PATTERN OF ORGAN DISRUPTION, MANAGEMENT AND OUTCOMES IN ADULT PATIENTS WITH BLUNT ABDOMINAL TRAUMA IN KENYATTA NATIONAL HOSPITAL.

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A DISSERTATION PRESENTED IN PART- FULFILMENT OF THE AWARD OF MASTER OF MEDICINE IN GENERAL SURGERY.

STUDENT DECLARATION

I Dr. Benson Cosmas Muthama Mutisya do declare that this dissertation is my original work an has not been presented for a degree in any other institution to the best of my knowledge.

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DEPARTMENTAL APPROVAL

The research proposal for this dissertation was presented at a general surgery departmental meeting of the University of Nairobi on 6th May 2021 and was submitted to the Kenyatta National Hospital -University of Nairobi Ethics and Research Committee (KNH-UON ERC) for approval. The proposal for this dissertation project was approved by the KNH-UON ERC on 4th October 2021. It is hereby submitted for examination with my approval.

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ABBREVIATIONS

AAST- American Association of Surgery for Trauma

AIS- Abbreviated Injury Score

ATLS- Advanced Trauma Life Support

BAT- Blunt Abdominal Trauma

CT- Computer Tomography

DPL- Diagnostic Peritoneal Lavage

eFAST- extended Focused Abdominal Sonography for Trauma

KNH- Kenyatta National Hospital

MDCT- Multi Detector Computer Tomography

NISS- New Injury Severity Score

OIS- organ Injury Severity

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ABSTRACT

Background: Blunt abdominal trauma (BAT) is a common condition encountered in daily clinical practice worldwide. Many factors interact to determine the outcome of patients. Institutions even in the same country report different mortality rates and complication rates. Operative and non-operative management options are employed depending on the clinical scenario. Information on Injury patterns, management and outcomes of BAT patients in Kenyatta National Hospital (KNH) is unavailable.

Objective: To determine the patterns of organ disruption, management, and outcomes of adult BAT patients in KNH.

Methodology: This was a longitudinal observational study. It was conducted at the general surgery, orthopaedic and neurotrauma surgical wards of Kenyatta National Hospital (KNH). A total of 176 adult patients were consecutively recruited into the study. Organ injury was graded using the American Association of surgery in Trauma (AAST) grading system as found on abdominal Computer Tomography (CT) images or laparotomy findings. The New Injury Severity Score (NISS) was calculated from the Abbreviated Injury Score (AIS) to determine severity of patient injury. Patients were followed up from admission to discharge, death or thirty days. Demographic characteristics, Length of stay (LOS), blood transfusion, admission into the critical care unit (CCU) and extra- abdominal injuries were recorded.

Data analysis: SPSS version 26.0 was used for data analysis. Means, mode, median and frequencies were used for descriptive statistics. Chi square test was used for categorical testing

between occurrence of outcomes and demographic and clinical characteristics. Logistic regression was used for multivariate analysis to assess the risk factors for mortality. A p value of 0.05 or less was considered statistically significant.

Results: Out of the 176 patients recruited, 164(93.3%) were male with a male to female ratio of 13.7:1. Mean age was 30.3 years with a range of 18- 62 and median of 28. A total of 127(73.3%) aged between 20-40 years. Road traffic accidents (RTA) were the leading cause of BAT in 133(76.7%) of the participants. The mean duration from injury to KNH was 13.72 hours with a range of 1-312 hours. The liver was the most common injured organ in 95(54%) participants. Extra abdominal injuries were present in 87(49%) with long bones injuries the commonest in 38(21.6%). The mean NISS was 14, range of 1-36 and a median of 13. A total of 108(61.9%) had successful non-operative management (NOM), while 53(30.1%) had laparotomy immediately after admission. The remaining 14(7.9%) had failed NOM. The mean LOS was10.9 days with a range of 1-30 days. There were 26(14.8%) mortalities and 13(8.7%) complication rate among the survivors. The commonest complication was surgical site infections (SSI) in 8(5.3%) cases. High score on NISS (Odds ratio (OR): 2.53, P=<0.039), preoperative hemodynamic instability (OR:6.55, P=<0.001) and blood transfusion (OR:0.11, P=<0.001) significantly predicted mortality.

Conclusion: the leading cause of BAT was RTA and the liver was the most common injured organ. It was associated with other body region injuries in half of the participants. Severe injury in NISS, preoperative hemodynamic instability, ICU admission and blood transfusion significantly predicted mortality.

CHAPTER 1

1.0 BACKGROUND INFORMATION

Trauma is a leading cause of morbidity and mortality globally. It accounts for a third of all patients seen in the emergency departments. The abdomen is the third most injured body region and is frequently encountered in clinical practice. Blunt abdominal trauma(BAT) is more common than penetrating injuries to the abdomen in civilian practice worldwide(1). The trend of injuries in urban settings is different with penetrating abdominal injuries being more prevalent than BAT. This is collaborated by studies done in India, Tanzania and Kenya(2–4).

Isolated injuries are more likely to occur in penetrating abdominal injuries while in BAT there are high chances of injuries to other parts of the body. Head , chest and limb injuries of varying degrees are commonly associated with BAT(5,6). The associated extra abdominal injuries can distract the attention of the evaluating clinician masking the abdominal injuries. They can also be missed during patient evaluation and contribute to adverse outcomes in BAT(7). The NISS which takes into consideration the three most injured body organs grades overall patient injury and significantly influences outcome(2). Other factors interact to determine the outcome of BAT patient management. They include but are not limited to; premorbid condition of the patient, extent of anatomical organ disruption and the interval between trauma and intervention.(8,9)

The frequency of intraabdominal organ injuries differs from study to study. Some report the liver as the mostly injured organ while the spleen is reported in others. Sandesh K. et al in 2017 found the jejunum to be the most injured organ in BAT patients in India(10).Different institutions report different outcomes of patients managed for BAT. Reasons for failed non operative management

also differ from institution to institution. This study focused on determining the anatomical organ disruption as found on CT scans or patients managed nonoperatively or laparotomy findings and outcomes.

This study provided information on organ injury frequency, grade, and management outcomes among BAT patients in KNH practice.

CHAPTER 2

2.0: LITERATURE REVIEW

2.1: EPIDEMIOLOGY

Murray C.I et. al estimated that from the year 2020, about 8,100,000 people will die every year from trauma. A third of these patients would have abdominal injuries. With increase in motorization globally, there is a steady increase in motor vehicle collision abdominal injuries. vehicular road traffic accidents remain the leading cause of BAT(11). These collisions could be between motor vehicle to: motor vehicle, motor cycle, cyclists, pedestrians or even trains. In Finland, road traffic accidents account for 84%of BAT while in Brazil it accounts for 83%(8,9). In India, Kane V et. al found documented railway accidents as the second most common cause of BAT in 2019(1). Attack by wild animals was also noted to be a cause of BAT in India.(3)

Falls from heights, assault ,sporting accidents, industrial accidents are other recognized significant causes.(4,8,12)

Factors which contribute to increase in prevalence of BAT include ethnic clashes, increase in violent crime, infrastructural advancements and urbanization.(13)

People of all ages and genders are affected by BAT. However, there is a male predominance of BAT injuries worldwide. Male to female ratio range from 4.1:1 in India(3) to 12:1 in Kenya(5). In Nigeria the ratio is 7.6:1(4), while in Pakistan it is 4.5:1(14) People between the second and fourth decades of life are mostly affected. Mean age in Kenya of the patients is 28.2years(5), while in Tanzania the median age of abdominal injury patients is 31.5 years(2).

2.2: MECHANISM OF ORGAN INJURY AND PATHOPHYSIOLOGY

Three main mechanisms explain intraabdominal organ injuries in BAT. In deceleration, differential movement of adjacent organs create a shear force. this leads to tearing of organs especially at the fixed points. Both hollow and solid organs are affected. The second mechanism includes compression of an organ between two surfaces. The compression force is likely to distort the architecture of the organ. An example is crushing the liver between the anterior abdominal wall and the vertebral column. A direct blow to the abdomen results to a sudden increase in intraabdominal pressure and can result into hollow and solid organ rupture(15).

Solid organ disruptions cause lacerations, subcapsular and intraparenchymal hematomas. Lacerations lead to varying degrees of intraperitoneal haemorrhage depending on size and vascular injury. Organ avulsion can lead to a concealed rapidly exsanguinating haemorrhage and death(16,17).

Hollow viscus injuries range from wall hematomas, to wall contusions and laceration. Lacerations or rupture with consequent spillage of intraluminal contents cause peritonitis.(15,18)

2.3: FREQUENCY AND GRADING OF ORGAN INJURY

The spleen and the liver are the most injured organs in BAT. Retroperitoneal organs such as the kidneys and pancreas are rarely traumatized. Nikhil Mettah et al and Kane et al found the spleen to be injured in 53% of the patients in their studied while the liver was involved in 35% and 25% respectively(1,3). Other studies have found the liver to be the most common injured organ in BAT(12,13). The jejunum was the most injured organ in a study by Sandesh K. et al in India(10).

Madhumita M. evaluated the intestinal injuries in BAT. Injuries were mostly found close to the duodenojejunal junction as well as at the terminal ileum. Few patients had a scattered pattern of intestinal injuries and only one duodenal injury was documented. The colon was involved in 4% of the case. Mesenteric tears and mesenteric vein thrombosis was also found during laparotomy(18).

The severity of organ injury is determined using the American Association of Surgery for Trauma (AAST) Organ Injury Severity (OIS) grading system(19). The system takes into consideration the percentage surface area covered by a subcapsular hematoma, the presence of intraparenchymal bleed, size of organ laceration and devascularization. The grades vary from grade 1(mild) to grade v (severe) for most of the intraabdominal organs. Splenic and hepatic avulsions are grade VI injuries. A grade is advanced for grade 1 to grade 111 injuries where an organ sustains multiple injuries. Figure 1 below shows the liver AAST OIS grading system as an example of solid organ injury grading.

Table 1: AAST liver injury grading

Grade	Injury	Injury description
1	Laceration Hematoma	Capsular tear less than 1cm parenchymal depth Subcapsular less than 10% surface
11	Laceration Hematoma	1-3 cm parenchymal depth, less than 10cm long Subcapsular 10-50% surface area, intraparenchymal less than 10cm diameter.
111	Laceration Hematoma	More than 3 cm depth Subcapsular more than 50%surface area or expanding, ruptured subcapsular or parenchymal hematoma. Intraparenchymal hematoma more than 10cm.
1V	Laceration	Parenchymal disruption of 25-75%of hepatic lobe
V	vascular	Juxta-venous hepatic injuries, retro hepatic vena cava, central major hepatic veins
V1	Vascular	Hepatic avulsion
Advance one grade for multiple injuries up-to grade 111 AAST liver injury scale (1994 revision)		

Intestinal injuries are graded depending on the presence of wall hematomas, presence of a perforation and the percentage circumference of the wall involved by a laceration. Figure 11 below shows duodenal injury grading as an example of hollow viscus grading as per the AAST OIS.

Table 2: AAST Duodenal injury grading.

Grade	Injury	Description
1	Hematoma Laceration	Involves a single portion of duodenum Partial thickness, no perforation
11	Hematoma Laceration	Involving more than one portion of the duodenum Disruption of less than 50% of circumference
111	Laceration	Disruption of 50-75% circumference of second part of duodenum. Disruption 50-100% of circumference of first, third and fourth parts of duodenum
1V	Laceration	Disruption of more than 75% of second part of duodenum Involving ampulla or distal common bile duct
V	Laceration Vascular	Massive disruption of duodenopancreatic complex Devascularization of the duodenum
Advance one grade for multiple injuries up to grade 111 AAST duodenal injury grading (1994 revision)		

One of the shortcomings of the AAST OIS grading system is that it does not include active bleeding and in some cases does not guide management(16).

2.4 DIAGNOSTIC EVALUATION

The initial evaluation in trauma patients is aimed at identifying and treating conditions that pose immediate danger to life. The Advanced Trauma Life Support (ATLS) protocols should be applied. The primary survey ensures a patent airway, stable cervical spine and effective breathing. Exsanguinating hemorrhage is arrested. Disability and exposure are also assessed. The secondary survey involves history taking and whole body examination.(20)

Examination findings which suggest intraabdominal organ injury include hypovolemic shock, seat belt sign, abdominal distension, tenderness, guarding, rebound tenderness and rigidity of the abdominal wall. Presence of pelvic or femur fractures should increase suspicion for intraabdominal injuries.(15)

Many imaging modalities are used in the evaluation of blunt abdominal trauma. Extended Focused assessment with ultrasonography for Trauma (eFAST) evaluates the pleural, pericardial, and peritoneal spaces for fluid collection in trauma. It can also identify solid organ injuries.(21)This should be done for all hemodynamically unstable patients. An abdominal ultrasound has a sensitivity of 31.1% if done once. When repeated, the sensitivity increases to 72.1%. The specificity is 99.8%(22). A normal scan cannot rule out intraabdominal injuries. It is limited in capacity to evaluate source of intraabdominal fluid collection.

A multi detector Computer Tomography scan is the mainstay modality in identification and grading of intraabdominal organ disruption.(23) It has the advantage of identifying ongoing haemorrhage, defining the organ it can detect presence of , amount and source of hemoperitoneum. The vertebrae and retroperitoneal space are equally visualized. The sensitivity and specificity is 97-98 and 98-99% respectively(24).

The downfalls of MDCT include exposure to radiation, allergic reaction to intravenous contrast and is costly. Hollow viscus wall contusions, hematomas and perforations can be missed(25).

Diagnostic peritoneal lavage (DPL) can be used where imaging is not available. It has been greatly replaced by eFAST. Diagnosis of intraperitoneal haemorrhage, hollow viscus perforations can be detected by DPL(26). It is considered positive if:

- More than 10mls of gross blood is aspirated,

- More than 100,000 red blood cells are observed per high power field on microscopy of the aspirate,
- Presence of faecal matter in the aspirate,
- Bile in the aspirate and
- Leucocyte count of more than 5000 cells per milliliter of the aspirate.

Powel et al documented false positive and false negative rates of 1.4% and 1.3% respectively(27).

Diagnostic laparoscopy is slowly gaining space in evaluation of patients with BAT in hemodynamically stable patients (28). Khubutiya et al reported sensitivity of 98% and specificity of 100%(29). In a study by Cho and Lim, diagnostic laparoscopy allowed performance of definitive treatment procedures in 83% of the patients with BAT requiring operative treatment(30). challenges included assessment of retroperitoneal injuries and assessment of intraparenchymal organ injuries.

Laboratory investigations are useful in diagnosis and management of intraabdominal injuries. The parameters can be used as baseline for future comparisons in patients on nonoperative management. they include haematocrit, serum leucocyte count, pancreatic enzymes ,urine analysis, base deficit and lactate levels(31–33).

2.5 MANAGEMENT

Adam J et al categorized BAT patients into three categories: those requiring immediate laparotomy upon clinical evaluation, those with signs of intraabdominal injury but clinically stable enough for for further imaging and laboratory investigations to characterize the injuries and those with suspected abdominal injuries and have negative signs on examination. This last category may only need observation and re-examination(15).

Another classification groups patients into hemodynamically stable and unstable patients.

In BAT, hemodynamically unstable patients with a positive FAST should be taken to the operating room for laparotomy without further imaging. Other indications of laparotomy include: signs of peritoneal irritation, evidence of hollow viscus perforation, diaphragmatic rupture, persistent bleeding as indicated by blood in vomitus or nasogastric drainage and a positive DPL(6).

Angioembolization is an interventional method of stopping ongoing bleeding from solid organ injuries. It can be an alternative to laparotomy when the skills and infrastructural requirements are available(16).

Selected patients with solid organ injuries without indications for laparotomy can be managed nonoperatively. In these patients' serial clinical examinations, imaging and laboratory investigations are carried out to ensure indications for laparotomy are detected when they arise. Success rate of non-operative management vary from study to study and range from 78% to 90%. Conversion to operative treatment is attributed to delayed solid viscus rupture, delayed or missed perforation on hollow viscus organs.(5,12,32,33)

2.6 OUTCOMES

According to Rajkumar P. et al, trauma meets the criteria to be described as a pandemic with more than 16000 people dying every day from it. Further he noted that prudent patient evaluation and timely intervention was crucial in optimizing outcomes of patients with BAT(34). Worldwide, abdominal injuries account for 7-10% of all trauma related deaths(35).Patient factors which affect the outcomes in BAT include :injury to intervention time, severity of the organ injury and other associated injuries. Overall mortality in BAT range from 6.1% in the United Kingdom(15) to 13.2% in Tanzania(2). The deaths occur mostly in the postoperative period. The leading cause of

mortality in the first 48 hours post injury is haemorrhage after which infections top as a cause of mortality(2,15)

Other complications associated with BAT include surgical site infections, anastomotic leaks, intraabdominal abscesses, burst abdomen, chest infections and acute respiratory distress syndrome. Biliary leaks and fistula can occur in hepatobiliary injuries. The overall prevalence of these complications range from 28% in India to 41.9% in Tanzania.(2,3,6,34)

2.7 PREDICTORS OF OUTCOME

The outcome of management in BAT patients depends on many factors. Injury to intervention time, multiple intraabdominal injuries, associated extra abdominal injuries were found to be significant in predicting mortality in a study done in Lagos University Teaching Hospital, Nigeria(4). Near similar associations were reported by Silvania K. et al in a study done in Brazil(8). The New injury severity score (NISS) which considers the three most injured organs has been demonstrated to be useful in predicting outcomes in trauma patients. The NISS is calculated by adding the squared Abbreviated Injury scores (AIS) of the three most injured organs. It ranges from 0 to 75. A score of 6 on one organ makes the total score 75 automatically. A score of <16 is considered mild while a score between16 to 25 is considered moderate. Severe injuries have a score of 25 or more (2). The need for admission into critical care unit, blood and blood products transfusion are also associated with adverse outcomes in abdominal injury patients(5).

2.8 STUDY JUSTIFICATION

BAT is a commonly encountered condition in Kenyatta National Hospital practice. Many factors interact to determine the outcomes of treatment which can be operative or non-operative.

Outcomes of management differ from institution to institution even in the same country despite existing management guidelines for the condition.

This study provides local data on the organ injury frequencies, injury grade, management and outcomes. Reasons for failed operative management were also be documented. The knowledge gap in the predictors of outcome in BAT patients was bridged. The study findings will be a basis of improving management outcomes among BAT patients in KNH.

2.90 STUDY QUESTION

What are the patterns of organ disruption and management outcomes of adult patients presenting with blunt abdominal trauma in KNH?

2.91 BROAD OBJECTIVE

To determine the pattern of organ disruption, management and outcomes in patients presenting with blunt abdominal injury in KNH.

Specific objectives

1. To determine the pattern of organ disruption in patients presenting with BAT in KNH.
2. To determine the management of patients presenting with BAT in KNH.
3. To determine the outcomes of patients managed for BAT in KNH

SECONDARY OBJECTIVE

4. To determine the predictors of outcome among BAT patients in KNH.

CHAPTER 3

3.0: METHODOLOGY

3.1.1 STUDY DESIGN:

This was a prospective observational study.

3.1.2 STUDY SITE:

This study was carried out at the Kenyatta National Hospital surgical wards, surgical critical care unit and Accident and Emergency departments. The surgical wards included the general surgery wards (wards 5A, 5B and 5D), the urology ward (ward 5B), neurotrauma wards (wards 5A and 5D) and orthopaedic wards (wards 6A, 6B, 6C and 6D). Patients admitted in ward 4B (cardiothoracic) with blunt abdominal trauma were also recruited in the study.

3.1.3 STUDY POPULATION:

This study included all adult patients with BAT admitted at KNH.

3.1.4 INCLUSION CRITERIA:

All adult patients with blunt abdominal trauma admitted at Kenyatta National Hospital

All patients with BAT admitted in KNH willing to provide written informed consent.

3.1.5 EXCLUSION CRITERIA:

BAT patients with laparotomy performed in other facilities prior to admission at KNH.

3.2 SAMPLE SIZE DETERMINATION:

Sample size was calculated using the Cochrane formula: $n = (Z2 \times P \times (1 - P))/e2$

Where:

- Z = value from standard normal distribution corresponding to desired confidence level (Z=1.96 for 95% CI)

- P is expected true proportion

- e is desired precision (half desired CI width).

Estimated proportion 0.132 (mortality rate of 13.2% among BAT patients reported by Ntundu et al in Tanzania)(2)

Desired precision of estimate 0.05, Confidence level = 0.95

$$N=\frac{1.96\times1.96\times0.132\times0.868}{0.005\times0.005}=176$$

Therefore 176 participants were recruited to the study.

3.3 SAMPLING PROCEDURE:

Consecutive sampling was done for all the patients meeting the study population characteristics who consented into the study.

3.4 RECRUITMENT OF STUDY PARTICIPANTS:

Participants in this study were recruited from the Accident and Emergency department and adult surgical wards of Kenyatta National Hospital. Only patients whose intra-abdominal injuries met the threshold for admission into the hospital participated in the study. All consenting adults were recruited within 24 hours of admission. They were recruited either at the accident and Emergency

department or the surgical ward where they were admitted. The Accident and Emergency admission records were used to identify all patients admitted with BAT and traced to the wards.

3.5. DATA COLLECTION:

Data was collected using a standard data collection questionnaire. Patients' demographics such as age, sex, occupation, highest attained formal education, and residential setting (rural or urban) were documented. The causes of injury which include road traffic accidents, falls, assaults, sport associated injuries, animal attacks and others were captured in the data collection tool. Participants involved in road traffic accidents were further be grouped into pedestrians, cyclists, motorcycle riders, motorcycle passengers, vehicle passengers and drivers. This information was recorded during the first contact.

Intraabdominal organ injuries and grades were documented from Computer Tomography imaging reports for participants without immediate indication for laparotomy. Patients in the study who underwent immediate laparotomy had intraabdominal organ injury and grading documented as per laparotomy findings. The duration from the time of injury to presentation to KNH was documented in hours. Extraabdominal injuries were documented. Head, spine, chest, limb fractures and soft tissue injuries were captured in the data collection tool.

The injury grading was as per the AAST organ injury grading system. Patient injury severity was determined by calculating the NISS from the AIS.

Participants were observed until discharge from the hospital or demise or thirty days whichever came earlier. During the observation period, participants were observed for need for blood transfusion and admission into the critical care unit. In case of change of management plan from non-operative to laparotomy, the indication of such change and laparotomy findings were

documented too. Late development of hemodynamic instability, peritonitis, hollow viscus perforation or intraabdominal infection were noted in the data collection tool. Data was recorded progressively every twenty-four hours.

At discharge, death or 30 days of admission, the length of stay in the hospital was documented in days.

Participant management outcome was defined as mortality or survival. Complications associated with the injuries or management such as stoma creation, open abdomen management with a consequent ventral hernia were recorded.

3.6. DATA ANALYSIS:

Once data was collected, it was entered into an Excel Spreadsheet and data cleaning was done. SPSS Version 26.0 was used for data analysis. Descriptive statistics such as means, mode, median and frequencies were used to describe demographic and clinical characteristics of the study participants.

Chi Square was used for categorical testing to assess associations between occurrence of mortality and other outcomes and demographic and clinical characteristics. Logistic regression was used for multivariate analysis to assess risk factors for mortality. Results of regression analysis were reported on Odds ratios and corresponding 95% confidence intervals. P values of 0.05 was considered statistically significant.

Results were reported using proportions, frequency tables, bar charts, pie charts and scatter plots.

3.7. ETHICAL CONSIDERATIONS:

Permission and approval to conduct this study was sought from Kenyatta National Hospital-University of Nairobi Research and Ethics Committee. Authorization for data collection was sought from KNH administration. The researcher did not use incentives or coercion to recruit participants. Participation into this study was purely voluntary by the consenting participants. All participants voluntarily gave informed consent and signed the consent form before participating in the study. Consent for patients unable to consent due to the nature of their injuries was sought from their guardians.

3.8: MEASURES TO PREVENT COVID -19 DISEASE TRANSMISSION DURING THE STUDY:

The researcher and research assistants will put on appropriate personal protective equipment while interacting with the patients or their guardians. They (researcher and research assistants) will insist on the patients or guardians wearing masks during interactions with them. where person to person interaction can be avoided, e.g., review of CT scan images, file reviews, then physical contact will be avoided. Hand hygiene will be observed throughout the study period by all persons participating in the study.

3.9 CONFIDENTIALITY: The participants identification particulars such as the name and hospital inpatient number were included in the data collection tool. Data collection tools was kept in a cabin under lock and key while data will be stored in a password protected excel sheet. Confidentiality of patient information was observed at all stages of this study.

3.10: QUALITY ASSURANCE: Training of the research assistants was done to standardize data collection. Strict adherence to the data collection tool was ensured during the data collection period.

3.11: DATA DISSEMINATION: Findings from this study will be published in medical journals and presented in surgical conferences. The results will also be shared with the general surgery unit of KNH.

3.12. LIMITATIONS OF THE STUDY: This study relied on CT scan report to grade organ injury for patients managed non operatively. Since KNH is a referral facility, some patients were admitted with CT scan images and reports from other facilities hence it was difficult to standardize the reporting. Further some patients underwent surgeries for extra abdominal surgeries which were not accounted for in this study and could have influenced outcome of the participants.

CHAPTER 4

RESULTS:

This study investigated the 176 adult patients who presented with blunt abdominal injuries at KNH between October 2021 and March 2022.

Demographics

Age: Majority of the participants were in the third decade of life. Mean age of the study participants 30.3 years, SD 9.37, Median 28, Range 18 – 62 (Figure 1)

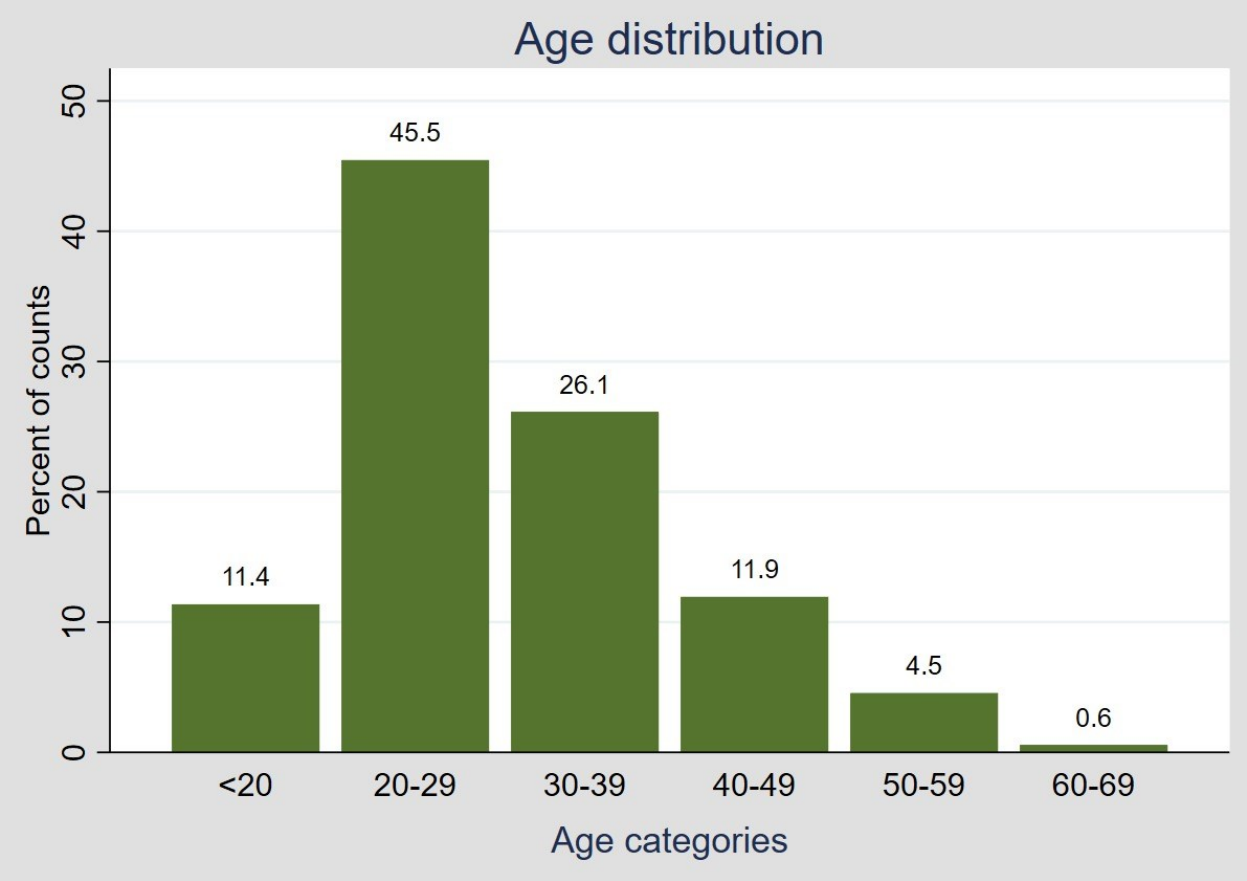

Figure 1: Bar graph showing age ranges of the participants.

Gender: Out of the 176 participants, 164 were male while 12 were females with male to female ratio of 13.6:1.

Setting: The injuries occurred in an urban setting in 140(80.7%) of the participants and in 36(19.3%) in rural areas.

Education: Majority of the participants, 86(48.9%) had attained primary school education level of formal education while 64(36.4%) and 26(14.8%) had secondary and tertiary education respectively.

Cause of Injury

The leading cause of BAT among the participants was road traffic accidents.as summarized in figure 2 below.

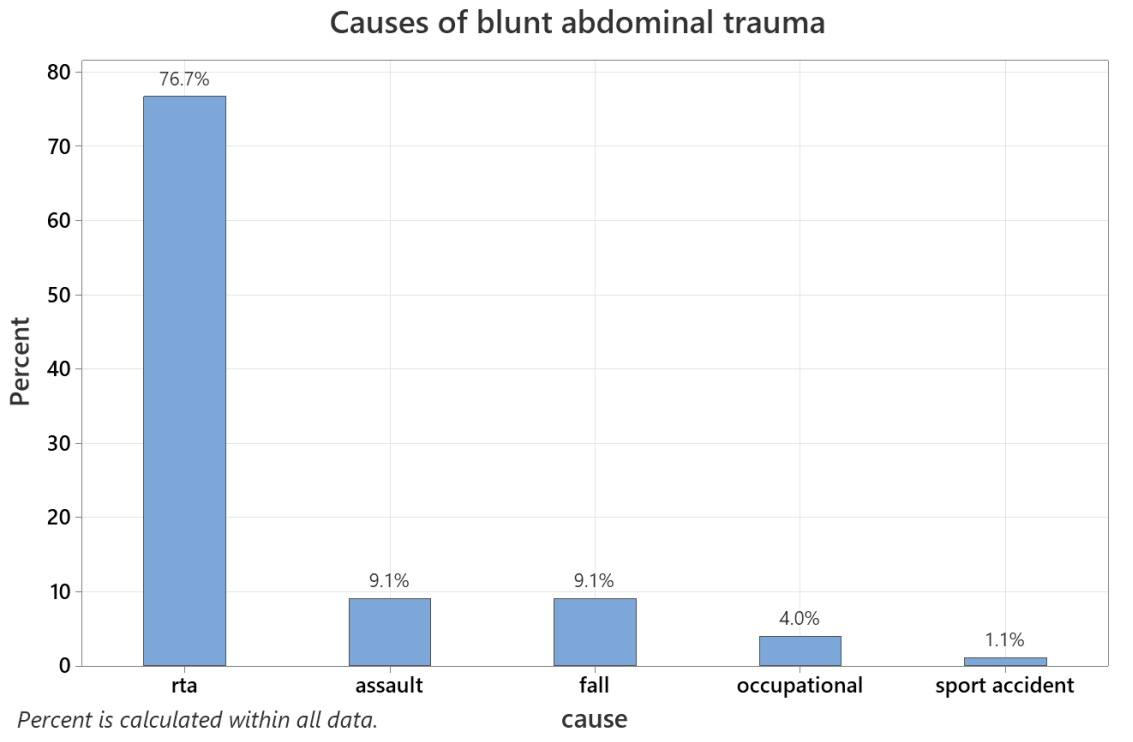

Figure 2: Bar graph showing the cause BAT among the participants.

Of the 135 patients who were involved in road traffic accidents, majority of them were passengers as shown (Table 3)

Table 3: Showing the distribution of the RTA victims.

Involvement in RTA	**Frequency**	**Percent (%)**
Passenger	67	49.6
Motorcycle rider	32	23.7
Pedestrian	22	16.3
Driver	8	5.9
Cyclist	6	4.4
Total	**135**	**100**

Time between the injury and presentation to KNH:

Most of the participants arrived at the hospital within 6 hours of the injury. The mean duration was 13.72 hours with a range of 1-312 hours (Figure 3)

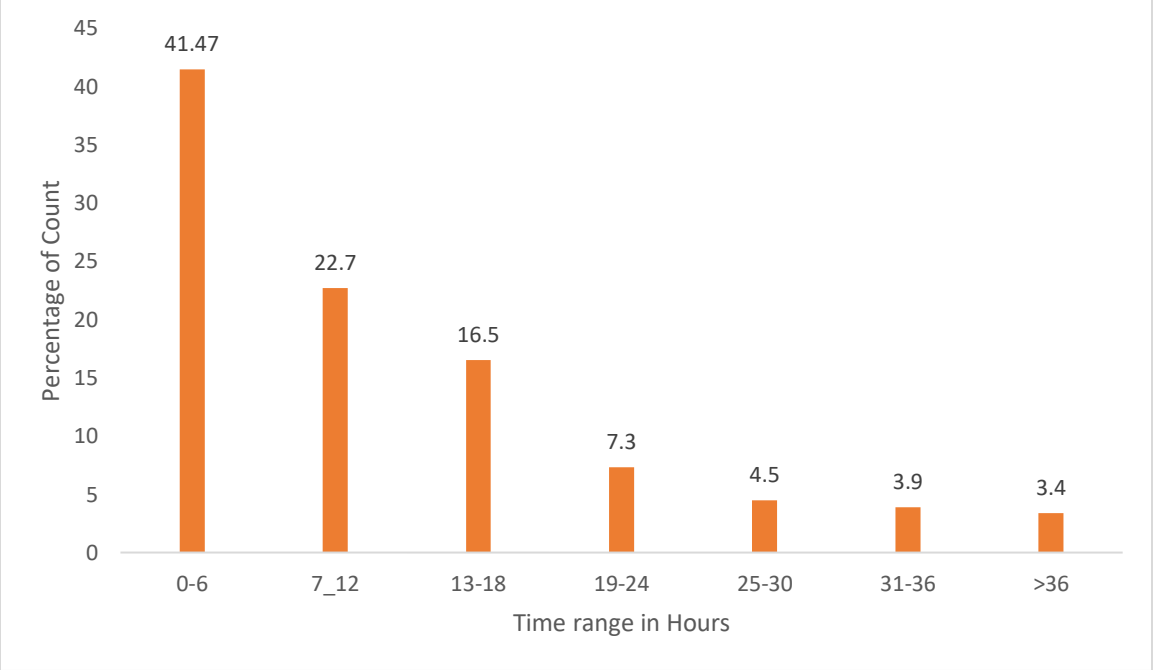

Figure 3: Bar graph showing the time ranges between injury and presentation to KNH in hours.

Intraabdominal organ injuries:

Diagnosis:

Intraabdominal organ injuries were determined by a contrast enhanced CT scan of the abdomen where there was no immediate indication for laparotomy. In cases where a laparotomy was done, the grading of the intraabdominal injuries was recorded ad found intraoperatively. In the event of

both a CECT scans and laparotomy being performed, the surgical findings were chosen over the imaging. CECT scans were performed in 153 participants (86.9%) while none was done in 23(13.1%). The remaining 53 (30.1%) patients had immediate indications for laparotomy either on clinical examination or imaging. Of the 53, 30 patients had CECT imaging of the abdomen on arrival.

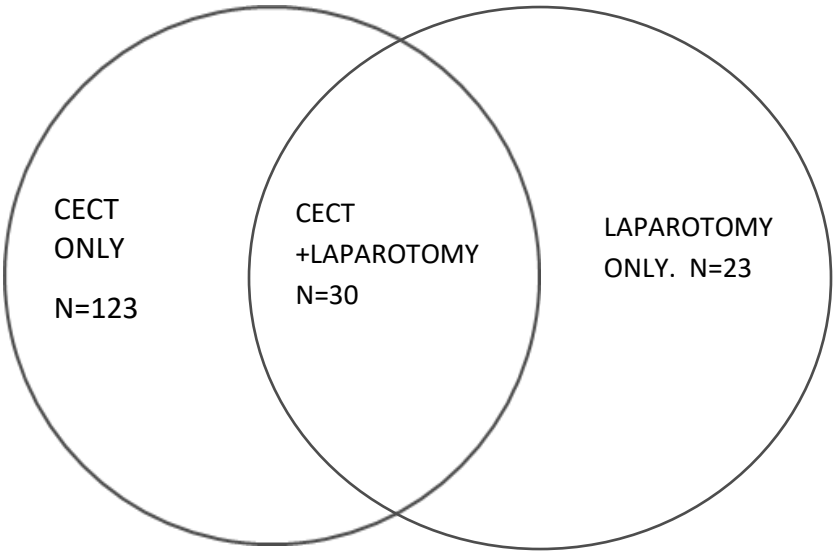

Figure 4: Diagnosis modality of the Abdominal injuries

Abdominal organ injury frequency: Out of all the 176 participants evaluated, 168 (95.5%) had evidence of intraabdominal injuries, 127 participants had a single organ involvement while 41 participants had more than one organs injured in the abdomen. The frequency of organ injuries was as shown (Table 4)

Table 4: showing the frequency of abdominal organ injury.

Organ involvement	Frequency (n = 168)	Percent (%)
Liver	95	54.0
Spleen	50	28.4
Ileum	11	6.3
Jejunum	12	6.8
Kidney	12	6.8
None	8	4.5
Diaphragm	5	2.8
Bladder	4	2.3
Retroperitoneal hematoma	4	2.3
Mesenteric tear	4	2.3
Pancreas	3	1.7
Duodenum	3	1.7
Caecum	1	0.6
	1	0.6

Extra abdominal injuries and Injury severity:

Extra abdominal injuries was present in 87 (49.4%) participants. Only one extra abdominal region was injured in 69 participants while 18 patients had multiple body region injuries beside the abdomen (figure 5)

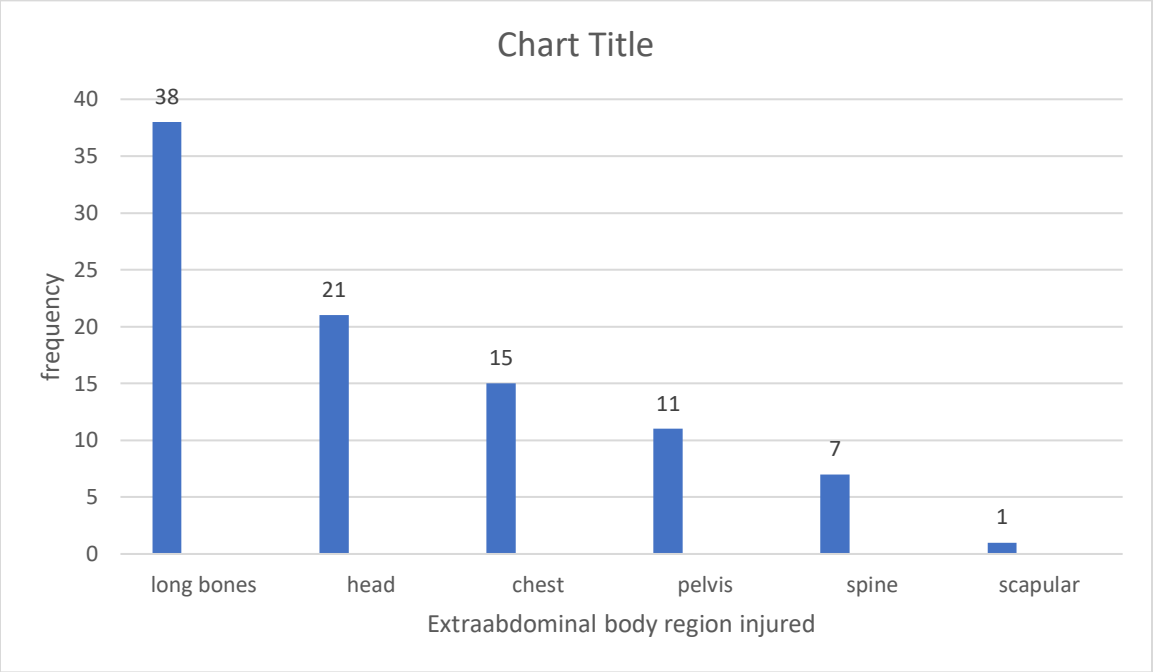

Figure 5: Bar graph showing the extra-abdominal injuries.

The severity of injury was determined by calculating the new Injury Severity Score (NISS). The mean NISS of the 176 participants was 14. The range was 1-36 with a median of 13. Majority of the participants, 111(63%) had a NISS range of 1-16 while 49(27%) had a range of 17-24. The remaining 26(14%) had a score >24.

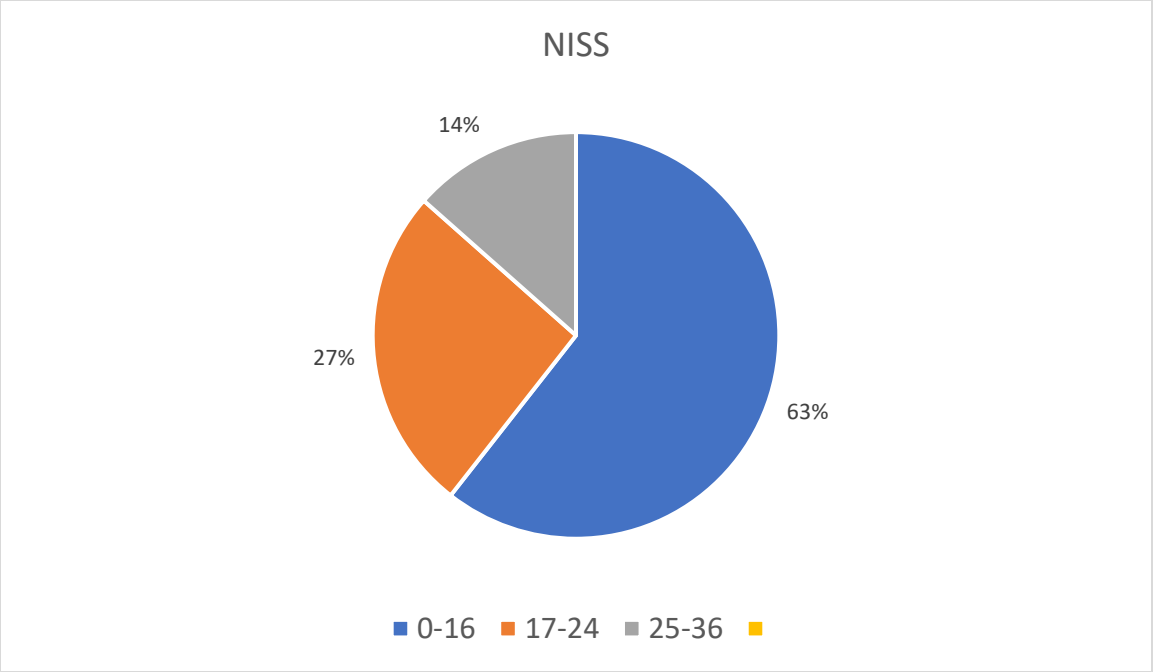

Figure 6: showing the NISS of the participants.

Management of abdominal organ injuries:

Of all the 176 patients admitted with BAT, 108 (61.93%) participants had successful NOM, 53 (30.1%) had a laparotomy performed immediately after admission. 14 (7.9%) had failed NOM. The pie chart below summarizes the mode of management (Figure 8)

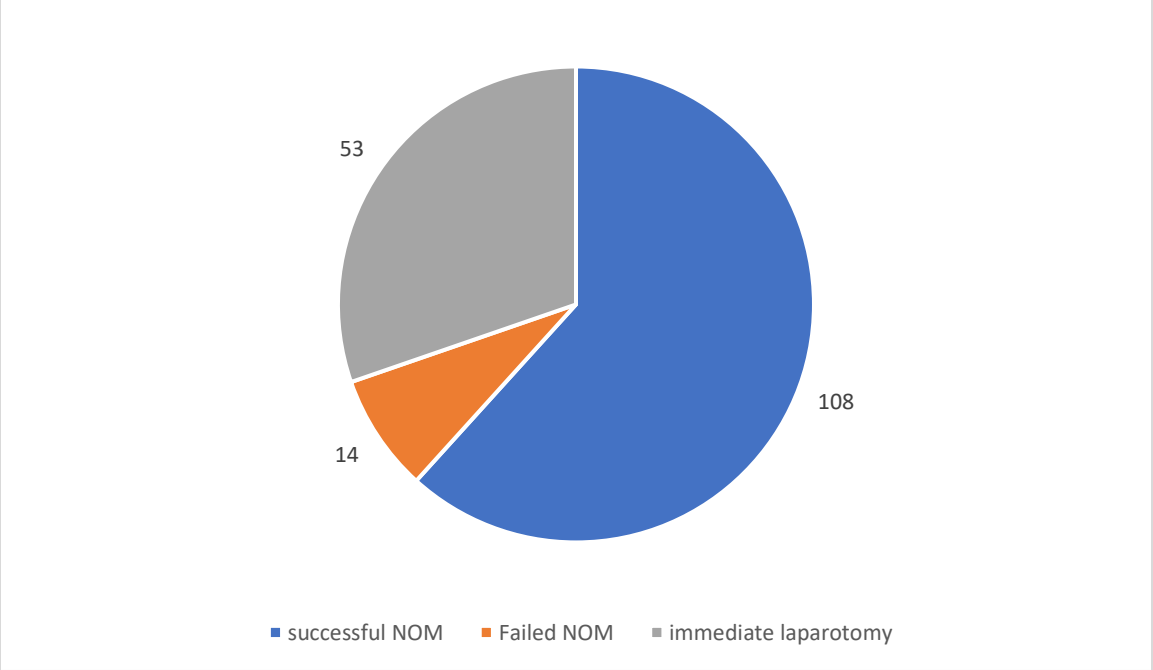

Figure 7: pie chart showing the management of the abdominal injuries.

The indications for laparotomy are summarized below (Table 5)

Table 5: indications for laparotomy

Indication	**Early laparotomy**		**Late laparotomy**	
	Frequency	**Percent (%)**	**Frequency**	**Percent (%)**
Hemodynamic instability	30	56.6	5	35.7
Peritonitis	11	20.75	8	57.14
Hollow viscus perforation	7	13.20	1	7.1
Diaphragm rupture	5	9.43	-	-
Total	**53**	**100%**	**14**	**100%**

.

Intraoperatively, 6 (8.5%) patients with hemodynamic instability and extraabdominal injuries were found to have no abdominal organ injuries (negative laparotomies). Six other patients had nontherapeutic surgeries (there was abdominal organ injuries but no further procedure was carried out). The frequency of intraoperative procedures carried out were as follows (Table 6)

Table 6: Intraoperative procedures:

Name of procedure	**Frequency**	**Percent (%)**
Primary bowel repair	12	16.9
Resection and anastomosis	10	14.1
Splenectomy	10	14.1
Liver repair	8	11.3
Diaphragm repair	7	9.9
Negative laparotomy	6	8.5
Non therapeutic	6	8.5
Peritoneal washout	3	4.2
Bladder repair	2	2.8
Perihepatic packing	2	2.8
IR drainage	1	1.4
Nephrectomy	1	1.4
Open abscess drainage	1	1.4
Mesenteric tear repair	1	1.4
Necrosectomy	1	1.4
	1	1.4

Surgical ICU admission:

Only 25 (14.2%) patients were admitted to the surgical ICU. The mean ICU length of stay was 3.8 days, range of 1-25 days. The median duration of ICU stay was 3 days. One patient was admitted for 25 days in the ICU at the end of 30-day observation period.

Table 7: Frequency and duration of ICU admission.

Number of Days of ICU admission	**Frequency**	**Percent (%)**
1	7	28
2	2	8
3	7	28
4	4	16
5	3	12
8	1	4
>25	1	4
TOTAL	25	100%

Blood transfusion:

Eighty one(46%) of the participants received blood/blood product transfusion during the admissions. The frequency of the units transfused is presented below (table 8)

Table 8: Blood transfusion; volume and frequency:

Blood transfusion (units)	**Frequency**	**Percent(%)**
0 1 2 3 4 >4	95 21 25 24 8 3	54.0 11.9 14.2 13.6 4.6 1.8
	176	100

Duration of admission/ Length of Stay (LOS)

The mean LOS for the participants was 10.9 days with a range of 1->30 days.7(3.9%) participants had a LOS of more than 30 days.

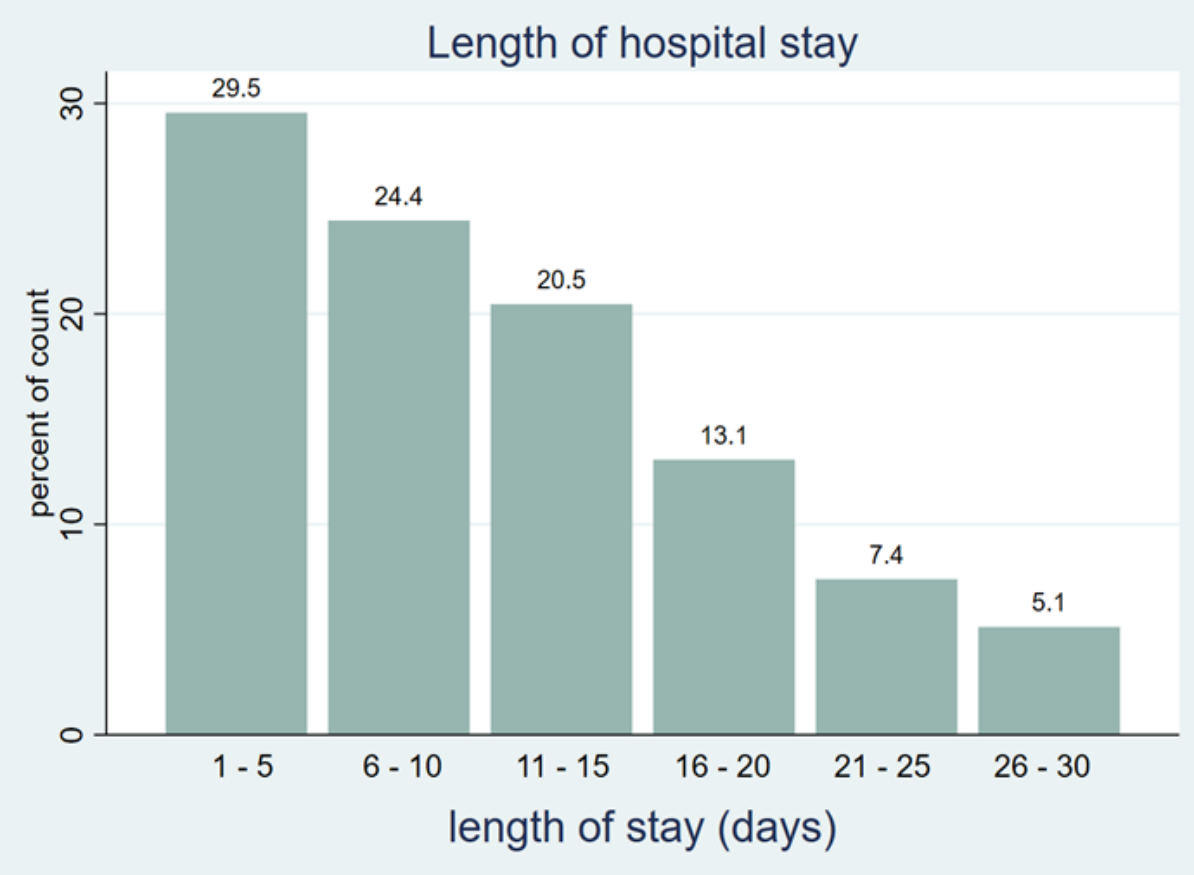

Figure 8: Bar graph summarizing duration of admission.

Outcomes of blunt abdominal injuries

Of all the 176 participants, 150 (85.2%) survived. Majority of the mortalities, 24(92.3%) had operative management. Two participants died while on NOM.

Death occurred in 14(54%) participants after 48 hours of hospital stay. The pie chart below represents the outcomes of the participants (Figure 8)

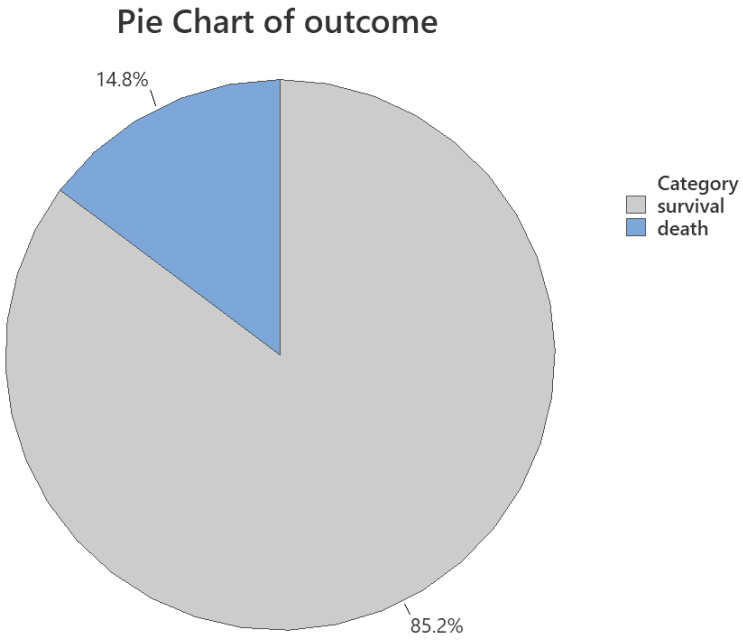

Figure 9: Pie chart showing the outcomes of management.

