditions