RADIOGRAPHIC FINDINGS AMONG CHILDREN OPERATED FOR ACUTE ABDOMEN AT MOI TEACHING AND REFERRAL HOSPITAL, ELDORET KENYA.

KIPROTICH SAMUEL NG'ENO

SM/PGR/03/12

A thesis presented in partial fulfillment for the award of the degree of Master of Medicine in Radiology and Imaging

RADIOGRAPHIC FINDINGS AMONG CHILDREN OPERATED FOR ACUTE ABDOMEN AT MOI TEACHING AND REFERRAL HOSPITAL, ELDORET, KENYA.

Investigator:

Kiprotich Samuel Ng'eno, Registrar in Radiology and Imaging,

Moi University School of Medicine.

Supervisors:

Dr. Onchagwa E. N.,

Lecturer, Department of Radiology and Imaging,

Moi University School of Medicine.

Prof Tenge Kuremu,

Associate professor, Department of Surgery,

Moi University School of Medicine.

DECLARATION

Student's Declaration:

I declare that this thesis is my original work and that it has never been presented to any other institution for academic purposes or otherwise. No part of this work may be reproduced without the sole permission of Moi University and/or the investigator.

Kiprotich, Samuel Ng'eno

Sign ……

Date ……

Supervisors' Declaration:

This thesis has been submitted for consideration with our approval as supervisors.

Dr Onchagwa, E.N.

Sign ……

Date ……

Prof Tenge Kuremu.

Sign ……

Date ……

ACKNOWLEDGEMENTS

I would like to acknowledge my parents Mr. Stanley Terer and Mrs. Hannah Terer who have been a pillar of support and encouragement, my employer the Ministry of Health for granting me study leave, my able supervisors Dr Onchagwa and Professor Tenge as well as the Department of Radiology faculty members Professor Onditi Elias and Dr Abuya Joseph who were instrumental throughout the course work and without whom this work would not have been possible.

Much gratitude also goes to my fellow registrars who tirelessly went through this work and offered key suggestions and improvements during the oral presentations and actual write up, and unfailing moral support towards the successful completion of the same.

DEDICATION

I dedicate this work to my amazing daughters Stacy Cheptoo, Tracy Chelang'at, Briannah Chepkoech and Kimberly Cherono who bore much brunt of my absence during the many long days, nights and weekends that I put in to beat the deadlines and complete the coursework.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

A & E	Accident and Emergency Department
ACR	American College of Radiology
AP	Anteroposterior
CI	Confidence Interval
CM	Centimetres
CT	Computerized Tomography
IREC	Institutional Research and Ethics Committee
KNH	Kenyatta National Hospital
MTRH	Moi Teaching and Referral Hospital
PA	Posteroanterior
SPR	Society of Pediatric Radiology
US	Ultrasound
WBC	White Blood Cell Count
WHO	World Health Organization
<	Less than

DEFINITIONS

Acute Abdomen: *'Generally refers to abdominal symptoms and signs secondary to nontraumatic pathology that begun recently (less* than 72 hours) *that may, but not necessarily, require an operation'(Peitzman, Rhodes Michael, Schwab CW, Yealy, & Fabian, 2008).*

Children: Those of age less than 14 years for purposes of this study.

ABSTRACT

Background: Acute abdominal pain is the most common gastrointestinal symptom in the emergency department, accounting for over 900,000 visits annually in US children less than 15 years of age. The challenge is in identifying those who may require urgent surgical intervention, as children present differently from adults and the symptoms and signs may not be straightforward. Radiological imaging is immensely important as a paraclinical aid to diagnosis. Plain abdominal radiography is the first-line modality in the evaluation of this subset of patients. Identification of pertinent radiographic features is important for early consultation and intervention thus reducing morbidity and mortality.

Objective: To describe the radiographic findings among children presenting with acute abdomen and operated upon at MTRH.

Methods: The study setting was Moi Teaching and Referral Hospital Paediatric Surgery ward and the Radiology and Imaging department.

A retrospective review of abdominal radiographs done among children operated for acute abdomen over a seven month period was conducted.

Paediatric patients aged 0-14years who presented with acute abdomen and underwent abdominal radiography and laparotomy formed the study population. A census of thirty (30) patients operated was conducted.

Data collection instruments with patient demographic information, clinical history, pre- and post-operative surgical notes were used in data collection. Interpretation of images was done with three senior radiologists blinded to the operative findings to minimise bias. Descriptive statistics like mean, median and mode were used for continuous variables while proportions, percentages, frequency tables, bar graphs and pie charts were used for categorical data.

Results: A total of 30 children were consecutively sampled, with their ages ranging from 3 days to 14 years old. Mechanical obstruction was found in 12 cases and the remainder had peritonitis. All x-rays reviewed were abnormal. Supine view followed by a combination of Supine and Cross- table were the most common radiographic views. The most common radiographic findings were absent rectosigmoid air with bowel distension in mechanical obstruction, and ground glass opacity with fluid levels in peritonitis.

Conclusion: Absent rectosigmoid air followed by small bowel distension and ground glass appearance were the most common radiographic findings encountered (60%, 57% and 53% respectively).

Recommendation: There is need for collaboration between the surgical and radiology departments in abdominal radiograph interpretation. The combination of Erect abdomen and Cross -table views should be abandoned.

CHAPTER ONE: INTRODUCTION

1.0 Background

1.1.0 Burden of Acute Abdomen

Acute abdominal pain is the most common gastrointestinal symptom in the US, accounting for 15.9 million all-case encounters, over 900,000 of these emergency department visits being children under 15 years of age (Wang L, Haberland C, Thurm C, Bhattacharya J, & Park, 2015).

With respect to specific causation, small bowel obstruction accounts for 12-16% of

Overall hospital admissions in the US, and a mortality rate of 2-8%, rising to 25% in the

presence of bowel ischemia (Paulson E & Thompson, 2015). Peritonitis on the other hand, is responsible for a mortality rate of 10-30% even in the best of facilities (Ojuka A., Ekwaro L., & Kakande, 2015).

The global burden of surgical emergencies is described insufficiently, with intestinal

obstruction being the third leading cause of death overall (Stewart B et al., 2014).

However, an enormous health burden is estimated, with 70% of deaths occurring in low

and middle income countries.

In Sub-Sahara Africa, pediatric abdominal surgical emergencies account for 2.4-3.1 % of all hospital pediatric admissions (Abdur-Rahman L.O., Adeniran J.O, & Adeyujigbe, 2012).

According to MTRH Hospital records for the year 2012, an average of 60 laparotomies for acute abdomen were carried out in the Pediatric Surgery ward.

1.1.1 Definition of 'Acute Abdomen'

Acute abdomen per se has no standard definition. According to Peitzman et al (2008) '*it refers generally to abdominal symptoms and signs secondary to nontraumatic pathology that begun recently (less than 72 hours) that may, but not necessarily, require an operation'.*

1.1.2 Causes of Childhood Acute Abdomen

In children, causes of acute abdomen are best considered according to the various age strata (Babcock, 2002 ; Wen-Chieh Yang, Chun-Yu Chen, & Wu, 2013):

Preterm neonates- necrotizing enterocolitis.

Full term neonates- congenital intestinal obstruction, paralytic ileus, malrotation of the gut.

Infant- intussusception, strangulated inguinal hernia, malrotation with volvulus, complicated Merckel's diverticulum, appendicitis less commonly. Other non-surgical

causes including primary peritonitis, colic and gastroenteritis are common and must be ruled out.

Child and adolescent;

Right upper quadrant pain: - gallbladder disease, renal colic, pyelonephritis, hepatitis.

Left upper quadrant pain: - splenomegaly/splenic torsion/splenic infarction, renal colic, pyelonephritis.

Right lower quadrant pain:- acute appendicitis most common. Also, gynecologic disorders, inflammatory bowel disease may arise.

Mid-abdominal pain: - bowel obstruction, malrotation with volvulus, intussusception, peptic ulcer disease, pancreatitis, mesenteric adenitis, bleeding disorders like Henoch-schonlein purpura, child abuse leading to internal bleeding and hematoma.

Surgical causes are in the minority, as demonstrated in a Nigerian study (Adeyujigbe O & Fashakin, 1989) which found that pediatric surgical abdominal emergencies accounted for 2.4-3.1% of all general pediatric hospital admissions. In a Turkish study (Erkan T et al., 2004) they comprised 20% of all referrals to general surgery for abdominal pain in children. With respect to surgical causes, a study in Taiwan (Tseng YC, Lee MS, Chang YJ, & Wu, 2008) concluded that acute appendicitis was the commonest cause in children over one year of age, followed by traumatic injury. However, a more recent study at Muhimbili National Hospital in Tanzania found intestinal obstruction to be most common at 58% of study subjects, followed by abdominal trauma, peritonitis and acute appendicitis in that order (Wella HL. & Carneiro, 2011). Mortality has been shown to be significantly

higher among those presenting with peritonitis, accounting for 15.4% of deaths in the Tanzanian study and a case fatality of 12.6% in a Ghanaian study, mostly due to typhoid perforation (Abantanga FA, Nimako B., & Amoah, 2009). Intussusception is the leading cause of obstruction in our setting, accounting for 25.7% of cases in a Kenyatta National Hospital study (Nyaga EM & Ndungu, 2010). There is paucity of data on leading causes of acute abdomen among children from the other parts of Kenya.

1.1.3 Imaging in Acute Abdomen

The common imaging modalities employed in investigating acute abdomen include Plain radiography, Ultrasonography and abdominal CT scan. Ultrasound is the modality of choice in suspected acute appendicitis, intussusception, as well as acute cholecystitis in older children (Manson, 2004).

The role of Computerized tomography is well documented in the adult population, and in children with equivocal ultrasound findings or perforated appendicitis although there is concern for the radiation dose (Manson, 2004). It also has a role in traumatic acute abdomen. It has been shown that proper clinical evaluation by a pediatric surgeon (serial in equivocal cases) combined with selective imaging in the diagnosis of acute appendicitis has an accuracy of over 97% with a low negative appendicectomy rate of 5% and perforation of rate 17%. This is compared with accuracies of 82% for ultrasound alone and 90% for CT alone, thus putting into question the radiation risk and increased costs in countries where CT has been widely considered to be the gold standard for such cases (Kosloske AM, Love CL, Rohrer JE, Goldthorn JF, & Lacey, 2004; Raman SS et al., 2008). This merits

consideration given that the Kenyatta National Hospital study found appendicitis contributed 30% of the total causes for pediatric acute abdomen.

Plain radiography has most utility in suspected intestinal obstruction or perforation (Feyler S., Williamson V., & King, 2002; Manson, 2004; Robson & Beasley, 2014). The basic views include supine abdomen and/or horizontal beam radiograph- erect, lateral decubitus or cross-table lateral ("American College of Radiology-Society of Pediatric Radiology Practice guidelines," 2014). In older children and adults an erect chest radiograph is more sensitive for the diagnosis of free intra-peritoneal air with 50 times less radiation dose compared to an abdominal one (Alexandra Knight & Howlett, 2010; Feyler S. et al., 2002). It also enables assessment of lung fields for any respiratory cause of acute abdomen. The utility of an erect view has been a subject of debate, especially since fluid levels have a myriad of causes and the interpretation of films varies greatly with the presenting clinical history (Adam A. & Dixon, 2008).

A number of criteria are thought to increase the diagnostic yield of plain abdominal radiographs greatly (Manson, 2004). These are prior abdominal surgery, abnormal bowel sounds, foreign body ingestion, abdominal distension and peritoneal signs. Presence of any one of them yields a sensitivity of 90% for imaging findings suggestive or diagnostic of a major abdominal pathology in children (Manson, 2004). However, in non-specific abdominal pain, plain film radiography is generally of limited value and is not recommended as a screening test (Feyler S. et al., 2002; Flak B. & Rowley, 1993).

1.2 Problem Statement

Pediatric abdominal surgical emergencies account for 2.4-3.1% of all pediatric admissions (Abdur-Rahman L.O., Adeniran J.O, & Adeyujigbe, 2012). The magnitude of morbidity and mortality in acute abdomen is enormous, peritonitis accounting for mortality ranging from 10-30% even in the best of centers (Ojuka A. et al., 2015).Management of the child with acute abdomen remains a persisting challenge, given that they do not always present with straightforward signs and symptoms unlike adults. Imaging in this case is relied on to aid in diagnosis.

Plain films are the first imaging modality of choice in investigation, given its easy availability, cheaper cost compared to other modalities, fast acquisition, lack of operator dependence and low radiation dose in comparison to CT (1mSV versus 10mSV). However, data shows decreasing use over the years in favour of cross-sectional imaging techniques, leading to a one-third decrease between 1992 and 2007 (Sarah L Gans, Jaap Stoker, & Boermeester, 2012). In addition, infrequent radiology consultation with abdominal radiography has been documented in various studies, with lack of interpretive skills among the different cadres of doctors despite widespread use (Feyler S. et al., 2002; Kellow ZS et al., 2008; Lim C.B., Chen V., Barsam A., Berger, & Harrison RA, 2006).

In patients with acute abdomen, especially children, lack of appreciation of pertinent abnormalities may result in delay to institute appropriate care or patient referral, with disastrous effect on morbidity, mortality and quality of life.

1.3 Justification

The identification of findings in abdominal radiographs of children presenting with acute abdomen that may suggest further consultation or urgent surgical intervention is a key and necessary skill among clinical staff. The pattern of findings obtained among children operated for acute abdomen has not been described in our setting. Similarly, no correlation of radiographic features with laparotomy findings has been done. This study will serve to fill the gap on interpretive skills among doctors that has been demonstrated by various studies (Lim C.B. et al., 2006; Thompson WM et al., 2007), especially in a training institution such as MTRH. Appreciation of these features will help in reducing morbidity and mortality among children, given that clinical signs and symptoms are not always reliable or straightforward in this patient population. In the same breadth, the actual practice on abdominal radiographic views vis-à-vis those recommended by various international guidelines is not known at MTRH, yet this has a major impact on the diagnostic yield/accuracy. This is important so as to inform hospital policy changes where necessary and thus reduce film wastage, overall costs and maximize on the diagnostic yield.

This study will serve to fill these gaps, and reinforce the role of radiography in the diagnostic work-up of this sub-set of patients, given the increasing challenge from cross-sectional imaging techniques. The study may also act as a trigger to a wider hospital and departmental review of abdominal x-ray utilisation practices in the rest of the in-patient wards as well as at the A&E.

In the event the study was not conducted, the radiographic patterns among children presenting with acute abdomen requiring surgery in our setting would remain a matter of extrapolation, and the question of what actual views are acquired and what patterns exist

locally remain unanswered. The bedside clinical staff especially at junior levels would lack local a reference on what common signs to look for during interpretation as well as their diagnostic utility, given the low rate of radiology consults for abdominal radiography. Similarly, information on high radiation dose of abdominal radiography would not be re-emphasized among requesting clinicians and appreciated, which should lead to a decrease in the performance of unnecessary repeats and/or for inappropriate indications.

Local hospital/departmental policies on abdominal radiography use and standard radiographic views to perform would likely remain undeveloped at MTRH without the findings from this study.

1.4 Research Question

1. What are the radiographic findings among children operated for acute abdomen at MTRH?

1.5 Objectives

1.5.1 Main Objective:

To describe the radiographic findings among children operated for acute abdomen at Moi Teaching and Referral Hospital between 1st April and 31st October, 2014.

1.5.2 Specific Objectives

1. To describe the demographic characteristics of children who presented with acute abdomen and were operated upon at MTRH pediatric surgery ward between 1st April and 31st October, 2014.
2. To list the causes of acute abdomen among children done radiography and operated for acute abdomen at MTRH pediatric surgical ward between 1st April and 31st October, 2014.
3. To determine the radiographic views of the abdominal films performed among children operated for acute abdomen at MTRH pediatric surgery ward between 1st April and 31st October, 2014.
4. To describe the radiographic findings in pediatric patients presenting with acute abdomen and done surgery at MTRH between 1st April and 31st October, 2014.
5. To correlate the radiographic and laparotomy findings in patients who presented with acute abdomen at MTRH pediatric surgery ward between 1st April and 31st October, 2014.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

Acute abdomen is a general term used to refer to abdominal signs and symptoms of recent onset, usually less than 72 hours and of uncertain causation that often require surgical consultation but may not necessarily need an operation (Peitzman et al., 2008).

The aetiology varies considerably with age strata in children as enumerated earlier.

2.1 Demographics and Clinical Presentation of Common Surgical Causes of Acute Abdomen in Children

The prevalence of acute abdomen vary according to the subsequent diagnoses arrived at, with the majority of cases (70%) having nonspecific abdominal pain and get discharged without any surgical intervention (Dickson JAS, Jones A, Telfer S, & de Dombal, 1988). Among the specific causes of acute non-traumatic abdominal pain in childhood as found in KNH were intussusception in infants (25.7%) and appendicitis (30%) in older children (Nyaga EM & Ndungu, 2010). At Muhimbili National Hospital, Tanzania, intestinal obstruction was leading (59.8% of study subjects), with intussusception as a sub-cause contributing 15% overall to the total number of children with acute abdomen requiring surgery (Wella HL. & Carneiro, 2011).

Worldwide, Intussusception, which occurs when one segment of bowel (intussusceptum) invaginates into another (intussuscipiens), is commonest between 6 months and 3 years of age, with 80 to 90% of affected children being less than 2 years of age (Mandeville K. et

al., 2012). Pathological lead points are found in only 5% of cases (Ein 1976). In the vast majority, lymphoid hyperplasia is the commonest cause and ileo-colic the most common type. A population-wide survey in Switzerland on yearly mean incidence of intussusceptions found 38, 31 and 26 cases per 100,000 live births in the 1st,2nd and 3rd year of life respectively (Buettcher, Baer G., Bonhoeffer J., Schaad UB., & Heininger, 2007).

In most cases, the classical triad of abdominal pain, red-currant jelly stool and a palpable abdominal mass are elicited. However; red-currant jelly stool is a late presentation together with signs of dehydration, abdominal distension, tenderness and even bloody diarrhea. Treatment in most advanced centers is non-operative, using air or liquid enema by a trained radiologist under fluoroscopic control with success rates between 75-85%. However, operative treatment is the norm in our setting (Mahesh Thapa & Raymond, 2005).

Appendicitis, which is most common in the older child (Abantanga FA et al., 2009; Erkan T et al., 2004; Nyaga EM & Ndungu, 2010; Pujari A, Methi RN, & Nishant., 2008; Tseng YC et al., 2008; Wella HL. & Carneiro, 2011), usually over 5 years of age, is usually preceded by luminal obstruction from a fecolith, appendicolith, lymphoid follicle or foreign body. The lifetime risk is 9% in males and 7% in females (Mahesh Thapa & Raymond, 2005).

Incidence is highest in the western world at 15%, whereas in Africans and Asians it is low at 1% but rising, maybe due to change in dietary habits with urbanization (Saidi H.S & Adwok, 2000). The clinical picture typically is of colicky abdominal pain that is initially periumbilical in location, which migrates to localize in the right iliac fossa with rebound tenderness due to local peritoneal inflammation (Norman S.W. & Christopher, 2012). It is usually accompanied by anorexia, nausea and vomiting. In delayed cases perforation often

occurs leading to generalized peritonitis. Studies have put incidence of advanced appendicitis at between 30 and 51% (Michael, 1997). This may probably explain the low incidence in our setting and the higher incidence of peritonitis due to delay in seeking medical attention. In the KNH study by Nyaga et al (2010), the perforation rate of acute appendicitis in children with acute abdomen was 68%. This may be due to the difficult diagnosis in the young as they may only present with anorexia and vomiting, hence the higher perforation rates compared to adults.

Peritonitis, another common presentation of acute abdomen in children, is of diverse aetiologies, most being from typhoid perforation followed by appendicitis as in the West African studies by Abantanga et al (2009) in Ghana and Abubakar and Ofoegbu (2003) in Nigeria to abdominal trauma, either blunt or penetrating (Langeveld H.R. & Van AS, 2012). Rare causes include primary peritonitis in girls, accounting for 10 cases over a 5 year period in the Ghana study, out of a total of 955 children.

In the KNH study over a 5 month period by Nyaga et al (2010), peritonitis was the second most common cause for surgical acute abdomen at 14.5% after intussusception (26%). Wella et al (2011) in Muhimbili, Tanzania, found it to be the third leading cause at 13.4% after intestinal obstruction (59.8%) and abdominal trauma (14.4%) over a 1 year period. It is also of note that Abantanga et al (2009), in their prospective study over a 5 year period, found typhoid perforation to be leading at 68%. A retrospective study in Northern Nigeria over a period of 8 years (Abubakar A.M. & Ofoegbu, 2003) found it accounted for 28.3% of 251 cases reviewed, hence second most common cause of childhood acute abdomen after intestinal obstruction (34.7%) in West Africa.

Peritonitis per se may result from typhoid perforation of the terminal ileum, which is most common where poor sanitation is prevalent like in most developing nations, or from intestinal obstruction with or without gangrene. Another frequent aetiology in children is perforated appendicitis as previously mentioned. The clinical signs include abdominal tenderness, rigidity, guarding, rebound tenderness, absence of bowel sounds, shallow respirations, anorexia and vomiting among others (Norman S.W. & Christopher, 2012). When present, these obviate the need for imaging and the management is usually fluid and electrolyte correction, antibiotic cover and urgent laparotomy. However, clinical presentation in neonates, infants and young children is not as straightforward and clinical history cannot be relied alone (Awolaran, 2015; Manson, 2004).

Intestinal obstruction is a clinical diagnosis, and the patient typically presents with abdominal distension, pain, bilious vomiting, increased or decreased/absent bowel sounds, failure to pass stool or flatus and peritoneal signs where perforation or gangrene has set in (Norman S.W. & Christopher, 2012). In infancy, intussusception accounts for over two-thirds of cases (Osuigwe AN & Anyanwu, 2002; Shija J.K, 1980). The Muhimbili study (Wella HL. & Carneiro, 2011) had obstructed inguinal hernia (11 cases) and infantile hypertrophic pyloric stenosis (8 cases) as other causes of intestinal obstruction in children.

2.2 Radiographic Views

The recommended abdominal radiographic views according to ACR-SPR guidelines (2014) include Supine AP and/or a horizontal beam, in this case either an Erect, Lateral decubitus or Cross-table Supine view. A combination of both dependent (supine) and nondependent (horizontal beam) generally improves the diagnostic accuracy substantially (Lappas JC,

Reyes BL, & Maglinte, 2001; Paulson E & Thompson, 2015). However, a number of studies have also demonstrated that a Supine view alone maybe adequate in the assessment of bowel obstruction (Hughes UM, Thomas KE, Shuckett B, Daneman A, & Stephens, 2002; Reynaldo O. et al., 2002) unless there is a persisting uncertainty. An Erect view has been shown to only marginally increase the diagnostic accuracy by about 5% (Simpson A. et al., 1985). Similarly, in the evaluation of pneumoperitoneum, an erect chest radiograph is far more sensitive than an Erect abdominal one (Adam A. & Dixon, 2008; Chiu YH et al., 2009; Feyler S. et al., 2002). Lateral decubitus view is the most sensitive in diagnosing pneumoperitoneum at 98% while a Cross-table view is more sensitive than Supine and especially useful in the very sick child who cannot be moved (Chiu YH et al., 2009; Ciro Esposito & Esposito, 2009). Lateral decubitus with left-side down has been demonstrated to increase the number of diagnostically determinate studies in intussusception by 31 percentage points (Hooker RL, Hernanz-Schulman M, Chang Yu, & Herman Kan, 2008).

2.3 Radiographic Findings in Common Surgical Causes of Childhood Acute Abdomen

Plain films are often the first-line modality in imaging the acute abdomen due to its wide availability, cheaper cost, and lack of operator dependence (Paulson E & Thompson, 2015) , which is especially relevant in our resource-constrained settings.

With respect to intussusception, which was the most common cause in infants from the KNH study (Nyaga EM & Ndungu, 2010), abdominal radiographs may be normal or demonstrate intestinal obstruction (Adam A. & Dixon, 2008; Brant & Helms, 2007). In

50% of cases a soft tissue mass effect along the course of the colon with radio-lucent areas representing trapped fat is present. Generally, positive criteria include presence of the discrete soft tissue mass and small bowel obstruction, while negative criteria include air or stool in the ascending colon and cecal air or stool (Hooker RL et al., 2008). A positive likelihood ratio of 3.9 has been computed for the presence of a soft tissue mass (Sargent, Babyn and Alton, 1994). Completely normal bowel gas patterns are seen in 24% of radiographs (Venter JA et al, 2013).

For small bowel obstruction, the general limit of bowel distension is a transverse diameter greater than 3cm at the jejunum or 2.5cm in the more distal ileum (Adam A. & Dixon, 2008; Musson RE, Bickle I, & Vijay, 2011). Other radiographic signs include two or more air-fluid levels wider than 2.5cm or in differential heights more than 5mm apart within same bowel loop (Lappas JC et al., 2001; Paulson E & Thompson, 2015; Thompson WM et al., 2007). In addition, a 'gasless' abdomen or a centrally-located pseudo-mass may be seen if obstructed bowel loops are fluid-filled (Paulson E & Thompson, 2015).

Large bowel obstruction is usually peripheral and distended more than 6cm in transverse diameter (9cm or greater for caecum) with incomplete haustral markings (Adam A. & Dixon, 2008), or may have a combination of both small and large bowel distension due to an incompetent ileocaecal valve (Alexandra Knight & Howlett, 2010) . Often, distinguishing small from large gut is difficult in neonates and infants (Awolaran, 2015).

Acute appendicitis was the most common cause of acute abdomen among children older than 6 years in the KNH study (Nyaga and Ndung'u, 2010). The value of plain radiography has not been fully appreciated in these cases, yet a misdiagnosis rate of about 20% is well

documented especially in children, women and the elderly (Petroianu A & Alberti, 2012). The radiographic signs in acute appendicitis that have been well documented in literature include increased soft tissue density in the right lower quadrant (12-33%), presence of sentinel loop with air-fluid levels in the right lower quadrant (15-55%), appendicoliths (2-22%), deformity of cecum (4-5%), gas in the appendix (< 2%), separation of the cecal content from right properitoneal fat (< 5%), loss of the right psoas outline (1- 8%) and scoliosis with concavity to the right (1-14%) (Petroianu A & Alberti, 2012). In addition, a new radiographic sign of cecal fecal loading has been described since 2005 that is comparable to CT diagnosis with a sensitivity of 97.05% and a negative predictive value of 98.08%, present through all stages of acute appendicitis and in all subset of patients, neonates included (Petroianu A & Alberti, 2012). The study utilized supine AP radiographs in evaluating for this sign.

Peritonitis, which was shown to be a common cause of acute abdomen in older children (Abantanga FA et al., 2009; Abubakar A.M. & Ofoegbu, 2003; Nyaga EM & Ndungu, 2010) may not be clinically obvious in neonates and very ill children (Awolaran, 2015). The radiological features of gastrointestinal perforation include lucency over the liver, air under the diaphragm or central tendon (cupola sign), Rigler's sign, falciform ligament sign, football sign, air in Morison's pouch (doge cap sign), accentuation of retroperitoneal ligaments, tell-tale triangle sign (triangular air-collection between loops of bowel and parietal peritoneum on Supine AP view), pneumoscrotum and peritoneal calcifications in meconium peritonitis (Alexandra Knight & Howlett, 2010; Awolaran, 2015). Mural air may indicate impending perforation while aerobilia may represent portal sepsis or gallstone ileus

(Alexandra Knight & Howlett, 2010). Thickened bowel wall and portal vein gas may indicate ischemia (Guo W, Wang J, Zhou M, Sheng M, & Fang, 2011).

2.4 Comparison of Findings in Mechanical Intestinal Obstruction and Ileus

The radiological distinction of ileus and mechanical obstruction is difficult radiologically (Morrison, 2005). Therefore, the importance of a background clinical history when interpreting abdominal radiographs must be emphasized, and be provided together with the imaging request.

CHAPTER THREE: METHODOLOGY

3.1 Design

This was a descriptive cross-sectional study done between 1st April and 31st October 2014.

3.2 Study site

This study was done at The Moi Teaching and Referral Hospital Pediatric Surgical ward and Radiology Department, which is the second national referral facility in the country after KNH. The hospital serves a large catchment population estimated at over 20 million people from the Western part of Kenya, the North, Central and Southern Rift regions, Lake Basin, Eastern Uganda and South Sudan. It is situated about 320km to the North-West of the capital, Nairobi and has a bed capacity of 800. The functional departments number over 25 including over 10 surgical sub-specialties. It serves as a teaching hospital for over 1000 undergraduate students and over 200 postgraduate students pursuing Medicine, Nursing, General and Orthopedic Surgery, Radiology, Child Health, Reproductive Health, Family Medicine among others.

3.3 Study population

All children aged 0-14 years who presented with a clinical diagnosis of acute abdomen in the MTRH pediatric surgical ward and underwent plain abdominal radiography plus a subsequent laparotomy.

3.4 Sampling and Recruitment

A census study was chosen given the low prevalence of acute abdomen among general pediatric hospital admissions (Abdur-Rahman L.O. et al., 2012). All pediatric surgical patients admitted with a diagnosis of acute abdomen and who underwent plain abdominal radiography and laparotomy were recruited into the study. Patient demographic details, clinical history, physical examination and laparotomy findings were captured in the data collection instrument. Plain abdominal films were captured using a digital camera and subsequently read with three consultant radiologists blinded to the surgical outcomes. The results were entered once consensus was reached on the findings.

3.4.1 Inclusion Criteria

a. Child who presented with acute abdomen

b. Child underwent laparotomy and had prior plain abdominal radiography done.

3.4.2 Exclusion Criteria

a. Incomplete patient data

b. Patient's on management for Hirschsprung's disease, Anorectal Malformations, Pyloric Stenosis, Acute Scrotum and Abdominal Tumors that may have presented as acute abdomen.

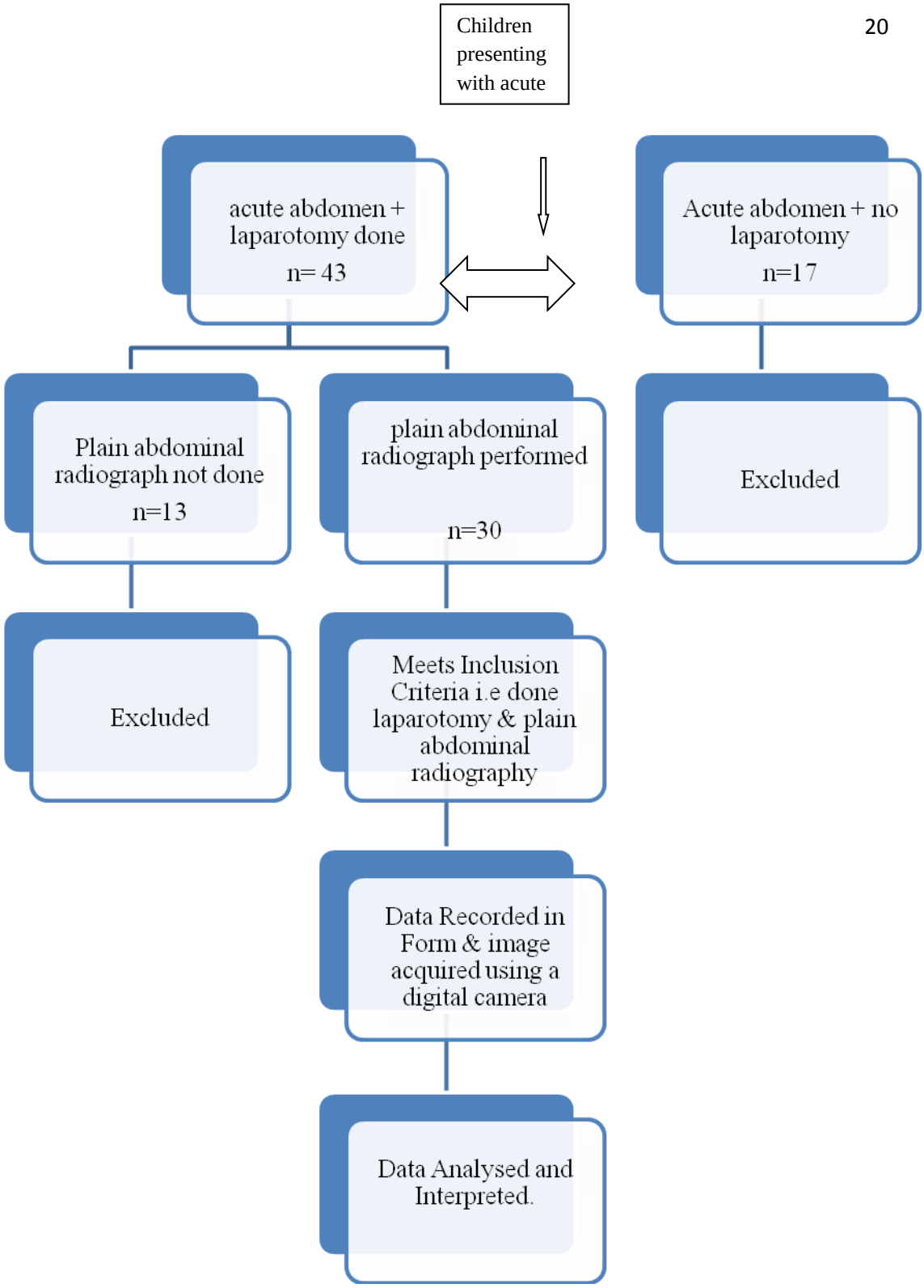

Figure 1: Study Flow Chart

3.5 Quality Control

All images acquired were read with three consultant radiologists blinded to the surgical findings. The intra-operative findings were taken as the gold standard in establishing the accuracy of abdominal radiography among the study participants.

3.6 Data Collection and Management

Data was collected using a standardized form (see appendix I). Plain abdominal films were acquired using a digital camera (Model Nikon S3200, 16 Megapixels) on a view box with shutters and labeled to correspond to the questionnaire number and subsequently read with three experienced radiologists. Surgical findings and clinical history were obtained from the patient's file immediately after laparotomy was done. Data processing was done using Microsoft Office and Excel computer programs and presented in the form of frequency tables, pie charts, 2x2 contingency tables, proportions, percentages and bar graphs.

3.7 Ethical Considerations

Approval to carry out the study was sought from the Institutional Research and Ethics Committee (IREC) vide formal approval number FAN: IREC 1079 of 3rd October, 2013 and amendment approval number 0001079 of 15th July, 2015. Dissemination of data was done via Departmental and School Board oral presentations, as well as a thesis write-up. Effort will be pursued to also publish the same in a peer-reviewed journal with a wide circulation, and in the Moi University Press.

3.8 Study Limitations

1. Possibility of selection bias due to retrospective nature of temporal events.

2. Small sample size.

3. The investigator had no control over radiographic views already ordered and performed.

CHAPTER FOUR: RESULTS

4.0 Introduction

The study was carried out between April and October 2014. During this period, 43 laparotomies were done for acute surgical abdominal emergencies, out of which 30 respondents had plain abdominal radiographs performed prior to surgery. Seventeen (17) children who were on conservative management were excluded. Thirteen (13) children who had laparotomy for acute abdomen had been imaged using other modalities and were also excluded from the study.

4.1 Burden of Acute Abdomen

During the study period, a total of 388 surgeries were carried out in pediatric surgery and the total hospital pediatric admissions were 3,040. Surgical abdominal emergencies were 43 giving a point prevalence of 1.4% among all children admitted at the time, and accounted for 11% of the total pediatric surgeries ("MTRH Health management & Information System Records," 2014).