Complications:

Of the 150 survivors, 13 (8.7%) participants had complications at the time of discharge or end of observation period (30 days). Majority of the patients had surgical site infections as shown in Table 9.

Table 9: complications among the survivors.

Complications among survivors	**Frequency**	**Percent(%)**
None	137	91.3
Surgical site infection	8	5.3
Bile fistula	1	0.7
Ileostomy	1	0.7
Bedsores	1	0.7
Incisional hernia	1	0.7
Open abdomen	1	0.7
Total	**150**	**100**

Associations of mortality:

Patient demographics, cause of injury, severity of injury and management were tested for prediction of mortality (Table 10).

Table 10: Bivariate Associations of mortality

Variable	Category	Frequency	Test statistic	Outcome		P value
				Death	survival	
Age	18 – 40 41 – 60 >60	148 27 1	T test	NA	NA	0.118
Sex	Males Females	164 12	Fishers exact	22 4	142 8	0.081
Level of education	Primary school Secondary school Tertiary	86 64 26	Chi square	9 9 8	77 55 18	0.037
Cause of BAT	RTA Assault Fall Occupational Sport accident	135 16 16 7 2	Fishers exact	26 0 0 0 0	109 16 16 7 2	0.064
Laparotomy	Yes NO	71 105	Chi square	17 9	54 96	0.005
Blood transfusion	Yes No	81 95	Fishers exact	23 3	58 92	<0.001
ICU stay	Yes No	25 151	Chi square	15 11	10 140	<0.001
NISS	1-17 18-36	126 50	Chi square	5 21	121 29	<0.001
Preoperative hemodynamic instability	Yes No	34 142	Chi square	13 13	21 129	<0.001

Table 11: Logistical regression of multivariate associations of mortality.

Variable	Category	Frequency	Odds Ratio	Confidence interval	Outcome		P value
					Death	survival	
Sex	Males Females	164 12			22 4	142 8	0.081
Level of education	Primary school Secondary school Tertiary	86 64 26	4.54	2.21-9.33	9 9 8	77 55 18	<0.001
Cause of BAT	RTA Assault Fall Occupational Sport accident	135 16 16 7 2	1.49	1.17-1.89	26 0 0 0 0	109 16 16 7 2	0.001
Laparotomy	Yes NO	71 105	2.70	0.633-11.53	17 9	54 96	0.178
ICU stay	Yes No	25 151	5.12	0.77-33.65	15 11	10 140	0.089
NISS	1-17 18-36	126 50	2.53	1.04-6.11	5 21	121 29	0.039
Preoperative hemodynamic instability	Yes No	34 142	6.55	1.25-34.35	13 13	21 129	0.026
Blood transfusion	Yes No	81 95	0.11	0.300-0.406	23 3	58 92	0.001

CHAPTER 5

DISCUSSION:

Of the 176 participants, the male to female ratio was 13.6:1. The participants had mean age was 30.3 years, median of 28 years and a range of 18-62 years. BAT was thus a predominantly male disease affecting mostly those in the third and fourth decades of life. The findings of this study are collaborated by studies done in Tanzania, India, Brazil, Nigeria and Germany. (3,4,8,33).

The injuries occurred in an urban setting in 142(80.7%) and 34(19.3%) in a rural setting. These findings suggest that BAT is still common in urban areas despite a study by Ntundu and colleagues in Tanzania which found that penetrating abdominal injuries were more common than BAT in urban areas(2). This can be explained by movement restriction that occurred during the time of the study due to Covid -19 pandemic.

This study found out that 86 (48.9%) participants had attained primary level of education, 64 (36.4%) secondary education and 26 (14.8%) had attained tertiary level of formal education. Even though all levels of formal education were affected, the findings imply that BAT is more prevalent among people of low socio-economic strata in the society. No other study was found to consider the level of education among BAT patients.

Similar to other studies carried out in other countries , road traffic accidents was the leading cause of BAT(8,10,14).it accounted for injuries in 135(76.7%). Of the 135, 67(49.6%) of the participants were either vehicular or motorcycle passengers,32(23.7%) motorcycle riders, 22(16.3%) pedestrians, 8 (5.9%) drivers and 6(4.4%) were cyclists. Two studies done in India found that RTAs led in causing BAT in 53% and 48%(3,12).other causes of BAT included : assault and falls in 17(9.1%) participants each, occupational accidents in 7(4%) and 2(1.1%) sporting accident

injuries. Railway accidents and animal attacks recorded in Indian studies were not encountered in this study(10)

The mean latent time between injury and presentation at the hospital was 13.72 hours with a range of 1-312 hours. Majority of the participants 73(41.5%) arrived within 6 hours if injury. This was in contrast to the 75% reported by Musau P. in 2006, in KNH and Ntundu et al in 2019 in Tanzania in studies involving both penetrating and BAT(2,5). This could be explained by the fact KNH had changed to a referral only facility and although trauma patients were exempted, some were still seen in other facilities then referred to KNH. Movement restriction due to Covid 19 pandemic could explain some of the late presentations. one was referred to KNH after 312hours (13 days) admission in a different facility after a grade 3 liver injury was complicated by an abscess. Being the only level 6 public health facility in the eastern and central Kenya, referrals in were expected at different times after attempted management in lower level facilities.

To diagnose intraabdominal injuries, abdominal CECT scans were done in 153(86.9%) of the participants while 23 (13.1%) had immediate laparotomy based on positive FAST and clinical examination on examination. Of the 153 who did not have clinical indications for laparotomy before imaging, indication for surgery was found in 30(17%) of the total 176. This was in line with the ATLS protocol which guides the management of trauma patients(20).

Out of all the patients evaluated, abdominal injuries were evident in168 (95.5%) participants. Of the 168, 127 had a single organ injured while 41 had two or more abdominal organs injured. The liver was the most commonly injured solid organ injured in 88(52.3%) followed by the spleen in 50(29.8%) participants. The jejunum was the most injured hollow viscus organ in 12(6.8%) participants followed closely by the ileum in 11(6.3%). Ntundu and colleagues in Tanzania reported the spleen to be the most commonly injured organ in 2019 while Sandesh K, et al in India

reported the jejunum as most commonly injured(2,10). A study carried out in German looking at the outcomes of NOM in BAT patients found that the liver was the mostly injured abdominal organ as found in this study(33). Although different studies report different findings as far as the most commonly injured organ is concerned, the liver, the spleen and jejunum top in majority studies. Other organ injuries in this study included: kidneys in 12(6.8%), ileum in 11(6.3%), diaphragm in 5(2.8%), mesentery, retroperitoneal hematoma and urinary bladder in 4 (2.3%) each, pancreas in 3 (1.7%), duodenum and caecum in 1(0.7%) each.

There were 87(49.4%) participants with simultaneous extra abdominal injuries. Sixty- nine of them had one extra regional injuries while eighteen had multiple body regional injuries. The commonest extra abdominal injuries were long bone fractures present in 38(43.6%) of the participants. This was followed by head; 21(24.1%), chest; 15(17%), pelvis; 11(12%), and spine; 7(8%). Ntundu et al reported the chest to be the most commonly injured extra abdominal region followed by the head(2). Sandesh K. et al found the pelvis as most commonly injured region followed by the long bones(10). Although there was a difference in the order of frequency of extra abdominal injuries, there is a consensus that BAT is associated with other injuries in a significant number of patients.

Severity of injury of the participants was estimated using the New Injury Severity Score (NISS). The mean NISS was 14.13 with a range of 1-36. Majority, 111(63%) had a NISS of between 1-16 while 49(27.8%) had a range of 17-24. The remaining 26(14.7%) had a range of 25-36. A value of up to 16 is regarded as a mild injury, 17-24 as moderate while a value >24 depicts severe injury.(2). Majority of participants in this study therefore had a mild injury according to NISS. The NISS is directly proportional to extent of overall injury and therefore impacts on outcome.

Initial participant evaluation found no indication for immediate laparotomy in 123 (69.9%) of the participants while 53(30.1%) had laparotomy immediately after admission. Fourteen patients (7.9%) developed indications for laparotomy while on NOM. A total of 108(61.93%) had a successful NOM. The indications for laparotomy were hemodynamic instability in 35(52%), peritonitis in 19(28%), evidence of hollow viscus perforation in 18(10.4%) and evidence of diaphragmatic rupture in 5(7%) of the 67(38%) participants who were managed operatively. A study carried out in University of Southern California Medical Centre in 2003 reported early laparotomy rates of 28% with a 22 % failure of NOM(36). Musau P. et al reported NOM failure of 20% in KHN in 2006.one study done in the UK reported early laparotomy rate of 3.7% and 1.1% NOM failure. A study in Germany in 2019 found that 80% of BAT patients were managed non operatively with a success rate of 90%. Negative laparotomies were found in 6(8.5%) participants compared to 16% reported in 2006 in KNH(5). No patient was treated with laparoscopy or angioembolization since KNH has not embraced those modalities routinely for trauma management.

A total of 25(14.2%) participants were admitted in the surgical ICU. The mean length of ICU admission was 3.8 days, range of 1-25 days. The median ICU stay was 3 days. Of the 25, 24 (96%) had a stay of up to eight days in the ICU. One patient has an ICU stay of more than 25 days (at the end of the 30day observation period) due to a duodenal, pancreatic, and common bile duct injury on open abdomen management. No study was found for comparison on this aspect.

Blood and blood transfused in 81(46%) of participants in this study. 46(56.7%) of these received between one and two units of blood,32(39%) between 3 and 4 units while the rest 3(3.7%) received more than 4 units. Blood transfusion was done depending on the hemodynamic instability at

presentation as well as blood loss during surgeries. BAT therefore is a significant consumer of blood and blood products in the hospital.

The mean length of stay was 10.9 days with a range of 1->30 days. Majority of the participants,52(29.6%) stayed between 1-5 days. Only 7(4%) of them stayed beyond the observation period of 30 days. While Musau P, et al in 2006 reported an average LOS of 6.4 days for both penetrating and BAT trauma patients, he noted that complications and extra abdominal injuries were more prevalent among BAT patients which may explain the higher mean in this study(5).

Out of all the participants, 150(85.2%) survived the injuries. Of the survivors, 137(91.3%) had no complications either at discharge or the 30th day of observation. The remaining 13(8.7%) had complications. Surgical site infections were the commonest surgical complications of BAT management as collaborated by a study in India by Manohar et al(13). This can be explained by the fact that most of the BAT surgeries were done as emergency cases(37). Further peritoneal contamination by hollow viscus contents increases the risks of surgical site infections. A total of 26(14.8%) of the participants died. Majority of the deaths, 24(92%), occurred after operative management. Two patients died while on NOM, one from confirmed pulmonary thromboembolism while one patient developed unexplained bilateral haemorrhagic pleural effusions and died despite bilateral tube thoracostomies. Early deaths from trauma are mostly from haemorrhage as well as primary and secondary injuries(15). In this study, 12 (46%) died within 48 h0urs of admission while 14(54%) died after 48 hours of hospital stay. The overall mortality reported in other studies include 5.1% in Germany, 6.1% in the United Kingdom, 13.2% in India and 13.2% in Tanzania.(2,6,10,33). The slightly higher mortality rate can be partly explained by inclusion of participants with extra abdominal injuries who had been excluded in other studies.

Strong predictors of mortality in this study included high NISS, ICU admission, and preoperative hemodynamic instability. Similarly, a study by Ntundu et al found significant association of high NISS with mortality(2). Hemodynamic instability and ICU admission were found significant by Silvania K et al in India(8). The similarities in these studies may be explained by the fact that high NISS, ICU admission and hemodynamic instability are commonly associated with severe injuries.

CONCLUSION

From this study, BAT was predominantly a disease affecting young males. Road traffic accidents were the leading cause of BAT. The liver was the most injured organ while long bones were the leading concomitant extra abdominal injuries. NOM was successful in majority of BAT patients. Hemodynamic instability was the leading indication of operative management. Surgical site infection was the commonest complication. Blood transfusion, ICU admission, preoperative hemodynamic instability and high NISS were significant predictors of mortality.

RECOMENDATIONS

From the findings of this study, it is recommended that the public health department should combine effort with the public transport ministry to formulate regulations aiming at reducing road traffic accidents. Public education on road safety and occupational safety precautions should be incorporated in primary education curriculum to reduce the number and severity of injuries.

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STUDY TIMELINE

ACTIVITY	MARCCH/APRIL 2021	MAY-OCTOBER 2021	0CTOBER 2021-MARCH2022		APRIL 2022
PROPOSAL DEVELOPMENT					
ETHICAL APPROVAL					
DATA COLLECTION					
DATA ANALYSIS, DISSERTATION WRITING AND SUBMISSION					

STUDY BUDGET

ITEM	**COST(ksh)**
Research fees for KNH-UON ERC	5,000
Stationary	15,000
Statistician fees	40,000
Research assistant	20,000
Printing and Binding	25,000
contingencies	20,000
Total	**125,000**

APPENDIX 1: DATA COLLECTION SHEET

DATA COLLECTED ON THE FIRST CONTACT:

PARTICIPANT DEMOGRAPHICS

Patient serial number----------

1:What is your age in years ……

2:What is your gender (Tick as appropriate)

- Male
- Female

3: What was the setting of the injury: rural

urban

4: what is the highest level of formal education attained?

- Primary school
- Secondary school
- Tertiary
- Others (specify)

5: What was the cause of the injury?

