# STRATIFIED OUTCOME EVALUATION IN PERITONITIS

BY:

DR. BENJAMIN WABWIRE
MBChB (NAIROBI)

SUPERVISOR:
DR. HASSAN SAIDI
BSc Anat (Hons), MBChB, M. MED (SURGERY), FCS (ECSA),
SENIOR LECTURER, UNIVERSITY OF NAIROBI

A dissertation submitted in part fulfilment for the award of Master of Medicine (Surgery) degree of the University of Nairobi

## DECLARATION

**Researcher:**

I hereby declare that this dissertation is my own work and has not been submitted to any university for the award of a degree.

Signed.....

Date.....30.03.09.....

Dr Benjamin Wabwire

**Supervisor:**

I hereby declare that this dissertation has been submitted with my approval as the supervisor.

Signed.....

Date.....30.03.09.....

Dr Hassan Saidi

## Acknowledgement

Am grateful to my supervisor, Dr Hassan Saidi for the time and effort he invested in this work, from proposal development to the final draft. I also want to thank my colleagues and other staff in the surgical wards from which the study patients were recruited for their cooperation during data collection.

I wish to thank the Kenyatta National Hospital Ethics and Research Committee for approving this study.

My sincere gratitude goes to Mrs Alice Lakati who was very helpful with the final data analysis.

Above all, I thank the Almighty God from whom I drew the strength and encouragement as I worked on this dissertation.

**CONTENTS**

## LIST OF ABBREVIATIONS

MPI.....Mannheim peritonitis index
KNH.....Kenyatta National Hospital
SIRS.....Systemic inflammatory response syndrome
MOF.....Multiorgan failure
MODS.....Multiorgan dysfunction syndrome
CFU.....Colony forming unit
RD.....Relaparotomy on demand
PR.....Planned relaparotomy
APACHE.....Acute physiology and chronic health evaluation
SPSS.....Statistical package for the social sciences
ROC.....Receiver operator characteristic
AUC.....Area under curve
ICU.....Intensive care unit

## SUMMARY

***Background:*** The heterogeneity of disease severity in peritonitis often makes outcome prediction and treatment planning problematic. Disease severity stratification has been shown in studies elsewhere to relate with outcome. Risk evaluation in secondary peritonitis is of value in treatment planning, outcome prediction and conduction of surgical audits. This study evaluated outcome in peritonitis by stratifying patients according to disease severity using the Mannheim Peritonitis Index (MPI) at Kenyatta National Hospital.

***Objective:*** The main objective was to determine the usefulness of the MPI in predicting outcome of secondary peritonitis at KNH.

***Design:*** This was a prospective descriptive cross sectional survey.

***Materials and methods:*** Seventy patients meeting the inclusion criteria and admitted within the study period were consecutively enrolled into the study within 24 hours of operation. Data encompassing the risk factors under evaluation was collected comprising of age, sex, preoperative duration, organ failure, sepsis source, malignancy, character and extent of exudate from which the MPI was calculated. Patients were then followed up till discharge or death to record outcome (complications, hospital stay or death). Outcome evaluation was stratified in accordance with the MPI score. Data analysis was done with the aid of the SPSS version 12 computer programme.

***Results:*** A total of 56 males and 14 females (M:F =4:1) were recruited into the study. The age range was 13-59 years with a mean of 32.17 years. Forty six patients (65.7%) had generalised peritonitis, 15(21.4%) had 2-3 quadrant peritonitis while 9(12.9%) had focal peritonitis. The commonest source of sepsis was perforated appendicitis (31.4%), followed by perforated duodenal ulcer (22.9%) and ileal perforation (18.6%). Ileus was the most frequent

organ dysfunction (48.6%). Source control was not achieved in 12.9% of patients with an attendant 100% morbidity. Males had a lower mean MPI score (23.17) compared to females (31). Patients with morbidity had a higher mean MPI (26.9) compared to those without morbidity (22.8) (p=0.018). Morbidity rates within group increased with rising MPI scores (31% for MPI <21, 54.2% MPI 21-29, 64% MPI >29).

Nine (12.9%) patients died of which only 1(4.17%) had an MPI of <29. The mean MPI for non survivors was 33.8 (23.4 for survivors). Females had a higher mortality rate compared to males (21.43% vs 10.71%). The overall mean hospital stay was 14 days but 22 days for those who developed complications. Only 4 of 17(23.53%) patients with an MPI >29 had no recorded adverse outcome at discharge. Those with an MPI ≥26 had x2.1 risk of in hospital death. ROC curve analysis showed a mortality predictive power of 0.916 with a sensitivity of 88.9% and specificity of 85.2% at MPI of 29 points.

***Conclusion:*** The findings of this study appear to be in keeping with others elsewhere in showing that increasing MPI score does relate with outcome. The MPI is therefore useful in prognosticating early outcome in patients with surgical peritonitis at KNH.

# LITERATURE REVIEW

## Introduction

Peritonitis refers to inflammation of the serosal membrane lining the abdominal cavity and contained viscera. The disease has higher morbidity and mortality rates when compared to outcome in other general surgical conditions.[1, 2]

Advances in surgical techniques, basic sciences and intensive care have had little impact on improving these. The disease heterogeneity coupled with fairly uniform symptomatology compound to often make treatment planning problematic.[3]

This is underscored by the fact that the peritoneum responds fairly uniformly to irritation irrespective of the source. The irritant may be blood, acid, bile, urine, pus, faeces or foreign substances. Surgical intervention does not guarantee a uniformly predictable recovery pattern owing to the differences in the severity of the pathophysiology that the different irritants induce.[4]

Contaminants with a high bacterial load and foreign or particulate matter (such as faeces) are likely to be associated with systemic complications which may progress to multiorgan failure and adversely affect outcome.[5, 6]

It is from this background that scoring systems were introduced in surgical practice. Scoring systems have proved useful in helping surgeons objectively plan for treatment in difficult patients, reasonably prognosticate outcome and give appropriate feedback to patients or their relatives. Scoring systems have also equipped the surgeon with an efficient tool with which to conduct surgical audits by which care standards can be improved.[7, 8]

## Historical Perspectives

Fernel, in 1554 described the first documented case of secondary peritonitis due to perforated appendicitis in a seven year old girl.[5] Veillon and Zuber in 1893 recognized the role of bacterial synergism and toxins in the pathophysiology of peritonitis. Herbert Durham in 1897 showed that stomata existed on the peritoneal surface of the diaphragm through which bacteria were absorbed into lymphatics. The exact bacteriology of peritonitis was however identified by Weinberg.[9, 10]

Between 1880and 1884, Johann von Mikulicz successfully performed a laparotomy for perforated gastric ulcer, a cholecystectomy for perforated cholecystitis and exteriorized a perforated sigmoid colon.[9, 3] After years of controversy, it was Kirschner Martin in 1926 that summarized what has come to be the current principles of surgical therapy for peritonitis.[9]

The discovery of antibiotics failed to stem the high mortality rates in peritonitis seen then. The emergence of modern intensive care medicine however resulted in improved results. Osler, in 1904 observed that patients often died from the body's response to infection. This was later explained following the discovery of cytokines and understanding of their role in the evolution of systemic inflammatory response syndrome (SIRS), and multiorgan failure (MOF).[10, 11]

## Anatomical and physiological considerations

The peritoneum is a complex serous membrane, with a surface area comparable to the total body surface area. The peritoneal cavity communicates with the exterior in females via the uterine tubes ostia forming a potential route for ascending infections to access the peritoneal

cavity. Rupture or perforation of hollow visceral organs invariably contaminates the peritoneal cavity with their contents resulting in peritoneal membrane inflammation.[12, 13] This cavity is compartmentalized into interconnected spaces by peritoneal ligaments and mesenteries, influencing the localization and spread of peritoneal infections.

The most important of these are the subphrenic and subhepatic spaces, the omental bursar, the paracolic gutters and the pelvic cavity.[12, 13, 14]

The peritoneum promotes sequestration and removal of bacteria as well as facilitating migration of inflammatory cells from the microvasculature into the cavity.

Fluid absorption into lymphatics and systemic circulation is facilitated by presence of microvilli on the apical surface of the mesothelial cells which increase the absorptive surface area.

The diaphragm acts as a pump, driving movement of peritoneal fluid in a cephalad direction. Its relaxation in exhalation opens the stomata on its inferior peritoneal surface as the negative intrathoracic pressure draws fluid, toxins and particles via stomata into the lymphatics. Contraction in inhalation propels lymph towards the thoracic duct.

This partly explains the rapid appearance of bacteraemia in patients with generalized intra-abdominal infections.[5, 15, 16]

## SURGICAL PERITONITIS

Peritonitis may occur following infection of, or introduction of an irritant into the peritoneal cavity. Inflammation may involve a single quadrant or space in which case it is said to be localised, or diffuse if two or more quadrants are involved.[3]

Traditionally, peritonitis has been classified into 3 main categories.

1. Primary (spontaneous bacterial) peritonitis that is often associated with ascites of renal or hepatic origin.
2. Secondary peritonitis which follows spillage of visceral organ contents into the peritoneal cavity, commonly due to pathological perforation.
3. Tertiary peritonitis encountered in surgical practice often following iatrogenic visceral perforation, anastomotic leaks or dehiscence.

Surgical intervention is uncommon as part of the management of primary peritonitis which is almost entirely a medical problem.

**Microbiology of Peritonitis**

Normal gastrointestinal tract (GIT) micro flora becomes pathogenic if introduced into a sterile body cavity. The normal bacterial load along the GIT is not uniform. It increases down the tract, reaching a load as high as $10^{11\text{-}12}$ CFU/ml in the colon.[10]

Inoculation of the peritoneal cavity with a small amount of colonic content may contain enough organisms to overwhelm the host response and result in peritonitis compared to a similar amount of inoculum of gastro duodenal origin. In secondary peritonitis, the commonly isolated organisms include *Escherichia Coli*, *Bacteroides fragilis*, *Enterobacter*, *Klebsiella*, *Proteus* and *Enterococci* species.[17]

Except in patients on long term gastric acid suppressive therapy, gram positives are commonly isolated in upper GIT perforations. Patients with tertiary peritonitis and associated with long intensive care unit stay may be colonized by multidrug resistant organisms.[6, 17]

**Pathophysiology of Peritonitis**

Following contamination, the peritoneum mounts an immediate response aimed at ridding the cavity of the contaminants by complement activation, bacterial clearance via diaphragmatic stomata and activation of the fibrinolytic system.[5, 9]

Overt intra-abdominal sepsis develops where these mechanisms are overwhelmed. In patients with an initial chemical peritonitis, the already inflamed peritoneum is rendered susceptible to secondary bacterial colonization and suppuration. Development of diffuse peritonitis is favoured by increasing amount and virulence of organisms, synergism, continuing peristalsis, spurious contamination, immunodeficiency and in children.[9, 17]

Activation of mast cells results in degranulation and histamine release which leads to increased vascular permeability and exudation within the cavity of fibrinogen rich fluid. The reduced fibrinolytic activity coupled with fibrinous exudation is in essence a host response to sequester bacteria, limit disease spread and thus prevent systemic dissemination. This may result in abscess formation and be a source of persisting sepsis.

Inflammatory cell response begins with macrophage recruitment and concomitant up regulation of cytokine secretion. Release of pro-inflammatory factors TNFα, IFNγ, IL2, IL1β, IL6 and IL8 follows. Complement activation results in increased amounts of C3a and C5a, both potent chemo tactic factors for neutrophils. Cellular recruitment is also enhanced by IL2 and IL8.[4, 15] The occurrence of systemic manifestations in peritonitis signifies the onset of SIRS. SIRS is associated with an immense intraperitoneal cytokine response to infection. Mediated by a cascade of proinflammatory factors, its common precipitants are known to be

lipopolysaccharide from gram negative bacteria (endotoxin), peptidoglycan and teicoic acid from gram positives alongside mannan from yeast cells and other fungi. Activation of immune cells and release of vasoactive substances within the peripheral circulation causes expansion of the capacitance vessels and decreased venous return. If severe enough, septic shock ensues. This combined with circulatory toxins and deleterious cytokines may damage organs systemically leading to multiorgan dysfunction syndrome (MODS) which may progress to new onset multiple organ failure (MOF) and death. Acute organ dysfunction in the context of infection (severe sepsis) has an attendant mortality rate of between 20-56%.[11, 14, 15, 18]

High levels of TNFα and IL6 in the systemic circulation have come to be related with poor outcomes mainly because they are thought to uncontrollably activate the systemic inflammatory cascade.[19]

## DIAGNOSIS

### Laboratory Evaluation

A full blood count may show a leukocytosis above 11000/ml except in some patients with severe sepsis or those immunosuppressed. The finding of anaemia and thrombocytopaenia correlates with poor outcomes.[19]