4.2 Clinical Presentation

The most common symptoms and signs encountered were abdominal pain, abdominal distension, vomiting, tenderness, abnormal bowel sounds and peritonism. Babies with jejunal atresia typically presented with failure to pass meconium since birth, bilious vomiting and abdominal distension. Ten (10) of the study subjects had fever on admission.

4.3 Demographic Data

Sixteen (16) of the study participants were female and 14 male, giving a male to female ratio of 1.1: 1. The age range was 3 days to 14 years, with a median of 6 months for those under 5 years and 10 years for respondents 5 years and above. The mean age was 8.9 years for participants 5 years and above, who comprised 19 out of the 30 participants (63% of study subjects).

Thirty percent (30%, n=9) of the study participants were aged 1 year or less.

4.4 Causes of Acute Abdomen

Causes of acute abdomen among the respondents were as tabulated below:

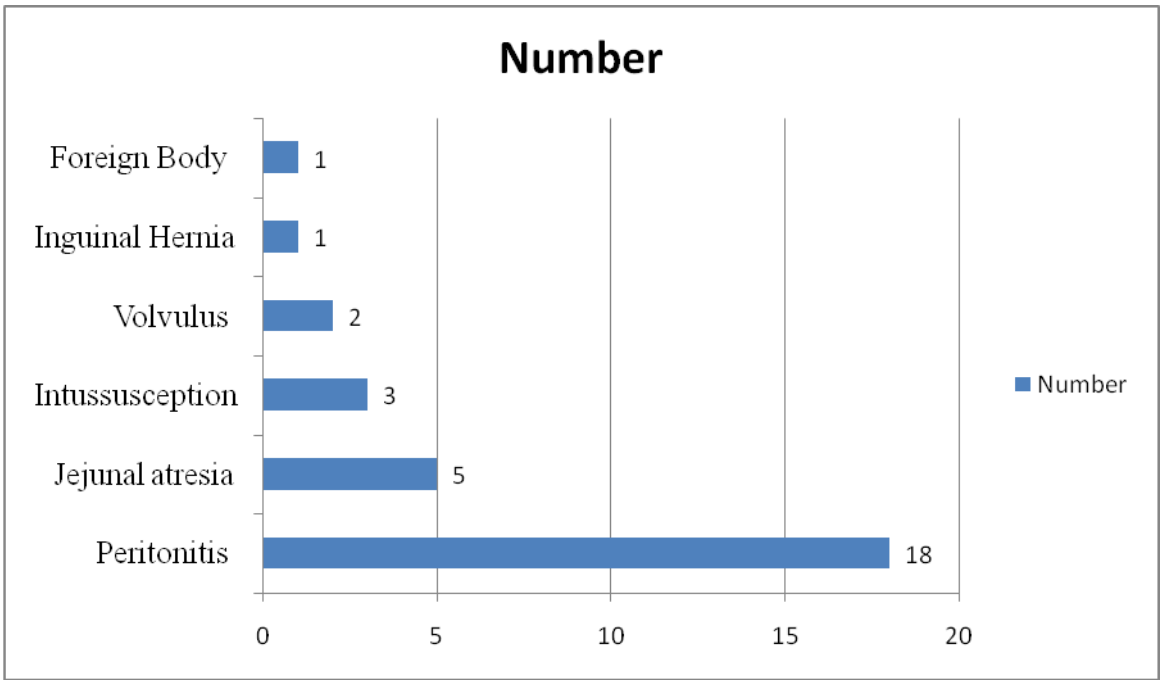

Figure 2: Bar Graph Showing Causes of Acute Abdomen

Among children who presented with peritonitis, the causes are as shown in the pie chart below.

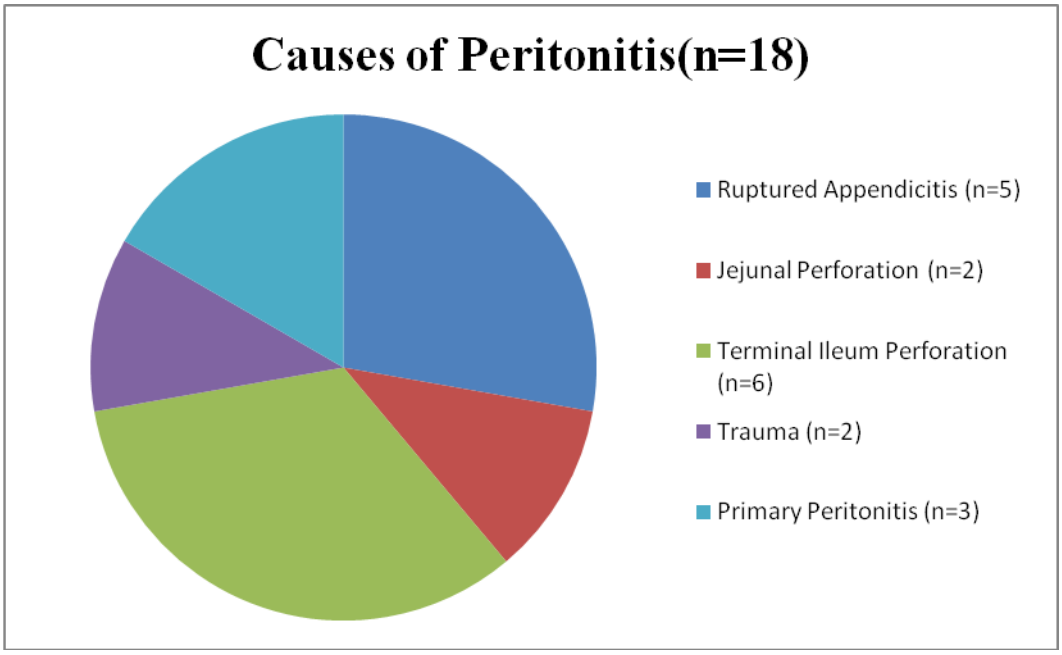

Figure 3: Causes of Peritonitis.

Most of these children (14 out of 18, 77%) were aged 5years and above.

There were 12 children with mechanical intestinal obstruction, whose causes were as tabulated below:

Table 1: Causes of Mechanical Intestinal Obstruction among Study Participants.

Causes	**No**
Intussusception	3
Strangulated hernia	1
Sigmoid volvulus	1
Small bowel volvulus	1
Adhesions	1
Jejunal atresia	5
Total	**12**

Nine (9) of the children were of less than 1year of age, comprising 75% of the total number with mechanical intestinal obstruction.

4.5 Radiographic Views

The most common radiographic views provided were Supine (n= 12) followed by Supine + Cross-table (n= 8), Erect Abdomen + Cross-table (n= 4), Cross-table alone (n= 3) and Erect Abdomen only (n= 3).This is shown in the bar graph below:

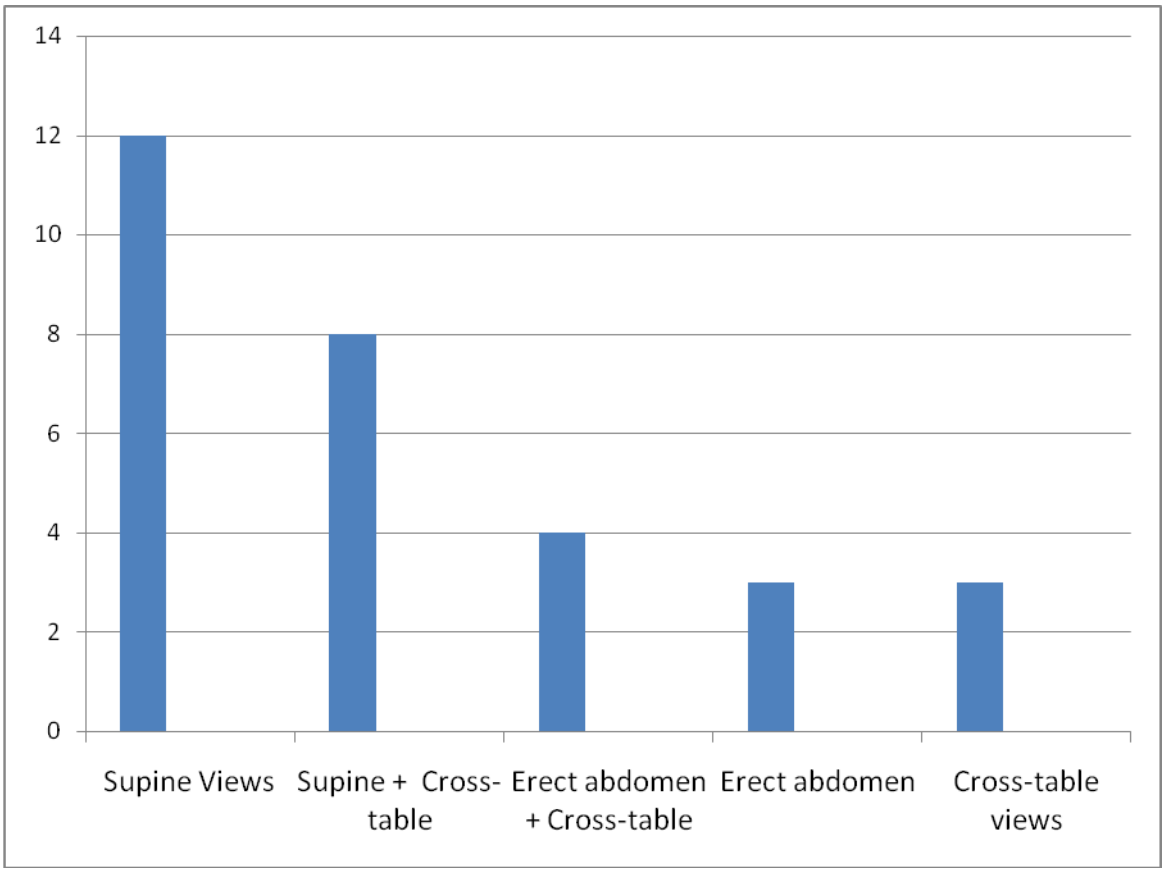

Figure 4: Radiographic Views

4.6 Radiographic Findings

The radiographic findings in patients with peritonitis were as illustrated in the bar graph below:

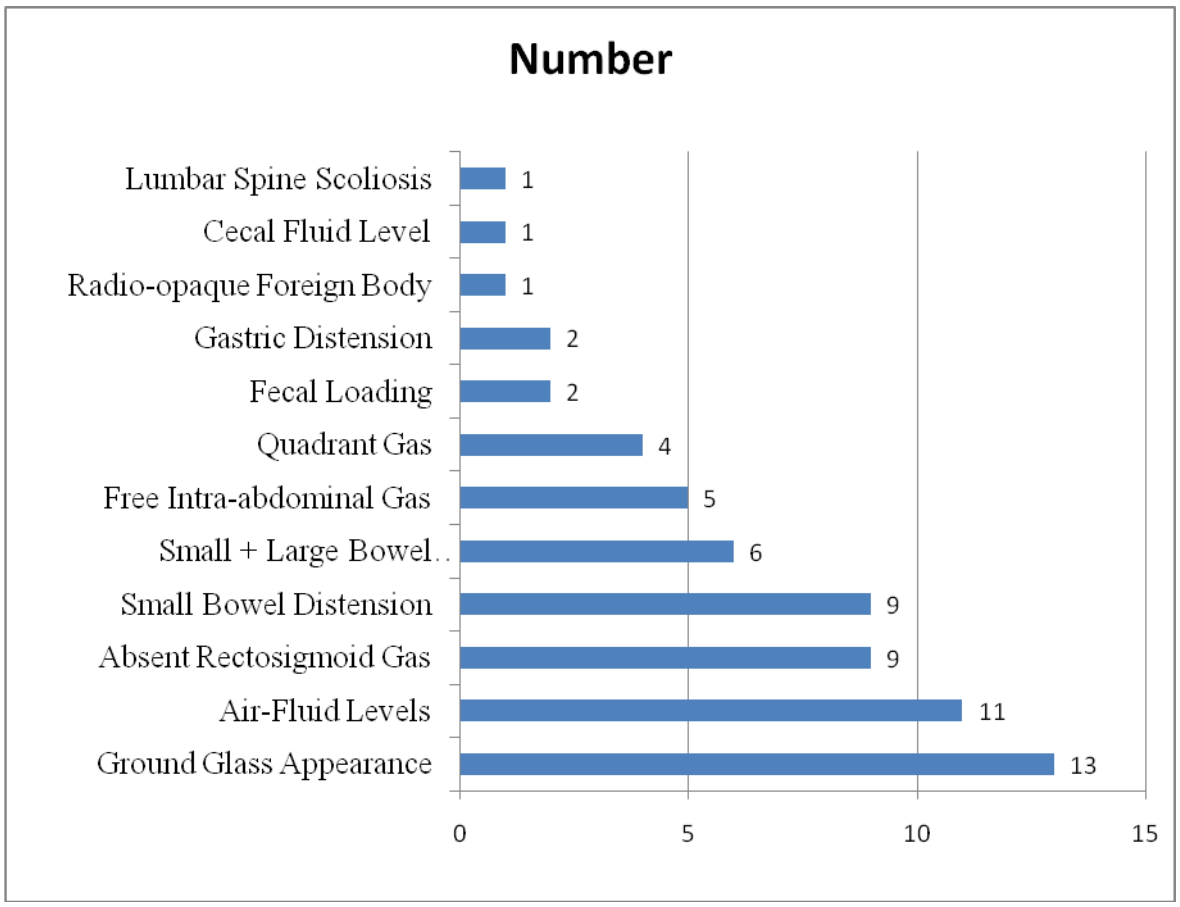

Figure 5: Radiographic Findings among Patients with Peritonitis (n=18).