- Fall
- Sporting accidents
- Assault
- Animal attack

- Road traffic accident

If the cause was a road traffic accident, specify whether the participant was a:

A. Passenger
B. Motor vehicle driver
C. Motorcycle rider
D. Cyclist
E. Pedestrian
F. Others (specify)

6: What was the duration of time from the time of injury to the time of presentation at KNH in hours

……

<u>DATA RECORDED DURING THE ADMISSION PERIOD:</u>

7: DIAGNOSIS OF INTRAABDOMINAL INJURIES

Was an abdominal CT scan done on admission?

- Yes
- No

8: MANAGEMENT

a. Was a laparotomy done on admission?

- Yes

- No

b. If yes, what was the indication?

i. Hemodynamic instability

ii. Evidence of hollow viscus perforation

iii. Features of peritonitis

iv. Others (specify)

c. What was the intraoperative intervention?

I. Bowel resection and anastomosis

II. Primary repair of bowel

III. Splenectomy

IV. Splenorrhaphy

V. Repair of liver lacerations

VI. Nephrectomy

VII. Others(specify)……

……..

d. Was a delayed laparotomy (for NO above) done?

A. Yes

B. No

e. If yes what was the indication?

a) Intraabdominal infection

b) Hemodynamic instability

c) Missed injuries

d) Late solid organ rupture

e) Delayed hollow viscus perforation

f) Others (specify)

9.ORGANS INJURED AND AAST OIS GRADING

ORGAN INJURED	AAST OIS GRADING					
	1	11	111	1V	V	V1
Liver						
spleen						
kidney						
pancreas						
stomach						
Duodenum						
Jejunum/ileum						
colon						
Rectum						
Ureter						
Bladder						
Diaphragm						
Others (specify)						

10: EXTRA ABDOMINAL INJURIES

a. **Are there etraabdominal injuries diagnosed in the participant?**

- Yes
- No

b. If yes, which body region is involved?

A. Head injury

B. Long bone fractures /limbs

C. Chest injuries

D. Vertebral coloumn /spinal cord injuries

E. Pelvic fractures

F. Others (specify)

11: New Injury Severity Score calculation

Organ injured	Abbreviated Injury score (AIS)	AIS squared
New injury severity score		

12: INTENSIVE CARE ADMISSION

Was the participant admitted into the surgical critical care unit?

- Yes
- No

If yes, for how many days?.....

13: BLOOD TRANSFUSION

Was the participant transfused with blood/ blood products during the admission in the hospital?

- Yes
- No

If yes, how many units ?.....

<u>DATA COLLECTED AT DISCHARGE, DEATH OR AT THIRTY DAYS OF ADMISSION</u>

14: LENGTH OF STAY

For how long did the patient stay in the hospital (from admission to discharge) in days?

……..

15: OUTCOME

What was the outcome of the admission management on the participant?

- Survival
- Death

16: If the patient survived, were there any complications at or before discharge?

- Yes
- No

17: If yes what were the complications?

a) Surgical site infection

b) Burst abdomen/wound dehiscence

c) Enterocutaneous fistula

d) Stoma creation

e) Open abdomen/ventral hernia

f) Others (specify)

18: If the patient died, after how many hours in the hospital did the death occur?

A. Less than 48 hours

B. After 48 hours

Specify number of hours…….

APPENDIX 2: INFORMED CONSENT FORM

This informed consent is for the guardians of, or patients in the Accidents and Emergency department, adult surgical wards including the surgical critical care unit who will be recruited into the study entitled; PATTERNS OF ORGAN DISRUPTION, MANAGEMENT AND OUTCOMES IN ADULT PATIENTS WITH BLUNT ABDOMINAL TRAUMA IN KENYATTA NATIONAL HOSPITAL.

Principal investigator: Dr. Benson, Cosmas Muthama Mutisya

Institution: Department of Surgery, School of Medicine, University of Nairobi.

Introduction:

My name is: Dr. Benson, Cosmas Muthama Mutisya, a post graduate student pursuing a masters degree in general surgery at the University of Nairobi. I am carrying out a study on the patterns of organ disruption, management and outcomes in patients presenting with blunt abdominal trauma in KNH.

The purpose of this research is partly as a curriculum requirement for completion of postgraduate studies as well as bettering patient care in clinical practice.

This will be an observational study documenting demographic features of the participant, interventions carried out and the outcomes of the management.

Voluntary participation.

Participation in this study is voluntary. You have the right to turn down our request for your participation or even withdraw from the study at any point when you consent into it. Should you choose to decline or withdraw from the study, there are no repercussions and treatment will be provided as usual.

Confidentiality.

Your/your patient's name or inpatient number will not appear on any of our data collection sheets. A serial number will be used which will not have any of your/ your patient's identifying details. Information collected from you/ your patient will be held confidentially and will not be shared with any unauthorized person.

Sharing of results:

Once data is collected , cleaned and analysed, it will be shared with the department of surgery in KNH. Findings will be published in medical journals and presented in medical confrences.

Risks, harm and discomfort

This study confers no risks to you/ your patient as a participant and therefore no harmful effects will be experienced. The interview will be conducted in a place with comfort to your satisfaction. Should you feel uncomfortable with any part of the interview, share your concern with the interviewer and it will be addressed. You can skip any question you are uncomfortable answering.

Benefits and compensation

You/your patient will not be compensated for participating in this study. No monetary or other enticing benefits will be offered. There are no direct benefits to you/ your patient for participating in this study, but will help improve treatment of BAT patients in the future

Cost:

You/your patient will not incur any cost beyond the cost of treatment when you participate in this study.

Who to contact should you have questions in the future:

If you wish to ask any questions later, you may contact:

Principal Researcher:

Dr. Benson Cosmas Muthama Mutisya,

Department of Surgery, School of Medicine,

University of Nairobi.

P.O. Box 19676 KNH, Nairobi 00202.

Mobile no. 0725 739 891

DR Daniel Kinyuru Ojuka,

MBchB, MMed General surgery(Nairobi), PhD

Consultant surgeon and Senior Lecturer,

Department of Surgery,

University of Nairobi

Dr. Dan kipkemboi Kiptoon, M.B.ch.B,MMed (surgery) (UON)

Consultant Surgeon and Lecturer,

Department of Surgery,

University of Nairobi.

If you have any ethical concerns, you may contact:

Secretary, UON/KNH-ERC,

P.O. Box 20723- 00202, KNH, Nairobi.

Tel: 020-726300-9 EXT 44355

Email: uonknh_erc@uonbi.ac.ke

Certificate of Consent:

I have read the above information, or it has been read/ and translated to me. I have had the opportunity to ask questions about it and any questions that I have asked have been answered to my satisfaction.

I consent voluntarily to participate/ for my patient to participate in this research.

Print Name of Participant / guardian_____

Signature of Participant/guardian _____

Date _____

Statement by the researcher

I have accurately read out the information sheet to the participant/participants guardian, and to the best of my ability made sure that the participant understands that: Refusal to participate or withdrawal from the study will not in any way compromise the care of treatment, all information given will be treated with confidentiality and that the results of this study might be published. I confirm that the participant/guardian was given an opportunity to ask questions about the study, and all the questions asked by the participant/gurdian have been answered correctly and to the best of my knowledge and ability.

I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

A copy of this Informed Consent Form has been provided to the participant.

Name of researcher/research assistant _____

Signature of researcher/research assistant_____

Date_____

APPENDIX 3: FOMU YA IDHINI YA KUJIUNGA NA UTAFITI

Fomu ya makubaliano

Idhini hii ya habari ni kwa walezi wa, au wagonjwa katika Idara ya Ajali na Dharura, wodi za upasuaji za watu wazima ikiwa ni pamoja na kitengo cha wagonjwa mahututi watakaajiriwa katika utafiti ulioitwa; MIFUMO YA UVUNJIFUZI WA VIUNGO, USIMAMIZI NA MATOKEO KWA WAGONJWA WAZIMA NA WENYE KUUMIA SEHEMU ZA TUMBO WALIOLAZWA KATIKA HOSPITALI YA TAIFA YA KENYATTA.
Mchunguzi mkuu: Dk. Benson, Cosmas Muthama Mutisya
Taasisi: Idara ya Upasuaji, Shule ya Tiba, Chuo Kikuu cha Nairobi.

Utangulizi:
Jina langu ni: Daktari Benson, Cosmas Muthama Mutisya, mwanafunzi aliyehitimu masomo ya shahada ya uzamili katika upasuaji wa jumla katika Chuo Kikuu cha Nairobi. Ninafanya utafiti juu ya mifumo ya usumbufu wa viungo, usimamizi na matokeo kwa wagonjwa wanaowasilisha kiwewe butu cha tumbo katika KNH.
Madhumuni ya utafiti huu ni sehemu kama mahitaji ya mtaala wa kumaliza masomo ya uzamili na pia kuboresha huduma ya mgonjwa katika mazoezi ya kliniki.
Hii itakuwa utafiti wa uchunguzi unaoandika kumbukumbu za idadi ya washiriki, hatua zilizofanywa na matokeo ya usimamizi.

Ushiriki wa hiari:

Kushiriki katika utafiti huu ni kwa hiari. Una haki ya kukataa ombi letu la ushiriki wako au hata kujiondoa kwenye utafiti wakati wowote unapokubali. Iwapo utachagua kukataa au kujiondoa kwenye utafiti, hakuna athari na matibabu yatatolewa kama kawaida.

Usiri:

Jina lako / mgonjwa wako au nambari ya wagonjwa haitaonekana kwenye karatasi yoyote ya ukusanyaji wa data. Nambari ya serial itatumika ambayo haitakuwa na maelezo yako ya kutambua / ya mgonjwa wako. Habari iliyokusanywa kutoka kwako / mgonjwa wako itafanyika kwa siri na haitashirikiwa na mtu yeyote asiyeidhinishwa.

Kushiriki matokeo:

Mara tu habari ya utafiti itakapokusanywa, kusafishwa na kuchambuliwa, itashirikiwa na idara ya upasuaji katika KNH. Matokeo yatachapishwa katika majarida ya matibabu na kuwasilishwa katika mikutano ya matibabu.

Hatari, madhara na usumbufu:

Utafiti huu hautoi hatari kwako / kwa mgonjwa wako kama mshiriki na kwa hivyo hakuna athari mbaya itakayopatikana. Mahojiano yatafanyika mahali na kwa faraja ili kuridhika kwako. Ikiwa utasikia wasiwasi na sehemu yoyote ya mahojiano, shiriki wasiwasi wako na muhojiwa na itashughulikiwa. Unaweza kuruka swali lolote ambalo huna raha kujibu.

Faida na fidia:

Wewe / mgonjwa wako hatalipwa fidia kwa kushiriki katika utafiti huu. Hakuna faida ya pesa au nyingine ya kuvutia itatolewa. Hakuna faida ya moja kwa moja kwako / kwa mgonjwa wako kushiriki katika utafiti huu, lakini itasaidia kuboresha matibabu ya wagonjwa wa maumivu butu ta tumbo katika siku zijazo.

Gharama:

Wewe / mgonjwa wako hautapata gharama yoyote zaidi ya gharama ya matibabu wakati unashiriki katika utafiti huu.
Nani wa kuwasiliana naye ikiwa una maswali katika siku zijazo:

Ikiwa unataka kuuliza maswali yoyote baadaye, unaweza kuwasiliana na:

Mtafiti Mkuu:
Dk. Benson Cosmas Muthama Mutisya,
Idara ya Upasuaji, Shule ya Tiba,
Chuo Kikuu cha Nairobi.
Sanduku la posta: 19676 KNH, Nairobi 00202.
Simu ya rununu. 0725 739 891

Dkt Daniel Kinyuru Ojuka,
MBchB, Upasuaji Mkuu wa MMed (Nairobi), PhD
Daktari wa upasuaji na Mhadhiri Mwandamizi,
Idara ya Upasuaji,
Chuo Kikuu cha Nairobi

Dk Dan kipkemboi Kiptoon, M.B.ch.B, MMed (upasuaji) (UON)
Daktari wa Upasuaji na Mhadhiri,
Idara ya Upasuaji,
Chuo Kikuu cha Nairobi.

Ikiwa una wasiwasi wowote wa kimaadili, unaweza kuwasiliana na:

Katibu, UON / KNH-ERC,
Sanduku la posta, 20723- 00202, KNH, Nairobi.
Simu: 020-726300-9 EXT 44355
Barua pepe: uonknh_erc@uonbi.ac.ke

Hati ya Ruhusa:

Nimesoma habari hiyo hapo juu, au imesomwa / na kutafsiriwa kwangu. Nimepata nafasi ya kuuliza maswali juu yake na maswali yoyote ambayo nimeuliza yamejibiwa kwa kuridhika kwangu.
Ninakubali kushiriki kwa hiari / kwa mgonjwa wangu kushiriki katika utafiti huu.
Chapisha Jina la Mshiriki / mlezi_____
Saini ya Mshiriki / mlezi _____

Kauli ya mtafiti:

Nimesoma kwa usahihi karatasi ya habari kwa mshiriki / mlezi wa washiriki, na kwa kadri ya uwezo wangu nilihakikisha kwamba mshiriki anaelewa kuwa: Kukataa kushiriki au kujiondoa kwenye utafiti hakutaweza kwa njia yoyote kuhatarisha utunzaji wa matibabu, yote habari itakayotolewa itashughulikiwa kwa usiri na kwamba matokeo ya utafiti huu yanaweza kuchapishwa. Ninathibitisha kwamba mshiriki / mlezi alipewa nafasi ya kuuliza maswali juu ya utafiti, na maswali yote yaliyoulizwa na mshiriki / gurdian yamejibiwa kwa usahihi na kwa kadiri ya ufahamu na uwezo wangu.

Ninathibitisha kwamba mtu huyo hajalazimishwa kutoa idhini, na idhini hiyo imepewa kwa hiari na kwa hiari.