Serum amylase levels, if raised above four times the normal are consistent with a diagnosis of acute pancreatitis and are helpful in excluding this entity.[20]

Urea, creatinine and electrolyte evaluation is key to proper and adequate resuscitation plus electrolyte imbalance correction. Urea and creatinine levels have a prognostic bearing, forming part of the parameters used to evaluate for renal failure, as are arterial blood gases.[15, 21, 22, 23]

To date, routine culture of peritoneal exudates collected at laparatomy remains controversial. This followed the discovery that in only upto 10% of patients with secondary peritonitis were it necessary to alter empiric antibiotics on the basis of culture and sensitivity results. However, cultures may be useful in patients on prolonged antibiotic treatment, the critically ill and those instrumented where the risk of colonization by either a nosocomial or multidrug resistant pathogen is high.[17, 24, 25]

**Imaging**

Plain radiography has a role in detection of free air suggesting visceral perforation. Ultrasound is of value in abscess localisation and may be used therapeutically in ultrasound guided drainage of abscesses where indicated. If not contraindicated, triple contrast CT scan is the study of choice in intra-abdominal sepsis.[14] It has a high sensitivity for fluid collections, areas of inflammation, leak or obstruction and may also be used therapeutically. Nevertheless, investigations should never delay operative intervention in surgical peritonitis.[14, 15]

**MANAGEMENT**

The main aims of treatment are to achieve early source control, rid the cavity of bacteria and toxins, contain the inflammatory process and maintain organ function.[9]

**Medical Support**

Adequate medical support should constitute use of systemic antibiotics targeting the likely aetiological bacteria, intensive care aimed at stabilizing and optimizing haemodynamic, pulmonary and renal function, early

nutritional and metabolic support and modulation therapy targeting the inflammatory response.

At diagnosis, immediate volume resuscitation should be instituted and baseline serum electrolytes status and arterial blood gases determined. The target should be to correct pre-existing imbalances and prevent deterioration.

Patients with abdominal distension may have raised intra-abdominal pressure and impaired diaphragmatic function with attendant poor ventilation. Nasogastric tube decompression is therefore indicated both as a therapeutic and prophylactic measure. Adequate pain control with opioids should be achieved early. Urine output measurement is a sure way to asses the adequacy of fluid resuscitation, for which catheterisation may be necessary.[15]

**Antibiotics**

Antibiotics are an adjunct and not a substitute to surgical intervention in secondary peritonitis. Early initiation of antibiotic treatment is believed to be more effective than if delayed. There probably exists a linear relation between onset and mortality in peritonitis, the first few hours in disease pathogenesis being the most susceptible to antibiotic therapy.[17, 25]

Antibiotic choice should address individual patient risk category, duration of treatment, possible pathogens and alternatives incase of a therapeutic failure. Today, many antibiotics are effective either as single or in combination with others in the treatment of intra-abdominal sepsis. Selection of an agent may however be made difficult due to the wide range of alternatives and the diversity of microbial isolates in peritonitis depending on the location of the perforation. Patients presenting within 24 hours of perforation with an

infection focus eradicable at surgery and no co morbidities require a short course of either single or combination broad spectrum therapy. Prolonged combination broad spectrum coverage is mandatory in late presenters, those with co morbidity and where source control is not envisioned at initial surgery. Where fungal (Candida) infections are confirmed, fluconazole or amphotericin B should be used.[17, 25]

**Nutritional and Metabolic Support**

Early nutritional support is important for early reversal of the catabolic state. Postoperatively, oral feeding should be instituted as soon as bowel sounds return.

Parenteral hyper alimentation is recommended in patients in whom gut function does not return in 5 days, or earlier if initially malnourished.[15]

Therapies directed at modulating SIRS are unsatisfactory. Steroids are known to reduce TNFα synthesis by reducing mRNA synthesis and hence hydrocortisone in doses of 50mg 6 hourly has been shown to improve survival in upto 50% of patients.[26]

**Surgical therapy**

The main purpose of surgical therapy is to securely eliminate infection foci and restore peritoneal physiological and immunological functions to as near normal as possible.[27] Early and definitive source control plus bacterial and toxins elimination reduces the need for re-operation and poor outcome. Delay in surgical intervention is associated with adverse outcome.[3, 18]