Radiographic findings among children with mechanical causes of acute abdomen were also graphically illustrated as shown below (n=12).

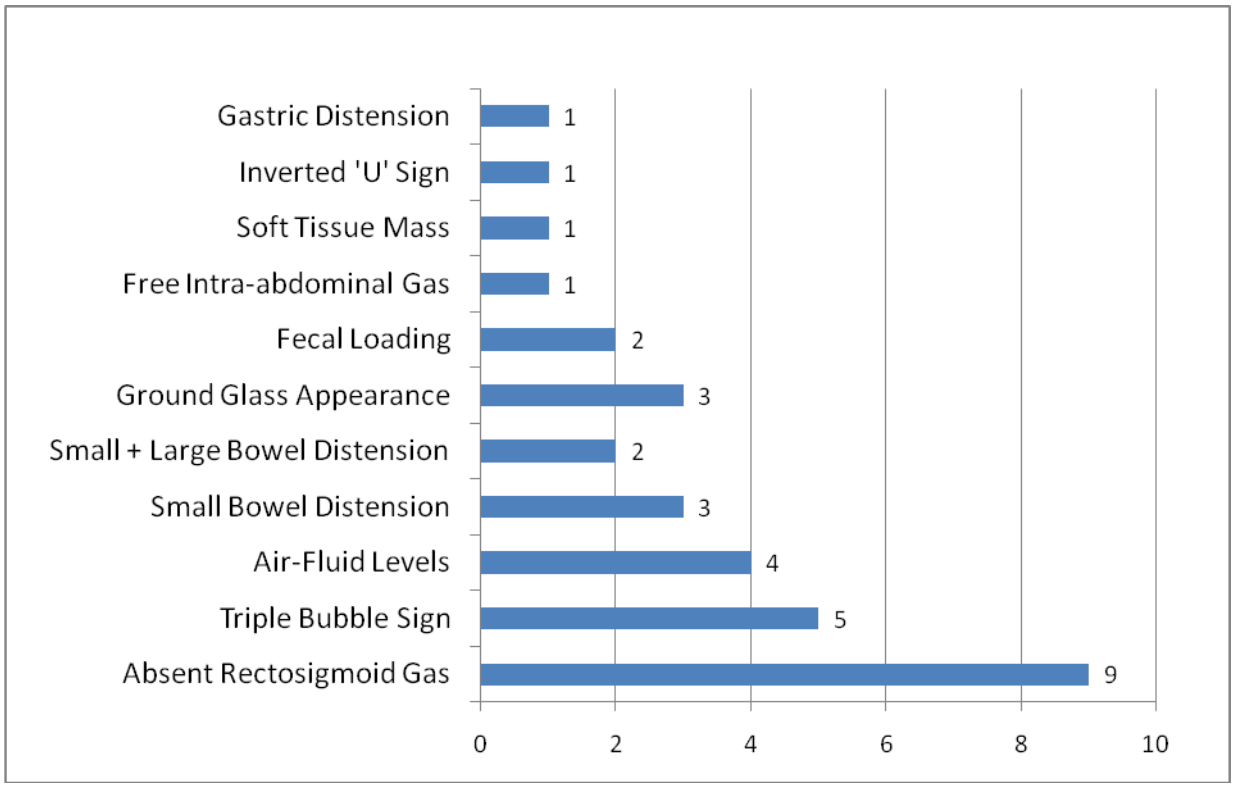

Figure 6: Radiographic Findings in Children with Mechanical Intestinal Obstruction.

Combined radiographic findings in all respondents (n=30).

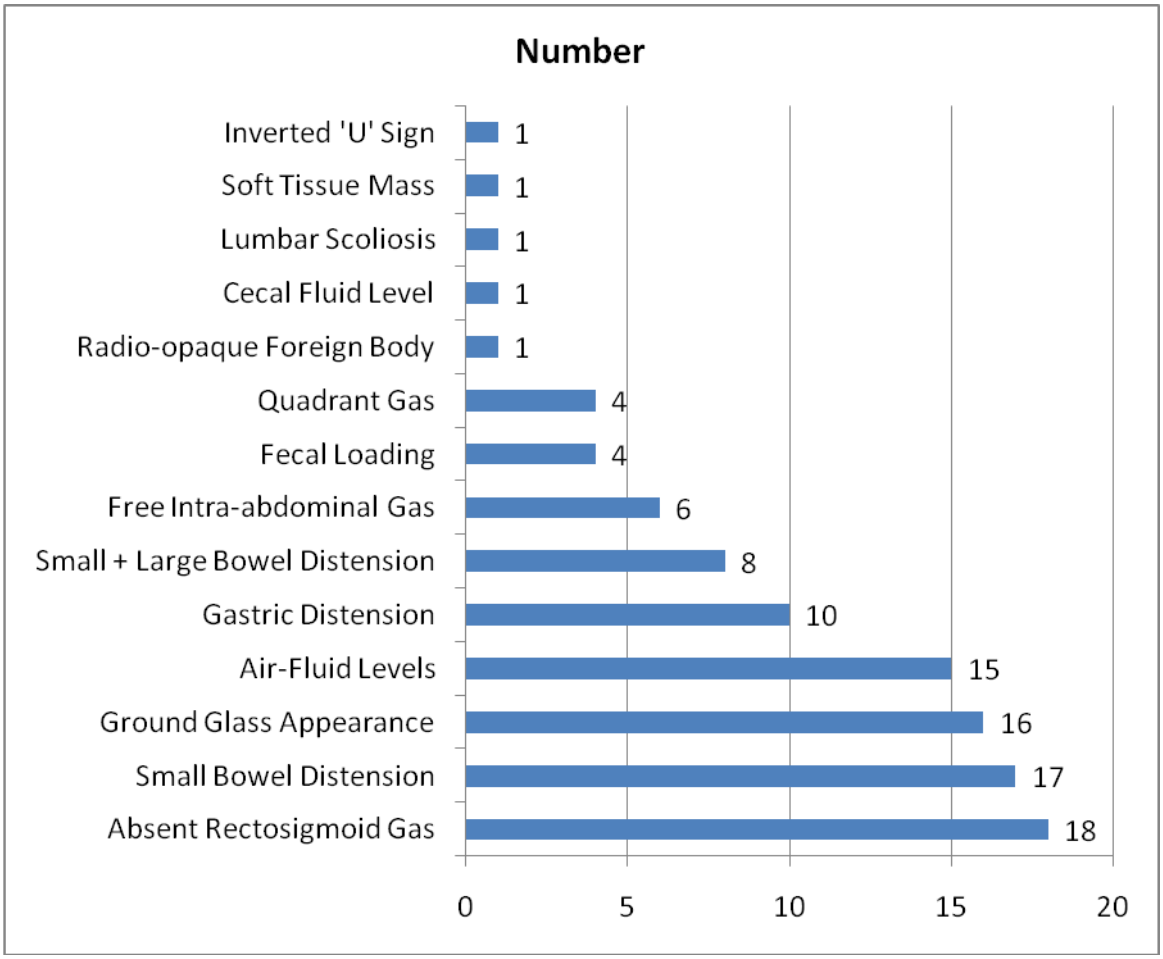

Figure 7: Combined Radiographic Findings in All Respondents (n=30).

4.7 Sample Images

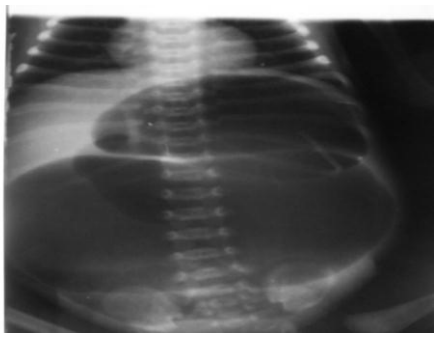

Figure 8: Supine abdominal radiograph of a 10 day old female who presented with proximal jejunal

.

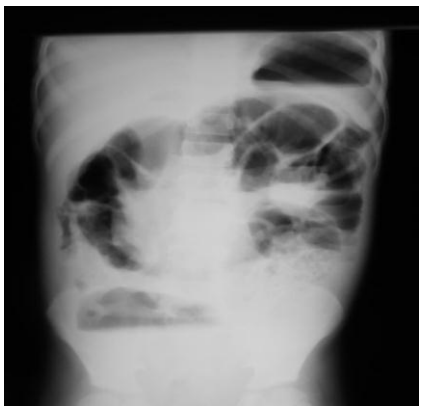

Figure 9: Erect abdominal radiograph of a 6 year old boy who presented with ruptured appendicitis.

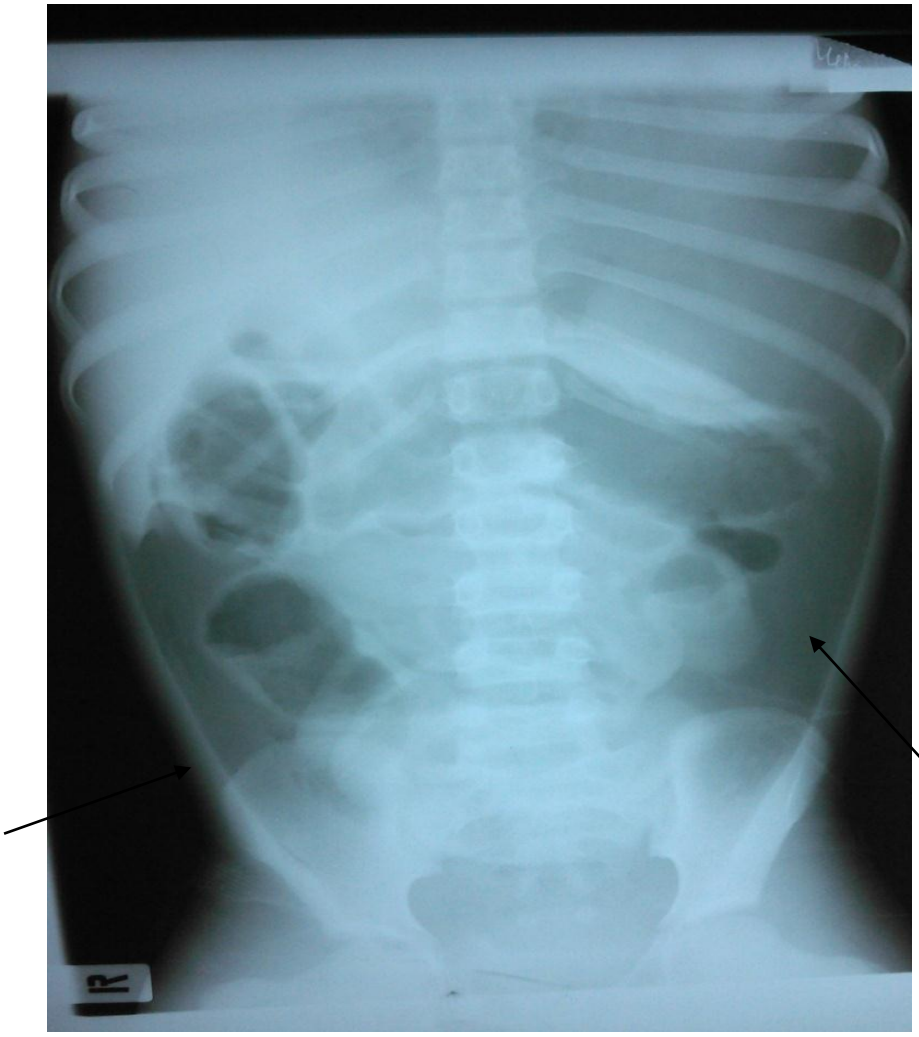

Figure 10: Supine abdominal radiograph of a 10 year old girl who presented with peritonitis secondary to terminal ileum perforation.