Nakala ya Fomu hii ya Ruhusa iliyoarifiwa imetolewa kwa mshiriki.

Jina la mtafiti / msaidizi wa utafiti _____

Saini ya mtafiti / msaidizi wa utafiti_____

Tarehe_____

APPENDIX 4: AAST OIS GRADING SYSTEM AND ABBREVIATED INJURY SCORE

Table 1

Cervical vascular organ injury scale

Grade	Description of injury	ICD-9	AIS-90
I	Thyroid vein	900.8	
	Common facial vein	900.8	
	External jugular vein	900.81	1-3
	Non-named arterial/venous branches	900.9	
II	External carotid arterial branches (ascending pharyngeal, superior thyroid, lingual, facial maxillary, occipital, posterior auricular)	900.8	
	Thyrocervical trunk or primary branches		
	Internal jugular vein	900.8	
	External carotid artery	900.1	1-3
III	Subclavian vein	900.02	2-3
	Vertebral artery	901.3	3-4
	Common carotid artery	900.8	2-4
IV	Subclavian artery	900.01	3-5
	Internal carotid artery (extracranial)	901.1	3-4
V		900.03	3-5

*Increase one grade for multiple grade III or IV injuries involving more than 50% vessel circumference. Decrease one grade for less than 25% vessel circumference disruption for grade IV or V.

Table 2

Chest wall injury scale*

Grade	Injury Type	Description of Injury	ICD-9	AIS-90
I	Contusion	Any size	911.0/922.1	1
	Laceration	Skin & subcutaneous	875.0	1
	Fracture	< 3 ribs, closed; nondisplaced clavicle closed	807.01	1-2
			807/02	
			810.00/810.03	2
II	Laceration	Skin, subcutaneous and muscle	875.1	1
	Fracture	≥3 adjacent ribs, closed	807.03/807.09	2-3
		Open or displaced clavicle	810.10/810.13	2
		Nondisplaced sternum, closed	807.2	2
		Scapular body, open or closed	811.00/811.18	2
III	Laceration	Full thickness including pleural penetration	862.29	2
	Fracture	Open or displaced sternum	807.2	2
		Flail sternum	807.3	
		Unilateral flail segment (<3 ribs)	807.4	3-4
	Laceration	Avulsion of chest wall tissues with underlying rib fractures	807.10/807.19	4
		Unilateral flail chest (≥3 ribs)		
	Fracture	Bilateral flail chest (≥3 ribs on both sides)	807.4	3-4
V	Fracture		807.4	5

*This scale is confined to the chest wall alone and does not reflect associated internal or abdominal injuries. Therefore, further delineation of upper versus lower or anterior versus posterior chest wall was not considered, and a grade VI was warranted. Specifically, thoracic crush was not used as a descriptive term; instead, the geography and extent of fractures and soft tissue injury were used to define the grade. From Moore et al. [2]; with permission.

Table 3

Heart injury scale

Grade	Description of injury	ICD-9	AIS-90
I	Blunt cardiac injury with minor ECG abnormality (nonspecific ST or T wave changes, premature arterial or ventricular contraction or persistent sinus tachycardia)	861.01	3
	Blunt or penetrating pericardial wound with out cardiac injury, cardiac tamponade, or cardiac herniation		
II	Blunt cardiac injury with heart block (right or left bundle branch, left anterior fascicular, or atrioventricular) or ischemic changes (ST depression or T wave inversion) without cardiac failure	861.01	3
	Penetrating tangential myocardial wound up to, but not extending through endocardium, without tamponade	861.12	3
III	Blunt cardiac injury with sustained ($\geq$6 beats/min) or multilocal ventricular contractions	861.01	3-4
	Blunt or penetrating cardiac injury with septal rupture, pulmonary or tricuspid valvular incompetence, papillary muscle dysfunction, or distal coronary arterial occlusion without cardiac failure	861.01	3-4
	Blunt pericardial laceration with cardiac herniation		
	Blunt cardiac injury with cardiac failure		
IV	Penetrating tangential myocardial wound up to, but extending through,	861.01	3-4
	endocardium, with tamponade	861.12	3
	Blunt or penetrating cardiac injury with septal rupture, pulmonary or tricuspid		
	valvular incompetence, papillary muscle dysfunction, or distal coronary arterial	861.12	3
	occlusion producing cardiac failure		
	Blunt or penetrating cardiac injury with aortic mitral valve incompetence		
	Blunt or penetrating cardiac injury of the right ventricle, right atrium, or left atrium		
	Blunt or penetrating cardiac injury with proximal coronary arterial occlusion		
	Blunt or penetrating left ventricular perforation		
	Stellate wound with < 50% tissue loss of the right ventricle, right atrium, or of left atrium	861.03	5
V	Blunt avulsion of the heart; penetrating wound producing > 50% tissue loss of a chamber	861.03	
		861.13	5
		861.03	5
VI		861.13	6

*Advance one grade for multiple wounds to a single chamber or multiple chamber involvement.

Table 4

Lung Injury Scale

Grade*	Injury Type	Description of Injury	ICD-9	AIS-90
I	Contusion	Unilateral, <1 lobe	861.12 861.31	3
II	Contusion	Unilateral, single lobe	861.20 861.30	3
	Laceration	Simple pneumothorax	860.0/1	3
III	Contusion	Unilateral, > 1 lobe	861.20 861.30	3
	Laceration	Persistent (> 72 hrs) air leak from distal airway	860.0/1 860.4/5 862.0	3-4
	Hematoma	Nonexpanding intraparenchymal	861.30	
IV	Laceration	Major (segmental or lobar) air leak	862.21 861.31	4-5
	Hematoma	Expanding intraparenchymal		
	Vascular	Primary branch intrapulmonary vessel disruption	901.40	3-5
V	Vascular	Hilar vessel disruption	901.41 901.42	4
VI	Vascular	Total uncontained transection of pulmonary hilum	901.41 901.42	4

*Advance one grade for bilateral injuries up to grade III. Hemothorax is scored under thoracic vascular injury scale.

Table 5

Thoracic Vascular Injury Scale

Grade*	Description of injury	ICD-9	AIS-90
I	Intercostal artery/vein	901.81	2-3
	Internal mammary artery/vein	901.82	2-3
	Bronchial artery/vein	901.89	2-3
	Esophageal artery/vein	901.9	2-3
	Hemizygous vein	901.89	2-3
	Unnamed artery/vein	901.9	2-3
II	Azygos vein	901.89	2-3
	Internal jugular vein	900.1	2-3
	Subclavian vein	901.3	3-4
	Innominate vein	901.3	3-4
III	Carotid artery	900.01	3-5
	Innominate artery	901.1	3-4
	Subclavian artery	901.1	3-4
IV	Thoracic aorta, descending	901.0	4-5
	Inferior vena cava (intrathoracic)	902.10	3-4
	Pulmonary artery, primary intraparenchymal branch	901.41	3
	Pulmonary vein, primary intraparenchymal branch	901.42	3
V	Thoracic aorta, ascending and arch	901.0	5
	Superior vena cava	901.2	3-4
	Pulmonary artery, main trunk	901.41	4
	Pulmonary vein, main trunk	901.42	4
VI	Uncontained total transection of	901.0	5
	thoracic aorta or pulmonary	901.41	4
	hilum	901.42	

*Increase one grade for multiple grade III or IV injuries if more than 50% circumference; decrease one grade for grade IV injuries if less than 25% circumference.

Table 6

Diaphragm injury scale			
Grade*	Description of injury	ICD-9	AIS-90
I	Contusion	862.0	2
II	Laceration <2cm	862.1	3
III	Laceration 2-10cm	862.1	3
IV	Laceration >10 cm with tissue loss $\leq$ 25 cm^2	862.1	3
V	Laceration with tissue loss > 25 cm^2	862.1	3

*Advance one grade for bilateral injuries up to grade III.

Table 7

Spleen injury scale (1994 revision)				
Grade*	Injury type	Description of injury	ICD-9	AIS-90
I	Hematoma	Subcapsular, <10% surface area	865-01 865.11	2
	Laceration	Capsular tear, <1cm	865.02	2
		parenchymal depth	865.12	2
II	Hematoma	Subcapsular, 10%-50% surface area intraparenchymal, <5 cm in diameter	865.01 865.11	2
	Laceration	Capsular tear, 1-3cm parenchymal depth that does not involve a trabecular vessel	865.02 865.12	3
III	Hematoma	Subcapsular, >50% surface area or expanding; ruptured subcapsular or parenchymal hematoma; intraparenchymal hematoma $\geq$ 5 cm or expanding		
	Laceration	>3 cm parenchymal depth or involving trabecular vessels	865.03 865.13	3
IV	Laceration	Laceration involving segmental or hilar vessels producing major devascularization (>25% of spleen)		4
V	Laceration	Completely shattered spleen	865.04	5
	Vascular	Hilar vascular injury with devascularizes spleen	865.14	5

*Advance one grade for multiple injuries up to grade III.

Table 8

Liver injury scale (1994 revision)

Grade*	Type of Injury	Description of injury	ICD-9	AIS-90
I	Hematoma	Subcapsular, <10% surface area	864.01 864.11	2
	Laceration	Capsular tear, <1cm parenchymal depth	864.02 864.12	2
II	Hematoma	Subcapsular, 10% to 50% surface area intraparenchymal <10 cm in diameter	864.01 864.11	2
	Laceration	Capsular tear 1-3 parenchymal depth, <10 cm in length	864.03 864.13	2
III	Hematoma	Subcapsular, >50% surface area of ruptured subcapsular or parenchymal hematoma; intraparenchymal hematoma > 10 cm or expanding		3
	Laceration	>3 cm parenchymal depth	864.04 864.14	3
IV	Laceration	Parenchymal disruption involving 25% to 75% hepatic lobe or 1-3 Couinaud's segments	864.04 864.14	4
V	Laceration	Parenchymal disruption involving >75% of hepatic lobe or >3 Couinaud's segments within a single lobe		5
	Vascular	Juxtahepatic venous injuries; ie, retrohepatic vena cava/central major hepatic veins		5
VI	Vascular	Hepatic avulsion		6

*Advance one grade for multiple injuries up to grade III

Table 9

Extrahepatic billiary tree injury scale

Grade*	Description of injury	ICD-9	AIS-90
I	Gallbladder contusion/hematoma	868.02	2
	Portal triad contusion	868.02	2
II	Partial gallbladder avulsion from liver bed; cystic duct intact	868.02	2
	Laceration or perforation of the gallbladder	868.12	2
III	Complete gallbladder avulsion from liver bed	868.02	3
	Cystic duct laceration	868.12	3
IV	Partial or complete right hepatic duct laceration	868.12	3
	Partial or complete left hepatic duct laceration	868.12	3
	Partial common hepatic duct laceration (<50%)	868.12	3
	Partial common bile duct laceration (<50%)	868.12	3
V	>50% transection of common hepatic duct	868.12	3-4
	>50% transection of common bile duct	868.12	3-4
	Combined right and left hepatic duct injuries	868.12	3-4
	Intraduodenal or intrapancreatic bile duct injuries	868.12	3-4

*Advance one grade for multiple injuries up to grade III.

Table 10

Pancreas Injury Scale

Grade*	Type of Injury	Description of Injury	ICD-9	AIS-90
I	Hematoma	Minor contusion without duct injury	863.81-863.84	2
	Laceration	Superficial laceration without duct injury		2
II	Hematoma	Major contusion without duct injury or tissue loss	863.81-863.84	2
	Laceration	Major laceration without duct injury or tissue loss		3
III	Laceration	Distal transection or parenchymal injury with duct injury	863.92/863.94	3
IV	Laceration	Proximal[?] transection or parenchymal injury involving ampulla	863.91	4
V	Laceration	Massive disruption of pancreatic head	863.91	5

*Advance one grade for multiple injuries up to grade III. *863.51,863.91 - head; 863.99,862.92-body;863.83,863.93-tail. [a]Proximal pancreas is to the patients' right of the superior mesenteric vein.

Table 11

Esophagus injury scale

Grade*	Description of injury	ICD-9	AIS-90
I	Contusion/hematoma	862.22/.32	2
	Partial thickness laceration	862.22/.32	3
II	Laceration <50% circumference	862.22/.32	4
III	Laceration >50% circumference	862.22/.32	4
IV	Segmental loss or devascularization <2cm	862.22/.32	5
V	Segmental loss or devascularization >2cm	862.22/.32	5

*Advance one grade for multiple lesions up to grade III.

Table 12

Stomach injury scale

Grade*	Description of injury	ICD-9	AIS-90
I	Contusion/hematoma	863.0/.1	2
	Partial thickness laceration	863.0/.1	2
II	Laceration <2cm in GE junction or pylorus	863.0/.1	3
	<5cm in proximal 1/3 stomach	863.0/.1	3
	<10cm in distal 2/3 stomach	863.0/.1	3
III	Laceration >2cm in GE junction or pylorus	863.0/.1	3
	>5cm in proximal 1/3 stomach	863.0/.1	3
	>10cm in distal 2/3 stomach	863.0/.1	3
IV	Tissue loss or devascularization <2/3 stomach	863.0/.1	4
V	Tissue loss or devascularization >2/3 stomach	863.0/.1	4

*Advance one grade for multiple lesions up to grade III. GE-gastroesophageal.