What remains controversial to date is what should be considered as effective therapy in patients in who adequate source control at the initial laparotomy cannot be achieved.[24]

**Source control**

Source control is a precept of all surgical infections and involves drainage of all purulent material, debridement of devitalized tissue and debris, remediation of primary pathology and copious lavage with warm normal saline.[11, 27, 28]

Lavage reduces the bacterial and hence toxins load alongside any debris in the peritoneal cavity thus halting the inflammatory cascade. Sufficient lavage requires use of 20-30L of warm antibiotic free saline. Addition of antimicrobials to saline has no therapeutic advantage. Perioperative lavage or continuous irrigation may be used in laparostomy patients.[3]

The underlying cause must be addressed if eradication of continuing peritoneal contamination is to be achieved. Simple drainage and diverting stoma should be avoided in patients with generalized peritonitis. Better source control is attained by primary resection and diverting stoma if indicated.[29] Resection and anastomosis should be performed except in patients with advanced faecal peritonitis, pre-existing organ failure or immunodeficiency.[21, 30]

**Planned Relaparotomy**

Scheduled reoperations are ideally reserved for patients in whom source control cannot be achieved at the initial laparotomy. Preliminary drainage and removal of necrotic tissue is done at the initial operation. Once the patient stabilizes, definitive drainage and source control is attempted. Planned relaparotomy has unfortunately been shown to have an increased morbidity and mortality rate. Toni et al found a 21% mortality rate compared to 13% in relaparotomy on demand(RD), an infection rate of 68% (15% in RD) and a MOF rate of 50% (24% in RD).[27]

Lamme et al found a 36% mortality rate in PR vs. 21.8% in RD, and a morbidity rate of 59% in PR vs. 43.1% in RD.[31] In a meta-analysis involving eight centres and 1266 patients, Reitsma et al found a 33% mortality rate in PR vs. 22% in RD.[32]

Planned relaparotomy enhances the stress response to surgical trauma and should be reserved for patients with intra-abdominal hypertension or missing source control. It probably acts as a second hit, raising levels of proinflammatory cytokines (IL6 and IL8). Significant falls in C3 and C5 levels plus reduction in opsonization activity are demonstrable in this patients.[19]

Where indicated, relaparotomy on demand should be performed within 48hours. The usual challenge is decision making in a patient whose initial operation was deemed successful.[14, 24]

**Laparostomy**

The principle behind laparostomy is to treat the entire abdominal cavity as an abscess cavity and hence leave the abdomen open.[28] It has been employed in situations where severe inflammation precludes primary closure of the abdomen. Such patients are prone to the development of intra-abdominal hypertension and abdominal compartment syndrome.

Temporary closure of the abdomen in this setting may be achieved by gauze and membrane dressings, prosthetic mesh (dexon, gore-tex, polypropylene) or vacuum assisted closure devices.

Laparostomy is however associated with an upto 25% rate of fistulation, abdominal contamination with nosocomial pathogens, bowel evisceration and in the long run, large incisional hernias.[28, 31, 33]

## Minimal Access Surgery in Peritonitis

### 1. Laparoscopy

This therapeutic approach has been slowly gaining acceptance in the diagnosis and treatment of intra-abdominal sepsis. It however requires proper patient risk stratification and selection. Patients in shock or with profound ileus are considered unfit for laparoscopic intervention.
Laparoscopy was found to be effective in the management of peritonitis due to gastric and appendiceal perforations with a conversion rate of only 16%. It was however ineffective in colonic perforations where a conversion rate of 80% was encountered.[34, 35]

Patients had a shorter mean hospital stay, morbidity and mortality rates compared with laparotomy for patients with the same risk stratification scores. Laparoscopy has a limited role in postoperative (tertiary) peritonitis, peritonitis with adhesions and in malignancy. Thorough abdominal cavity exploration in the setting of inflamed and possibly dilated bowel loops may not be possible.[14, 34, 35]

### 2. Image guided drainage

This may be achieved by means of ultrasound, or CT scan guided drainage. It is indicated in drainage of localised abscesses or if definitive surgery is to be delayed till the acute process and sepsis resolves.[14, 15]

### Complications

1. Surgical site infection remains the most common complication and its incidence rises with increasing degree of wound contamination. The risk of developing an SSI increases with advanced age, immunodeficiency, severe sepsis and malnutrition.[6, 21]