Note the free intra-peritoneal air in both paracolic gutters (arrows) and Rigler's sign.

4.8 Correlation of Radiographic and Laparotomy Findings

The most common finding in those with mechanical obstruction was absent rectosigmoid gas while ground glass appearance and air-fluid levels were common in children who had peritonitis.

The reliability of absence of rectosigmoid air in distinguishing between the two groups was assessed using the contingency table below:

Table 2: Comparison of Presence or Absence of Rectosigmoid Gas in Mechanical Obstruction and Peritonitis.

	Mechanical Obstruction	**Peritonitis**	**Totals**
Rectosigmoid Gas Absent (+ve sign)	9	9	18
Rectosigmoid Gas Present (-ve sign)	3	9	12
Totals	**12**	**18**	**30**

Odds ratio = 81/27

= 3 (CI 0.6, 15.0 for margin of error 5%)

Sensitivity= 75%

Specificity= 50%

Positive predictive value=50%

Positive likelihood ratio= $\frac{\text{Sensitivity}}{\text{1-specificity}}$

= 1.5

Negative likelihood ratio = $\frac{\text{1-sensitivity}}{\text{Specificity}}$

= 0.5

The reliability of air-fluid levels in the diagnosis of mechanical intestinal obstruction versus peritonitis was assessed in the following table:

Table 3: Comparison of Air- Fluid Level in Mechanical Obstruction and Peritonitis.

	Mechanicals Obstruction	**Peritonitis**	**Totals**
Air-fluid Levels Present (+ve sign)	4	11	15
Air-fluid Levels Absent (-ve sign)	8	7	15
Totals	**12**	**18**	**30**

Odds ratio = 28/88

= 0.3 (CI 0.1, 1.4 for margin of error 5%)

Sensitivity = 4/12

= 30%

Specificity=11/18

= 61%

Positive predictive value= 27%

Positive likelihood ratio = sensitivity/1-specificity

= 0.8

Negative likelihood ratios = 1-sensitivity/specificity

= 1.2

Ground glass appearance was the most common finding in those with peritonitis. Its accuracy in reliably distinguishing from mechanical intestinal obstruction was assessed using the contingency table below:

Table 4: Comparison of Ground Glass Appearance in Peritonitis and Mechanical Obstruction.

	Peritonitis	**Mechanical Obstruction**	**Totals**
Ground glass Appearance Present (+ve Sign)	13	3	16
Ground glass Appearance Absent (-ve Sign)	5	9	14
Totals	**18**	**12**	**30**

Odds ratio=117/15

= 7.8 (CI 1.5,41.3 for margin of error 5%)

Sensitivity=13/18

= 72%

Specificity=3/12

= 25%

Positive predictive value = 13/16

= 81%

Positive likelihood ratio = sensitivity/ (1-specificity)

= 1.0

Negative likelihood ratio = (1-sensitivity)/specificity

= 1.1

CHAPTER FIVE: DISCUSSION OF FINDINGS

5.1 Demographics

The male to female ratio was 1.1:1, whereas in the Nigerian and Tanzanian studies it was 2.5:1 and 1.8:1 respectively (Abdur-Rahman L.O. et al., 2012; Wella HL. & Carneiro, 2011). In the KNH study (Nyaga EM & Ndungu, 2010), males were majority at 62%. Therefore, the findings from our study could reflect a variation in local geographical trends or health-seeking patterns which need to be investigated further.

5.2 Causes of Acute Abdomen

Mechanical causes of acute abdomen were more frequent in those under 1 year of age (9 out of 12 cases, 75%) whereas 77% of peritonitis cases- which had the highest frequency in this study- was seen in children over 5 years of age (n= 14). This is in contrast to the Tanzanian study by Wella & Carneiro (2011) who found intestinal obstruction to be the leading cause among 97 children recruited prospectively over a one year period. However, it tallies with the findings in a Nigerian study (Abdur-Rahman L.O. et al., 2012) which similarly found peritonitis as the main presenting cause in late childhood and mechanical intestinal obstruction in neonates and infants. Acute appendicitis (n=5) was the second leading sub-cause of peritonitis and all cases were ruptured reflecting the difficulty in reaching this diagnosis in children. Nyaga and Ndung'u (2010) calculated a perforation rate of 68% at KNH over a six month period, and with a bigger sample of 390 patients. Terminal ileum perforation as a leading sub-cause among children with peritonitis (n= 6,

33%) may reflect the sanitation standards and prevalence of typhoid in the catchment population (Abantanga FA et al., 2009).

Intussusception was the leading cause among those with mechanical intestinal obstruction (n= 3, 25%) and predominantly in infants similar to other studies elsewhere (Mandeville K. et al., 2012; Nyaga EM & Ndungu, 2010; Wella HL. & Carneiro, 2011).

5.3 Radiographic views

Supine AP followed by combined Supine AP and Cross-table Supine views were the most common (n= 20) accounting for 66.7%. These are generally adequate to assess bowel gas patterns and fluid levels. However, there is concern for the Erect abdomen and Cross-table Supine combination (4/30, 13% of radiographs) as these do not improve on the diagnostic yield (both are horizontal beams) and represents potential film wastage that should be eliminated. Considering that each abdominal radiograph costs Kshs. 900-1100 at MTRH ("MTRH Health management & Information System Records," 2014) significant cost savings maybe realized from standardizing required views, as well as avoiding unnecessary irradiation of patients.

The ACR-SPR guidelines (2014) generally recommend Supine anteroposterior and/or horizontal beam views (decubitus, upright or cross-table) as sufficient depending on the indication. Supplementary views where necessary may also be performed in additional projections. A Supine AP view is considered part of the basic abdominal series.

Routine 2-view radiography in cases of suspected bowel obstruction has been shown not to significantly improve diagnostic yield and may be abandoned except in cases with

persisting uncertainty (Hughes UM et al., 2002; Simpson A. et al., 1985). In these studies, the mean change in accuracy was 6% and 5% respectively with the second view and this was not statistically significant between radiologists, surgeons and emergency staff. A multicentre collaborative study in the Philippines arrived at a consensus that a recumbent view was adequate in the assessment of suspected bowel obstruction without need for an upright one (Reynaldo O. et al., 2002).

Pneumoperitoneum can be diagnosed with upright, decubitus, cross-table or erect chest radiographs where patient is able to stand. A review by Chiu et al found sensitivities of 80.4% for supine abdominal, 78.7% for supine chest x-ray, 85.1% for erect chest x-ray, and 98.0% on left lateral decubitus (Chiu YH et al., 2009). Cross-table Supine view is more sensitive than a Supine AP in evaluation of free intra-abdominal air (Ciro Esposito & Esposito, 2009).

5.4 Radiographic Reports/Interpretation

None of the x-ray films was reported by radiologists. This may imply infrequent consultation between the two departments especially in abdominal radiography which was the focus in this study. This is not particularly unique to MTRH, as studies elsewhere have found the same (Kellow ZS et al., 2008). Interpretation of abdominal radiographs is however, quite daunting especially in pediatrics (Awolaran, 2015) and this may pose challenges where experienced radiologists or senior surgeons are not available for consultation (Lim C.B. et al., 2006; Thompson WM et al., 2007).

5.5 Radiographic Findings

All the x-rays reviewed were abnormal (100%), with one negative laparotomy giving a sensitivity of 96% (n= 29). Out of the 12 cases with mechanical intestinal obstruction, there was a firm radiographic diagnosis in 8 (67%). This correlates with a US study (Maglinte DD et al., 1996) that found a sensitivity of 69% for plain film in the evaluation of small bowel obstruction. More recent data suggests that in the clinical setting of small bowel obstruction, sensitivity could be as high as 82% and specificity 83% (Paulson, 2015).

Absence of rectosigmoid air with small bowel/small and large bowel distension was the most common radiographic sign in those with mechanical obstruction (9 out of 12 cases, 75%). It was also a finding in 50% of those with peritonitis (n= 9). Whereas absence of rectal air can occur normally, a combination with abnormal bowel gas patterns and collapse of the large gut in small bowel obstruction is more reliable (Musson RE et al., 2011). Rectal air may be present with partial obstruction, as well as getting introduced during digital rectal exam and must never be used in isolation accordingly.

There is conflicting literature on the role of air-fluid levels in evaluation of small-bowel obstruction. While some describe 2 or more levels air-fluid levels wider than 2.5cm or in differential heights within same bowel loop as useful in the diagnosis (Lappas JC et al., 2001; Lassandro F et al., 2001; Thompson WM et al., 2007), these are by no means pathognomonic and therefore cannot reliably distinguish mechanical obstruction from adynamic ileus (Adam A. & Dixon, 2008; Harlow CL, Stears RL, Zeligman BE, & Archer, 1993). Nevertheless, they are widely accepted in evaluation for luminal stasis (Alexandra Knight & Howlett, 2010; Lappas JC et al., 2001).

Free intra-abdominal air was detected among 5 respondents with peritonitis due to perforated viscus and one case of gangrenous ileo-colic intussusception. The sensitivity of plain radiographs in detecting small amounts of intra-abdominal gas is not in doubt, and this remains a key indication in suspected cases ("American College of Radiology-Society of Pediatric Radiology Practice guidelines," 2014). These were evident from Supine and Cross-table lateral views provided.

In three patients with perforated gut free gas was not detected, likely due to the oblique nature of the x-ray beam to the free gas pockets in erect or supine abdominal radiographs, which are not as sensitive as discussed before. An erect chest radiograph has been shown to be more precise in detecting free intra-peritoneal gas with 35-50 times less radiation exposure compared with a supine abdominal radiograph (Alexandra Knight & Howlett, 2010). However, this may not be possible in this subset of patients who are usually too ill for such a position. Conversely, an erect chest may be misleading due to many mimics of free sub-diaphragmatic gas (Adam A. & Dixon, 2008), and one would be best advised to request for a Lateral decubitus or Cross-table Supine view for this indication. Chest radiography has the additional benefit in evaluating for lower lobe pneumonia, which may be a cause of abdominal pain.

Small bowel distension was seen more frequently in those with peritonitis (9 versus 3), perhaps reflecting the higher number encountered in this study. However, if those with jejunal atresia were added the frequency is more or less the same in both groups (9 versus 8). The actual caliber of distension as well as bowel wall thickness was not measured in this study due to lack of grid markings and standardized views on most images that could have aided objective measurements. Nevertheless, the consensus of three consultant board-

certified radiologists was relied upon. Supine radiographs were 100% sensitive in the diagnosis of all cases of jejunal atresia encountered, with the triple bubble sign reliably demonstrated in all of them.

Intussusception was encountered in 3 study participants who had been investigated with abdominal radiographs. Notably, all these 3 children were referrals from county hospitals. A recent comparative study of ultrasonography versus plain radiography shows ultrasound as the far more sensitive of the two (Henderson AA et al., 2013), perhaps explaining a shift in clinical practice in our setting and the few numbers encountered in our study, unlike the 25.6% proportion in KNH by Nyaga and Ndung'u (2010), who looked at nontraumatic childhood acute abdomen from a purely surgical perspective.