Table 13

Duodenum injury scale

Grade*	Type of injury	Description of injury	ICD-9	AIS-90
I	Hematoma	Involving single portion of duodenum	863.21	2
	Laceration	Partial thickness, no perforation	863.21	3
II	Hematoma	Involving more than one portion	863.21	2
	Laceration	Disruption <50% of circumference	863.31	4
III	Laceration	Disruption 50%-75% of circumference of D2	863.31	4
		Disruption 50%-100% of circumference of D1,D3,D4	863.31	4
IV	Laceration	Disruption >75% of circumference of D2	863.31	5
		Involving ampulla or distal common bile duct		5
V	Laceration	Massive disruption of duodenopancreatic complex	863.31	5
	Vascular	Devascularization of duodenum	863.31	5

*Advance one grade for multiple injuries up to grade III. D1-first position of duodenum; D2-second portion of duodenum; D3-third portion of duodenum; D4-fourth portion of duodenum

Table 14

Small bowel injury scale

Grade*	Type of injury	Description of injury	ICD-9	AIS-90
I	Hematoma	Contusion or hematoma without devascularization	863.20	2
	Laceration	Partial thickness, no perforation	863.20	2
II	Laceration	Laceration <50% of circumference	863.30	3
III	Laceration	Laceration $\geq$ 50% of circumference without transection	863.30	3
IV	Laceration	Transection of the small bowel	863.30	4
V	Laceration	Transection of the small bowel with segmental tissue loss	863.30	4
	Vascular	Devascularized segment	863.30	4

*Advance one grade for multiple injuries up to grade III.

Table 15

Colon injury scale

Grade*	Type of injury	Description of injury	ICD-9	AIS-90
I	Hematoma	Contusion or hematoma without devascularization	863.40-863.44	2
	Laceration	Partial thickness, no perforation	863.40-863.44	2
II	Laceration	Laceration <50% of circumference	863.50-863.54	3
III	Laceration	Laceration ≥ 50% of circumference without transection	863.50-863.54	3
IV	Laceration	Transection of the colon	863.50-863.54	4
V	Laceration	Transection of the colon with segmental tissue loss	863.50-863.54	4
	Vascular	Devascularized segment	863.50-863.54	4

*Advance one grade for multiple injuries up to grade III. *863.41,863.51-ascending;863.42, 863.52-transverse;863.45,863.53-descending; 863.44,863.54-rectum.

Table 16

Rectum injury scale

Grade*	Type of injury	Description of injury	ICD-9	AIS-90
I	Hematoma	Contusion or hematoma without devascularization	863.45	2
	Laceration	Partial-thickness laceration	863.45	2
II	Laceration	Laceration < 50% of circumference	863.55	3
III	Laceration	Laceration ≥ 50% of circumference	863.55	4
IV	Laceration	Full-thickness laceration with extension into the perineum	863.55	5
V	Vascular	Devascularized segment	863.55	5

*Advance one grade for multiple injuries up to grade III.

Table 17

Abdominal vascular injury scale

Grade*	Description of injury	ICD-9	AIS-90
I	Non-named superior mesenteric artery or superior mesenteric vein branches	902.20/.39	NS
	Non-named inferior mesenteric artery or inferior mesenteric vein branches	902.27/.32	NS
	Phrenic artery or vein	902.89	NS
	Lumbar artery or vein	902.89	NS
	Gonadal artery or vein	902.89	NS
	Ovarian artery or vein	902.81/.82	NS
	Other non-named small arterial or venous structures requiring ligation	902.90	NS
II	Right, left, or common hepatic artery	902.22	3
	Splenic artery or vein	902.23/.34	3
	Right or left gastric arteries	902.21	3
	Gastroduodenal artery	902.24	3
	Inferior mesenteric artery, or inferior mesenteric vein, trunk	902.27/.32	3
	Primary named branches of messenteric artery (e.g., ileocolic artery) or messenteric vein	902.26/.31	3
	Other names abdominal vessels requiring ligation or repair	902.89	3
III	Superior mesenteric vein, trunk	902.31	3
	Renal artery or vein	902.41/.42	3
	Illiac artery or vein	902.53/.54	3
	Hypogastric artery or vein	902.51/.52	3
	Vena cava, infrarenal	902.10	3
IV	Superior mesenteric artery, trunk	902.25	3
	Celiac axis proper	902.24	3
	Vena cava, suprarenal and infrahepatic	902.10	3
	Aorta, infrarenal	902.00	4
V	Portal vein Extraparenchymal hepatic vein	902.33 902.11	3 3(hepatic vein) 5 (liver + veins)
	Vena cava, retrohepatic or suprahepatic	902.19	5
	Aorta suprarenal, subdiaphragmatic	902.00	4

*This classification system is applicable to extraparenchymal vascular injuries. If the vessel injury is within 2 cm of the organ parenchyma, refer to specific organ injury scale. Increase one grade for multiple grade III or IV injuries involving > 50% vessel circumference. Downgrade one grade if <25% vessel circumference laceration for grades IV or V. NS-not scored.

Table 18

Adrenal organ injury scale

Grade*	Description of injury	ICD-9	AIS-90
I	Contusion	868.01/.11	1
II	Laceration involving only cortex (<2 cm)	868.01/.11	1
III	Laceration extending into medulla (≥ 2 cm)	868.01/.11	2
IV	>50% parenchymal destruction	868.01/.11	2
V	Total parenchymal destruction (including massive intraparenchymal hemorrhage) Avulsion from blood supply	868.01/.11	3

*Advance one grade for bilateral lesions up to grade

Table 19

Kidney injury scale

Grade*	Type of injury	Description of injury	ICD-9	AIS-90
I	Contusion	Microscopic or gross hematuria, urologic studies normal	866.01	2
	Hematoma	Subcapsular, nonexpanding without parenchymal laceration	866.11	2
II	Hematoma	Nonexpanding perirenal hematma confirmed to renal retroperitoneum	866.01 866.11	2
	Laceration	<1.0 cm parenchymal depth of renal cortex without urinary extravasation	866.02 866.12	2
III	Laceration	>1.0 cm parenchymal depth of renal cortex without collecting system rupture or urinary extravasation	866.02	3
IV	Laceration	Parenchymal laceration extending through renal cortex, medulla, and collecting system	866.12	4
	Vascular	Main renal artery or vein injury with contained hemorrhage		4
V	Laceration	Completely shattered kidney	866.03	5
	Vascular	Avulsion of renal hilum which devascularizes kidney	866.13	5

*Advance one grade for bilateral injuries up to grade III

Table 20

Ureter injury scale

Grade*	Type of injury	Description of injury	ICD-9	AIS-90
I	Hematoma	Contusion or hematoma without devascularization	867.2/867.3	2
II	Laceration	< 50% transection	867.2/867.3	2
III	Laceration	≥ 50% transection	867.2/867.3	3
IV	Laceration	Complete transection with < 2cm devascularization	867.2/867.3	3
V	Laceration	Avulsion with > 2cm of devascularization	867.2/867.3	3

*Advance one grade for bilateral up to grade III

Table 21

Bladder injury scale

Grade*	Injury type	Description of injury	ICD-9	AIS-90
I	Hematoma	Contusion, intramural hematoma	867.0/867.1	2
	Laceration	Partial thickness		3
II	Laceration	Extraperitoneal bladder wall laceration <2 cm	867.0/867.1	4
III	Laceration	Extraperitoneal (≥2cm) or intraperitoneal (<2cm) bladder wall laceration	867.0/867.1	4
IV	Laceration	Intraperitoneal bladder wall laceration ≥2cm	867.0/867.1	4
V	Laceration	Intraperitoneal or extraperitoneal bladder wall laceration extending into the bladder neck or ureteral orifice (trigone)	867.0/867.1	4

*Advance one grade for multiple lesions up to grade III

Table 22

Urethra injury scale				
Grade*	Injury type	Description of injury	ICD-9	AIS-90
I	Contusion	Blood at urethral meatus; retrography normal	867.0/867.1	2
II	Stretch injury	Elongation of urethra without extravasation on urethrography	867.0/867.1	2
III	Partial disruption	Extravasation of urethrography contrast at injury site with visualization in the bladder	867.0/867.1	2
IV	Complete disruption	Extravasation of urethrography contrast at injury site without visualization in the bladder; <2cm of urethra seperation	867.0/867.1	3
V	Complete disruption	Complete transaction with ≥2 cm urethral separation, or extension into the prostate or vagina	867.0/867.1	4

Table 23

Uterus (nonpregnant) injury scale			
Grade*	Description of injury	ICD-9	AIS-90
I	Contusion/hematoma	867.4/.5	2
II	Superficial laceration (<1 cm)	867.4/.5	2
III	Deep laceration (≥ 1 cm)	867.4/.5	3
IV	Laceration involving uterine artery	902.55	3
V	Avulsion/devascularization	867.4/.5	3

*Advance one grade for multiple injuries up to grade III

Table 24

Uterus (pregnant) injury scale			
Grade*	Description of injury	ICD-9	AIS-90
I	Contusion or hematoma (without placental abruption)	867.4/.5	2
II	Superficial laceration (<1cm) or partial placental abruption <25%	867.4/.5	3
	Deep laceration (≥1cm) occurring in second trimester or placental abruption >25%		
III	but <50%	867.4/.5	3
	Deep laceration (≥1cm) in third trimester		
	Laceration involving uterine artery	867.4/.5	4
IV	Deep laceration (≥1cm) with >50% placental abruption	902.55	4
	Uterine rupture	867.4/.5	4
V	Second trimester		
	Third trimester	867.4/.5	4
	Complete placental abruption	867.4/.5	5
		867.4/.5	4-5

*Advance one grade for multiple injuries up to grade III

Table 25

Fallopian tube injury scale			
Grade*	Description of injury	ICD-9	AIS-90
I	Hematoma or contusion	867.6/.7	2
II	Laceration <50% circumference	867.6/.7	2
III	Laceration ≥50% circumference	867.6/.7	2
IV	Transection	867.6/.7	2
V	Vascular injury; devascularized segment	902.89	2

*Advance one grade for bilateral injuries up to grade III

Table 26

Ovary injury scale			
Grade*	Description of injury	ICD-9	AIS-90
I	Contusion or hematoma	867.6/.7	1
II	Superficial laceration (depth <0.5 cm)	867.6/.7	2
III	Deep laceration (depth ≥ 0.5 cm)	867.8/.7	3
IV	Partial disruption or blood supply	902.81	3
V	Avulsion or complete parenchymal destruction	902.81	3

*Advance one grade for bilateral injuries up to grade III

Table 27

Vagina injury scale

Grade*	Description of injury	ICD-9	AIS-90
I	Contusion or hematoma	922.4	1
II	Laceration, superficial (mucosa only)	878.6	1
III	Laceration, deep into fat or muscle	878.6	2
IV	Laceration, complex, into cervix or peritoneum	868.7	3
V	Injury into adjacent organs (anus, rectum, urethra, bladder)	878.7	3

*Advance one grade for multiple injuries up to grade III

Table 28

Vulva injury scale

Grade*	Description of injury	ICD-9	AIS-90
I	Contusion or hematoma	922.4	1
II	Laceration, superficial (skin only)	878.4	1
III	Laceration, deep (into fat or muscle)	878.4	2
IV	Avulsion; skin, fat or muscle	878.5	3
V	Injury into adjacent organs (anus, rectum, urethra, bladder)	878.5	3

*Advance one grade for multiple injuries up to grade III

Table 29

Testis injury scale

Grade*	Description of injury	ICD-9	AIS-90
I	Contusion/hematoma	911.0/922.4	1
II	Subclinical laceration of tunica albuginea	922.4	1
III	Laceration of tunica albuginea with <50% parenchymal loss	878.2	2
IV	Major laceration of tunica albuginea with ≥50% parenchymal loss	878.3	2
V	Total testicular destruction or avulsion	878.3	2

*Advance one grade for bilateral lesions up to grade V

Table 30

Scrotum injury scale

Grade	Description of injury	ICD-9	AIS-90
I	Contusion	922.4	1
II	Laceration <25% of scortal diameter	878.2	1
III	Laceration ≥25% of scrotal diameter	878.3	2
IV	Avulsion <50%	878.3	2
V	Avulsion ≥50%	878.3	2

Table 31

Penis injury scale

Grade*	Description of injury	ICD-9	AIS-90
I	Cutaneous laceration/contusion	911.0-922.4	1
II	Buck's fascia (cavernosum) laceration without tissue loss	878.0	1
III	Cutaneous avulsion	878.1	3
	Laceration through glans/meatus		
	Cavemosal or urethral defect <2cm		
IV	Partial penectomy	878.1	3
	Cavarnosal or urethral defect ≥ 2 cm		
V	Total penectomy	876.1	3

*Advance one grade for multiple injuries up to grade III

Table 32

Peripheral vascular organ injury scale

Grade*	Description of injury	ICD-9	AIS-90
I	Digital artery/vein	903.5	1-3
	Palmar artery/vein	903.4	1-3
	Deep palmar artery/vein	904.6	1-3
	Dorsalla pedia artery	904.7	1-3
	Plantar artery/vein	904.5	1-3
	Non-named arterial/venous branches	903.8/904.7	1-3
II	Basilic/cephalic vein	903.8	1-3
	Saphenous vein	904.3	1-3
	Radial artery	903.2	1-3
	Ulnar artery	903.3	1-3
III	Axillary vein	903.02	2-3
	Superficial/deep femoral vein	903.02	2-3

Table 32

	Popliteal vein	904.42	2-3
	Brachial artery	903.1	2-3
	Anterior tibial artery	904.51/904.52	1-3
	Posterior tibial artery	904.53/904.54	1-3
	Peroneal artery	904.7	1-3
	Tibioperoneal trunk	904.7	2-3
IV	Superficial/deep femoral artery	904.1/904.7	3-4
	Popliteal artery	904.41	2-3
V	Axillary artery	903.01	2-3
	Common femoral artery	904.0	3-4

*Increase one grade for multiple grade III or IV injuries involving >50% vessel circumference. Decrease one grade for < 25% vessel circumference disruption for grades IV or V