2. Fistulation follows laparostomy, but may occur where poor surgical techniques were employed or in patients with severe sepsis.[33]
3. Haemorrhage may complicate laparostomy patients.
4. Prolonged ileus (more than 5 days).
5. Systemic complications are usually a manifestation of SIRS and may involve any organ system.
6. Mortality rates in peritonitis are higher in patients with severe sepsis and multiorgan failure. Anaya found a 2% mortality rate in patients with one failing organ compared to 80% in those with 5 failing organs.[18] The same has been observed in patients in whom source control was not possible at initial laparatomy (13% where source control was possible vs. 27%).[11]

**PROGNOSIS AND RISK EVALUATION**

Successful treatment of intra-abdominal sepsis mandates that one attains adequate source control with resultant sepsis resolution and clearance of intra-abdominal infection.

Patients who develop SIRS, MODS and MOF have an increased mortality risk, as are those from whom multidrug resistant gram negative bacteria, fungi and enterococci are cultured from exudates.

Due to the varied sources, degree and severity of peritoneal contamination, patients with intra-abdominal sepsis do not follow a similarly predictable postoperative course. Many factors are known to be associated with poor outcomes, but singly on their own cannot be used to prognosticate outcome in peritonitis. Mortality is related to the severity of patient's systemic response and physiologic compromise.[22, 36]

The need for an early and objective way to asses and categorize the degree of sepsis in peritonitis arose from this realization. Scoring systems were introduced for this reason. .

An ideal scoring system should help the surgeon to:-

- Select patients who require an aggressive surgical approach with greater objectivity.
- Asses and define individual patient risk and thus predict prognosis.
- Communicate with patient and relatives with greater objectivity.
- Evaluate and validate the effectiveness of various treatment options.
- Objectively compare results with those from other centres.[7, 8, 18, 21, 22]

The main limitation of scoring systems is their inability to provide any therapeutic alternatives to the surgeon, more so in patients with high scores and certain to die.

Prognosis in peritonitis is strongly influenced by the health status of the patient at the start of treatment, and hence prediction of outcome can be made on the basis of risk scores determined then. Many scoring systems have been developed including the Mannheim Peritonitis Index (MPI), Acute Physiology and Chronic Health Evaluation (APACHE) II, Peritonitis Index Altona, Sepsis Severity Score, and Simplified Acute Physiology.[15, 24]

The MPI was first published by Wacha et al in 1987 based on data collected from 1253 patients from 1963 to 1979. 17 possible risk factors were

analysed for prognostic relevance out of which eight were found to be of significance and were entered into the current index.[8, 22, 37]

The index takes into account the patients age and gender, organ failure, malignancy as the source of contamination, preoperative duration of symptoms greater than 24 hours, origin of sepsis other than colonic, extent of spread and character of peritoneal fluid.

**Table 1: The Mannheim Peritonitis Index**

| **Risk factor** | **Points** |
|---|---|
| Age >50years | 5 |
| Female gender | 5 |
| Organ failure | 7 |
| Malignancy | 4 |
| Preoperative duration >24hours | 4 |
| Origin of sepsis not colonic | 4 |
| Diffuse generalised peritonitis | 6 |
| Exudates :- clear | 0 |
| - cloudy/purulent | 6 |
| -faecal | 12 |

Organ failure was defined by the following parameters:

1. Kidney: - creatinine >177μmol/L, urea >16.7mmol/L, oliguria <20ml/hr.
2. Lungs: - $PCO_2$ >50mmHg, $PO_2$ <50mmHg.
3. Shock; hypo or hyper dynamic
4. Intestinal obstruction- profound paralysis of >24hours duration or complete ileus.[8, 22, 23]

The sum total of individual risk factors defines the patients MPI score. For comparison purposes, three main groups have been validated based on mortality results from several centres.[3, 22]

| **MPI score** | **Mortality** |
|---|---|
| <21 points | 2.3% |
| 21-29 points | 22.5% |
| >29 points | 59.1% |

At a threshold score of 26 points, the MPI has an 86% sensitivity and 74% specificity rate in predicting mortality. Bielecki analysed 59 patients with colonic perforation and reported no mortalities in those who scored <26 points compared to 38% in those with MPI >26 points.[6] Increasing MPI score is strongly associated with outcome in secondary peritonitis. Morbidity specific to each category can also be similarly assessed.