With respect to the radiographic features of intussusception, one of the children had small bowel distension with surrounding ground glass pattern due to paucity of colonic gas, multiple air-fluid levels and an intracolonic soft tissue mass in the left upper quadrant. Pneumoperitoneum with small & large bowel distension was noted in the second and in the third, small bowel distension with absent rectosigmoid gas. In one study reviewing 60 cases of intussusception, presence of a soft tissue mass and sparse large bowel gas were strong positive predictors with likelihood ratios of 3.9 and 2.5 respectively, and a firm radiographic diagnosis had a diagnostic accuracy of 84%(Sargent MA, Babyn P, & Alton, 1994). The flipside however, is that abdominal gas patterns maybe completely normal in 24% of patients (Venter JA, le Grange SM, Otto SF, & Joubert, 2013) illustrating the difficulty in making such a diagnosis. This study demonstrated pneumoperitoneum as a presenting radiologic sign in intussusception, which has not been documented before and which authorities have been considering only as a complication of enema reduction and

unlikely as a presenting sign (Robson & Beasley, 2014). This means that patients in our setting present so late in the disease progression when severe complications have occurred and may be a pointer to state of accessibility of quality healthcare for the general population.

In centers where enema reduction is performed, plain radiography may have a role in assessing intussusception with vascular compromise as the role of Doppler is still unclear, and thus minimise failure rates (Guo W et al., 2011).

Ileus, represented in this study by combined small and large bowel distension, was seen more frequently in those with peritonitis than mechanical obstruction (6 versus 2 cases).

Fecal loading, observed in 4 radiographs in this study, is a non-specific sign that calls for careful consideration as it does not rule out presence of an alternative diagnosis (Freedman SB et al., 2014). However, specific cecal fecal loading is a new radiographic sign that has been shown to have comparable sensitivity with CT (97.05% versus 97%) in the diagnosis of acute appendicitis and maybe a very useful sign in the presence of silent clinical signs and symptoms (Petroianu A & Alberti, 2012). In our study, there were 5 children with ruptured appendicitis and fecal loading in the caecum was picked in none of them. We postulate that the sign may not be present in delayed cases as happens in our setting. In that study, radiographs were acquired within 12-24 hrs of onset of clinical features.

5.6 Correlation of Radiographic and Laparotomy Findings

Ground glass appearance, presence of air-fluid levels and absent rectosigmoid gas as the most common findings were interrogated to try and distinguish ileus due to peritonitis from mechanical intestinal obstruction. These are discussed in the subsequent paragraphs.

Ground glass appearance was observed more in those presenting with peritonitis (n= 13, 72%) than in those with mechanical obstruction (n= 3, 25%), odds ratio 7.8. This may reflect the presence of peritoneal effluent/ascitis which is more likely to occur with gut perforation or sequestered fluid in fluid-filled bowel loops. In mechanical obstruction this may be due to absence of bowel gas beyond the obstruction and/or surrounding mesenteric inflammation with extraluminal fluid exudate (Shalkow, 2014).

The positive and negative likelihood ratio of this radiographic finding was 1.0 and 1.1 respectively when the two groups were compared, meaning it has no diagnostic value in distinguishing between mechanical intestinal obstruction and peritonitis. However, its sensitivity and positive predictive value was quite high at 81% and 72% respectively. This could have been influenced by the higher prevalence of cases with peritonitis among the study participants (n=18, 60%).

Air-fluid levels in this study were more frequent in those with peritonitis (11 versus 4 cases), odds ratio 0.3. This means it was 3 times less likely as a feature if a child had a mechanical cause, with very low sensitivity and positive predictive value of 30% and 27% respectively when both groups were compared. The computed negative likelihood ratio of 1.2 and low positive likelihood ratio of 0.8 implies that this radiographic finding may not

be of any diagnostic value in separating a mechanical cause of obstruction from ileus due to peritoneal irritation.

Absence of rectosigmoid air with small bowel/small and large bowel distension was the commonest observed radiographic sign in those with mechanical obstruction (9 out of 12 cases, 75%) and also found in 50% of those with peritonitis (9/18 cases). From the contingency table an odds ratio of 3 was computed between the two groups meaning it was 3 times more likely to be observed in those with mechanical obstruction than in those with peritonitis. Also, the derived negative likelihood ratio of 0.5 is significant in that it implies presence of rectosigmoid gas can reliably exclude mechanical intestinal obstruction. This finding is sufficiently evaluated with a supine radiograph which is also used to evaluate bowel gas patterns without the need for other views.

The inference from all the above findings is that distinguishing the two radiologically remains onerous, with the exception of lack of rectosigmoid gas, and the value of clinical history before evaluating every abdominal radiograph cannot be overstated.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSIONS

1. The commonest causes of acute abdomen were peritonitis, followed by jejunal atresia and intussusception.
2. Mechanical causes of acute abdomen more frequent in those less than one year of age (75%) while peritonitis was the most common cause in older children (77%).
3. Supine AP views followed by combined Supine AP and Cross-table Supine were the most common radiographic views provided (40% and 27%).
4. The commonest radiographic findings in children operated for acute abdominal pain were absent rectosigmoid gas (60%), followed by small bowel distension (56%) and ground glass appearance (53%). Air-fluid levels were 4th most common (50%).
5. Absent rectosigmoid air was the most reliable finding in distinguishing between peritonitis and mechanical intestinal obstruction with a negative likelihood ratio of 0.5.

6. 2 RECOMMENDATIONS

1. There is need to standardize radiographic views in children presenting with surgical acute abdomen to maximize diagnostic yield and minimize film wastage. A Supine AP view should be made one of the basic projections in the evaluation of childhood acute abdomen at MTRH. The combination of Erect abdomen and Cross-table supine views should be abandoned.
2. There is need for collaboration between radiology and surgical departments in the reporting of plain abdominal radiographs to assist the clinicians in decision-making.

REFERENCES

Abantanga FA, Nimako B., & Amoah, M. (2009). The range of abdominal surgical emergencies in children older than 1yr at the Komfo Anokye Teaching Hospital,Kumasi,Ghana. *Annals of African Medicine, 8*(4), 236-242.

Abdur-Rahman L.O., Adeniran J.O, & Adeyujigbe, O. (2012). pediatric surgical emergencies in a north central Nigerian centre. *Annals of pediatric surgery, 8*, 25-28.

Abubakar A.M., & Ofoegbu, C. (2003). Factors affecting outcome of emergency paediatric abdominal surgery. *The Nigerian Journal of Surgical Research, 5*(3-4), 85-91.

Adam A., & Dixon, A. (Eds.). (2008). *Grainger & Allison's Diagnostic Radiology:A Textbook of Medical Imaging* (5th ed. Vol. 1). London,UK: Churchill Livingstone.

Adeyujigbe O, & Fashakin, E. (1989). Acute intestinal obstruction in Nigerian children. *Trop Gastroenterol, 10*, 33-40.

Alexandra Knight, & Howlett, D. (2010). Imaging of the acute abdomen. *Surgery, 28*(11), 568-573.

American College of Radiology-Society of Pediatric Radiology Practice guidelines [Electronic. (2014). Version],

Awolaran, OT. (2015). Radiographic signs of gastrointestinal perforation in children: A pictorial review. *Afr J Paediatr Surg, 12*, 161-166.

Babcock, DS. (2002). Sonography of the acute abdomen in the pediatric patient. *J Ultrasound Med., 21*(8), 887-899.

Brant, WE., & Helms, CA. (Eds.). (2007). *Fundamentals of Diagnostic Radiology* (3rd ed.). Philadelphia, USA: Lippincott Williams & Wilkins.

Buettcher, M., Baer G., Bonhoeffer J., Schaad UB., & Heininger, U. (2007). Three-year surveillance of intussusception in children in Switzerland. *Pediatrics, 120,* 473.

Chiu YH, Chen JD, Tiu CM, Chou YH, Yen DH, Huang CI, et al. (2009). Reappraisal of radiographic signs of pneumoperitoneum at emergency department. *Am J Emerg Med, 27*(3), 320-327.

Ciro Esposito, & Esposito, G. (Eds.). (2009). *Pediatric Surgical Diseases:A Radiologic Surgical Case Study Approach*. Verlag, Berlin, Heidelberg: Springer.

Dickson JAS, Jones A, Telfer S, & de Dombal, F. (1988). Acute abdominal pain in children. *Scand. J. Gastroenterol 23,* 43-46.

Ein , SH. (1976). Leading points in childhood intussusception. *J pediatr Surg, 11,* 209-211.

Erkan T, Cam H, Ozkan HC, Kiray E, Erginoz E, Kutlu T, et al. (2004). Clinical spectrum of acute abdominal pain in Turkish pediatric patients: a prospective study. *Pediatr Int. , 46*(3), 325-329.

Feyler S., Williamson V., & King, D. (2002). Plain abdominal radiographs in acute medical emergencies: an abused investigation? *Postgrad Med J, 78,* 94-96.

Flak B., & Rowley, V. (1993). Acute abdomen:plain film utilization and analysis. *Can Assoc Radiol J, 44*(6), 423-428.

Freedman SB, Thull-Freedman J, Manson D, Rowe MF, Rumantir M, Eltorki M, et al. (2014). Pediatric abdominal radiograph use, constipation,and significant misdiagnoses. *J Pediatr 164*(1), 83-88.

Guo W, Wang J, Zhou M, Sheng M, & Fang, L. (2011). The role of plain radiography in assessing intussusception with vascular compromise in children. *Arch Med Sci, 7*(5), 877-881.

Harlow CL, Stears RL, Zeligman BE, & Archer, P. (1993). Diagnosis of bowel obstruction on plain abdominal radiographs:significance of air-fluid levels at different heights in the same loop of bowel. *Am J Roentgenol*, *161*(2), 291-295.

Henderson AA, Anupindi SA, Servaes S, Markowitz RI, Aronson PL, McLoughlin RJ, et al. (2013). Comparison of 2-view abdominal radiographs with ultrasound in children. *Pediatr Emerg Care, 29*(2), 145-150.

Hooker RL, Hernanz-Schulman M, Chang Yu, & Herman Kan, J. (2008). Radiographic Evaluation of Intussusception: Utility of Left-Side Down Decubitus View. *Radiology, 248*(3), 987-994.

Hughes UM, Thomas KE, Shuckett B, Daneman A, & Stephens, D. (2002). The abdominal radiographic series in children with suspected bowel obstruction-should the second view be abandoned? *Pediatr Radiol, 32*(8), 556-560.

Kellow ZS, Maclnnes M, Kurzencwyq D, Rawal S, Jaffer R, Kovacina B, et al. (2008). The role of abdominal radiography in the evaluation of the nontrauma emergency patient. *Radiology, 248*(3), 887-893.

Kosloske AM, Love CL, Rohrer JE, Goldthorn JF, & Lacey, S. (2004). The diagnosis of appendicitis in children: outcomes of a strategy based on pediatric surgical evaluation. *Pediatrics*, *113*(1 pt 1), 29-34.

Langeveld H.R., & Van AS, A. B. (2012). Pediatric trauma [Electronic Version]. *Continuous Medical Education*, *31*, 5-7. Retrieved 27 may. 2013, from <http://www.cmej.org.za/index.php/cmej/article/view/2621/2681>

Lappas JC, Reyes BL, & Maglinte, D. (2001). Abdominal radiographic findings in small bowel obstruction:relevance to triage for additional diagnostic imaging. *Am J Roentgenol, 176*(1), 167-174.

Lassandro F, Giovine S, Pinto A, De Lutio Di Castelguidone E, Sacco M, Scaglione M, et al. (2001). [small bowel volvulus-combined radiological findings]. *Radiol Med, 102*(1-2), 43-47.

Lim CB., Chen V., Barsam A., Berger, J., & Harrison RA. (2006). plain abdominal radiographs:can we interpret them? *Ann R Coll Surg Engl, 88*, 23-26.