The MPI is the preferred prognostic scoring system for peritonitis because of its specificity to peritonitis and ease to calculate early in the postoperative period. Although shown to strongly correlate with outcome, APACHE II scores are mainly applied in the intensive care unit setting and on patients with chronic health.[3, 21, 28, 38, 39]

## STUDY RATIONALE

Peritonitis is a surgical emergency with comparatively high morbidity and mortality rates. Ndonga, in 2002 found an overall mortality rate of 22% in patients surgically managed for peritonitis at KNH. In a select group of 54 patients with jejuno-ileal perforations, he reported a morbidity rate of 61.1%.[1] Data on peritonitis from the KNH medical records statistics office covering the period 2001-2004 appears to follow this trend with the condition estimated to comprise 3% of all general surgical admissions. In comparison, Kimani found an overall mortality rate of 4.8% among patients undergoing laparotomy for varied indications at KNH.[2]

Appropriate surgical practice calls for both proper treatment planning and adequate information flow to other caregivers and patients or their relatives. Regular surgical audit to assess treatment versus outcome is key to improving surgical care in modern practice. This is no mean task in conditions associated with high morbidity and mortality rates. Patients with intra-abdominal sepsis have a wide spectrum of disease severity that often relates to outcome. An objective and standardized way of assessing individual patient risk facilitates treatment planning, prognostication, communication and centre performance evaluation. Scoring systems have proved their worth in this respect.

There has been no study at KNH on peritonitis that has focused on risk based outcome evaluation by a scoring system. This is the gap that this study set out to fill by use of an internationally validated scoring system. It was hoped that this would provide a framework for risk based evaluation and management of peritonitis and also serve as a basis for future surgical audits.

## STUDY OBJECTIVES

### Main Objective:

The main objective was to determine the usefulness of the MPI in predicting outcome of surgically managed peritonitis at KNH.

### Specific Objectives:

1. Calculate individual patient MPI score from concomitant risk factors.
2. Record the outcome in each patient.
3. Stratify outcome by respective MPI score and analyze their relationship.

## MATERIALS AND METHODS

### Study design:

This study was a prospective descriptive cross sectional survey.

### Study site and population:

The study was conducted at Kenyatta National Hospital between December 2007 and April 2008. Patients were recruited from the general surgical wards. The target population was patients admitted and operated for peritonitis.

### Ethical considerations

The study proposal was submitted to and approved by the KNH Ethics and Research Committee.

Patients were only recruited into the study after giving an informed consent. A parent or guardian was required to consent for minors (<18 years).

All data collected was treated with confidentiality.

This was an observational study, and hence did not interfere with or influence patient management in any way.

**Sample size estimation**

The sample size was estimated using Fischer's formula:-

$$n=\frac{Z^2p(1-p)}{d^2}$$

where Z is the standard deviation corresponding to 95% confidence interval and set at 1.96; p is the prevalence of peritonitis among general surgical admissions at KNH and estimated at 3%; d is the required precision of estimate set at 0.04. The sample size thus calculated was 70 patients.

**Inclusion criteria:**

All patients surgically managed for peritonitis within the period of study and from whom an informed consent was obtained were included in the study.

**Exclusion criteria:**

1. All patients from whom an informed consent was not obtainable.
2. All patients with peritonitis due to purely haemoperitoneum.
3. Patients who had suspected primary peritonitis occurring in the setting of renal or hepatic failure.
4. All patients transferred in after laparotomy for peritonitis, or transferred out to continue treatment elsewhere were excluded from the study.

**Data collection**

Patients who met the inclusion criteria were consecutively enrolled in the study until the sample size was achieved. Data collection was conducted by the investigator and entailed filling of a coded data sheet of variables under investigation. Prospective candidates for inclusion in the study were recruited within the first 24 hours of the post operative period. At this initial visit, relevant data on risk factors, intraoperative findings and definitive procedure as per case notes were entered into the data collection sheet.
The patient's age, sex, duration of symptoms and presence or absence of ileus from the preoperative assessment was recorded in the data sheet. The following data was recorded as per the surgeon's case notes:-

- Appearance of the exudate; whether clear, cloudy/purulent or faecal
- Extent of exudate; single quadrant, or diffuse if 2 or more quadrants involved
- Source of sepsis, for example perforated duodenal ulcer.