Maglinte DD, Reyes BL, Harmon BH, Kelvin FM, Turner WW Jr, Hage JE, et al. (1996). Reliability and role of plain film radiography and CT in the diagnosis of small-bowel obstruction *Am J Roentgenol, 167*(6), 1451-1455.

Mahesh Thapa, & Raymond, WS. (2005). Pediatric Gastrointestinal Emergencies [Electronic Version]. *www.appliedradiology.com*, 8-19. Retrieved 20/04/2012,

Mandeville K., Chien M., Willyard FA., Mandell G., Hostetler MA., & Bullock, B. (2012). intussusception:clinical presentations & imaging characteristics.pediatr Emerg Care. *Pediatr Emerg Care, 28*, 842.

Manson, D. (2004). Contemporary imaging of the child with abdominal pain or distress. *Paediatr Child Health, 9*(2), 93–97.

Michael, WL. (1997). Acute abdomen.When to Operate immediately and when to observe. *Seminars in Paed.Surg, 6*, 74-80.

Morrison, I. (2005). Interpreting a radiograph of the abdomen. *Surgery, 23*(5), 170-174.

MTRH Health management & Information System Records. (2014).

Musson RE, Bickle I, & Vijay, R. (2011). Gas Patterns on Plain Abdominal Radiographs: A Pictorial Review. *Postgrad Med J, 87*, 274-287.

Norman SW., & Christopher, J. (Eds.). (2012). *Bailey & Love's SHORT PRACTICE of SURGERY*. London: W.B Saunders.

Nyaga EM, & Ndungu, J. (2010). Acute non-traumatic abdominal pain in childhood at Kenyatta National Hospital,Kenya. *The Annals of African Surgery, 6*, 14-17.

Ojuka A., Ekwaro L., & Kakande, I. (2015). peritonitis outcome prediction using mannheim peritonitis index at st.Francis Hospital Nsambya,Kampala-Uganda. *COSECSA/ASEA publication-East & Central African Journal of Surgery, 20*(1), 79-89.

Osuigwe AN, & Anyanwu, S. (2002). Acute intestinal obstruction in Nnewi,Nigeria:a five-year review. *The Nigerian Journal of Surgical Research, 4*(3-4), 107-111.

Paulson E, & Thompson, W. (2015). Review of Small-Bowel Obstruction: The Diagnosis and When to Worry. *Radiology, 225*(2), 332-342.

Peitzman, A., Rhodes Michael, Schwab CW, Yealy, D., & Fabian, T. (Eds.). (2008). *Trauma Manual, The: Trauma and Acute Care Surgery*.

Petroianu A, & Alberti, LR. (2012). Accuracy of the new radiographic sign of fecal loading in the cecum for differential diagnosis of acute appendicitis in comparison with other inflammatory disease of the right abdomen: a prospective study. *J Med Life, 5*(1), 85-91.

Pujari A, Methi RN, & Nishant. (2008). Acute gastrointestinal emergencies requiring surgery in children. *African Journal of Pediatric Surgery, 5*(2), 61-64.

Raman SS, Osuagwu FC, Kadell B, Cryer H, Sagre J, & Lu, D. (2008). Effect of CT on false positive diagnosis of appendicitis and perforation. *N Engl J Med* (358), 972-973.

Reynaldo O., Edgardo P., Harry G., Adrian Yu, Ravel B., Alfonso N., et al. (2002). Is a recumbent plain abdominal x-ray (without an upright film) sufficient in the evaluation of patients with acute intestinal obstruction? (Publication. Retrieved 10/04/2015, from mcccars.tripod.com:

Robson, N., & Beasley, S. (2014). Role of plain abdominal radiography in the initial investigation of suspected intussussception. *J Pediatr Child Health, 50*(4), 251-252.

Saidi HS, & Adwok, JA. (2000). Acute Appendicits:An Overview. *East Afr Med J, 77*(3), 152-156.

Sarah L Gans, Jaap Stoker, & Boermeester, M. A. (2012). Plain abdominal radiography in acute abdominal pain; past, present, and future. *International Journal of General Medicine*(5), 525-533.

Sargent MA, Babyn P, & Alton, D. (1994). Plain abdominal radiography in suspected intussusception: a reassessment. *Pediatr Radiol*, *24*(1), 17-20.

Shalkow, J. (2014). Pediatric Small-Bowel Obstruction [Electronic Version]. Retrieved 18/04/2015, from http://emedicine.medscape.com/articles/930411

Shija JK. (1980). *Intestinal obstruction in infancy and childhood*. Paper presented at the proc. of the assoc of Surg. of E. Afr. (ASEA)

Simpson A., Sandeman D., Nixon SJ., Goulbourne IA., Grieve DC., & Macintyre, IMC. (1985). The Value of an Erect Abdominal Radiograph in the Diagnosis of Intestinal Obstruction. *Clinical Radiology*, *36*, 41-42.

Stewart B, Khanduri P, McCord C, Ohene-Yeboah M, Uranues S, Vega Rivera F, et al. (2014). Global disease burden of conditions requiring emergency surgery (Publication no. 10.1002/bjs.9329.). Retrieved 2016 July 18, from Pubmed:

Thompson WM, Kilani RK, Smith BB, Thomas J, Jaffe TA, Delong DM, et al. (2007). Accuracy of abdominal radiography in acute small-bowel obstruction:does reviewer experience matter? *Am J Roentgenol, 188*(3), 233-238.

Tseng YC, Lee MS, Chang YJ, & Wu, H. (2008). Acute abdomen in pediatric patients admitted to the pediatric emergency department. *Pediatr Neonatol, 49*(4), 126-134.

Venter JA, le Grange SM, Otto SF, & Joubert, G. (2013). An audit of pediatric intussusception radiological reduction at the Bloemfontein Academic Hospital Complex,Free State,South Africa. *S Afr J CH, 7*(2), 60-64.

Wang L, Haberland C, Thurm C, Bhattacharya J, & Park, K. T. (2015). Health Outcomes in US Children with Abdominal pain at major Emergency Departments Associated with race and Socioeconomic Status. *PLoS One, 10*(8), 1-17.

Wella HL., & Carneiro, P. (2011). Children with Acute Abdomen Requiring Surgery at Muhimbili National Hospital Dar es Salaam. *Tanzania Medical Journal, 25*(2), 16-20.

Wen-Chieh Yang, Chun-Yu Chen, & Wu, H-P. (2013). Etiology of non-traumatic acute abdomen in pediatric emergency departments. *World J Clin Cases, 1*(9), 276-284.

APPENDICES

APPENDIX I: DATA COLLECTION FORM

DEMOGRAPHICS

Date: ……. Medical Record Number: ……

Age: …… **Sex:** Male ☐ Female ☐

HISTORY

1. Duration of symptoms < than 3 days ☐ > 3 days ☐
2. Fever ☐
3. Abdominal distension ☐
4. Failure to pass stool/ meconium ☐
5. Abdominal pain ☐
6. Vomiting ☐
7. Other (Specify)

:……

……

EXAMINATION

Abdominal examination findings:……

……..

……..

Abdominal radiograph: available Yes ☐ No ☐

Radiographic View:

1. Supine AP ☐
2. Supine + Cross-table ☐
3. Supine alone ☐
4. Erect alone ☐
5. Erect + Cross-table ☐
6. Other (specify) ☐

Imaging findings:

1. Small bowel distension ☐
2. Small + Large bowel distension ☐
3. Absent rectosigmoid gas ☐
4. Air-fluid levels ☐
5. Ground glass appearance ☐
6. Free intra-abdominal air ☐
7. Fecal loading ☐

8. Gastric distension ☐
9. Quadrant gas-collection ☐
10. Foreign body ☐
11. Soft tissue mass ☐
12. Other (specify) ☐

Laparotomy ☐ **Conservative management** ☐

Laparotomy **Positive** ☐ **Negative** ☐

APPENDIX II: IREC APPROVAL LETTER

INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

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

MOI UNIVERSITY
SCHOOL OF MEDICINE
P.O. BOX 4606
ELDORET

Reference: IREC/2013/111
Approval Number: 0001079

3rd October, 2013

Dr. Kiprotich Samuel Ng'eno,
Moi University,
School of Medicine,
P.O. Box 4606-30100,
ELDORET-KENYA.

Dear Dr. Ng'eno,

RE: FORMAL APPROVAL

The Institutional Research and Ethics Committee have reviewed your research proposal titled:-

"The Diagnostic Utility of Plain Abdominal Radiography in Guiding Operative Intervention among Children Presenting with Acute Abdomen at Moi Teaching and Referral Hospital".

Your proposal has been granted a Formal Approval Number: ***FAN: IREC 1079*** on 3rd October, 2013. You are therefore permitted to begin your investigations.

Note that this approval is for 1 year; it will thus expire on 2nd October, 2014. If it is necessary to continue with this research beyond the expiry date, a request for continuation should be made in writing to IREC Secretariat two months prior to the expiry date.

You are required to submit progress report(s) regularly as dictated by your proposal. Furthermore, you must notify the Committee of any proposal change (s) or amendment (s), serious or unexpected outcomes related to the conduct of the study, or study termination for any reason. The Committee expects to receive a final report at the end of the study.

Sincerely,

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
APPROVED
03 OCT 2013
P.O. Box 4606 ELDORET

PROF. E. WERE
CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc Director - MTRH Dean - SOM Dean - SON
Principal - CHS Dean - SPH Dean - SOD

APPENDIX III: IREC AMENDMENT LETTER

INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

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

MOIUNIVERSITY
SCHOOL OF MEDICINE
P.O. BOX 4606
ELDORET
Tel: 33471/2/3

Reference

IREC/2013/111
15th July, 2015

Approval Number: 0001079

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
15 JUL 2015
APPROVED
P. O. Box 4606-30100 ELDORET

Dr. Kiprotich Samuel Ng'eno,
Moi University,
School of Medicine,
P.O. Box 4606-30100,
ELDORET-KENYA.

Dear Dr. Ng'eno,

RE: APPROVAL OF AMENDMENT

The Institutional Research and Ethics Committee has reviewed the amendment made to your proposal titled:-

"Radiographic Findings among Children Age 0-14 Years Operated for Acute Abdominal Pain at Moi Teaching and Referral Hospital".

We note that you are seeking to make an amendment as follows:-

1. To change the title as above from: ***"The Diagnostic Utility of Plain Abdominal Radiography in Guiding Operative among Children Presenting with Acute Abdomen at Moi Teaching and Referral Hospital".***

The amendment has been approved on 15th July, 2015 according to SOP's of IREC. You are therefore permitted to continue with your research.

You are required to submit progress(s) regularly as dictated by your proposal. Furthermore, you must notify the Committee of any proposal change(s) or amendment(s), serious or unexpected outcomes related to the conduct of the study, or study termination for any reason. The Committee expects to receive a final report at the end of the study.

Sincerely,

PROF. E. WERE
CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc: Director - MTRH Dean - SPH Dean - SOM
Principal - CHS Dean - SOD Dean - SON

APPENDIX IV: MTRH APPROVAL LETTER

MOI TEACHING AND REFERRAL HOSPITAL

Telephone: 2033471/2/3/4
Fax: 61749
Email: director@mtrh.or.ke
Ref: ELD/MTRH/R.6/VOL.II/2008

P. O. Box 3
ELDORET

3rd October, 2013

Dr. Kiprotich Samuel Ng'eno,
Moi University,
School of Medicine,
P.O. Box 4606-30100,
ELDORET-KENYA.

RE: APPROVAL TO CONDUCT RESEARCH AT MTRH

Upon obtaining approval from the Institutional Research and Ethics Committee (IREC) to conduct your research proposal titled:-

"The Diagnostic Utility of Plain Abdominal Radiography in Guiding Operative Intervention among Children Presenting with Acute Abdomen at Moi Teaching and Referral Hospital".

You are hereby permitted to commence your investigation at Moi Teaching and Referral Hospital.

DR. J. KIBOSIA
DIRECTOR
MOI TEACHING AND REFERRAL HOSPITAL

CC - Deputy Director (CS)
- Chief Nurse
- HOD, HRISM