Where tissue biopsies were taken, a follow up was made on such specimen to establish if malignancy was the primary pathology.
Laboratory parameters used to define organ failure were those of blood samples drawn within the first 24 hours of laparotomy. Renal and lung organ failure was defined by serum creatinine and urea levels, and partial pressures of carbon dioxide and oxygen in arterial blood gas analysis:-

- Renal; creatinine $\geq$177µmol/L and urea $\geq$16.7mmol/L
- Lungs; $PCO_2$ $\geq$50mmHg and $PO_2$ $\leq$50mmHg

Hypotension, defined as systolic BP <90mmHg recorded on admission was used to define shock or circulatory failure. Corroborative pulse and blood pressure recorded at initial visit was used to asses for persisting shock.

Presence of ileus, circulatory, renal or lung failure as defined above was taken as organ failure. The above factors were scored appropriately as per the MPI in the table below.

**Table 2: The Mannheim Peritonitis Index**

| Risk factor | Yes | No |
|---|---|---|
| Age >50 years | 5 | 0 |
| Female gender | 5 | 0 |
| Organ failure | 7 | 0 |
| Malignancy | 4 | 0 |
| Preoperative duration >24 hours | 4 | 0 |
| Origin of sepsis not colonic | 4 | 0 |
| Diffuse peritonitis | 6 | 0 |
| Exudates: Clear | 0 | 0 |
| Cloudy/purulent | 6 | 0 |
| Faecal | 12 | 0 |

Total patient MPI score was the sum total of all the positive risk factor scores.

Outcome evaluation entailed in-patient follow up. This was conducted regularly every alternate day following the initial visit until patient discharge or death. Morbidity during the follow up period was determined by duration of hospital stay and identification of one or more of the following complications; systemic(chest infection), local or gastrointestinal haemorrhage, wound sepsis, deep space infection, wound dehiscence, fistulation or ileus lasting more than 5 days.

Source control was deemed to have been achieved at initial laparotomy in patients who henceforth showed no continuing peritoneal contamination from the previous site of origin of sepsis.

The study end point was reached at on patient discharge or death.

**Results analysis and presentation**

The data collected was analysed both manually and with the aid of the computer programme Statistical Package for the Social Sciences (SPSS) software (version 12, SPSS Inc., Chicago, IL. USA). Individual patient MPI score and respective outcome was determined followed by stratification of the scores into 3 main groups of <21 points, 21-29 points and >29 points. A threshold score of 26 points was used to calculate morbidity and mortality relative risks, followed by evaluation of individual risk factors for significance. For statistical significance testing, Fisher's exact test, Mann Whitney U- test and Pearson correlation were applied as appropriate. Morbidity and mortality rates for the stratified MPI scores were calculated and the predictive power of the MPI, sensitivity and specificity derived from receiver-operator characteristic (ROC) curve analysis. P values of less than 0.05 were taken as statistically significant and 95% confidence intervals applied as necessary.

**Study limitations**

This was an observational study; hence the researchers assumed that all patients entered in the study had been subjected to a fairly standard treatment commensurate with the individual diagnosis. Inadequate treatment may have negatively impacted on outcome yet it was not the subject of this evaluation.

# RESULTS

## Background information

Seventy patients operated for peritonitis within the study period and meeting the inclusion criteria were recruited. Of these, 56 (80%) were males while 14 (20%) were females, giving a male to female ratio of 4:1. The mean age of presentation was 32.17 (Std dev 10.8) years, the youngest being 13 years and the oldest 59 years. 52 patients (74%) were aged between 20-40 years. The mean preoperative duration of symptoms was 5.5 (Std dev 3.5) days and ranged from 1-14 days with two peaks on the second and seventh days. 39 (55.7%) patients had one or more organ dysfunction with ileus being the most frequent at 48.6%. These are summarised in the table 3 and figures 1 and 2 below.

**Table 3: Background characteristics**

| Variable | Frequency | Percentage |
|---|---|---|
| Sex | | |
| Male | 56 | 80% |
| Female | 14 | 20% |
| Age group | | |
| <50 | 65 | 92.9% |
| ≥50 | 5 | 7.1% |
| mean age | 32.17 (min 13 yrs, max 59 yrs) | |
| Organ dysfunction | | |
| Yes | 39 | 55.7% |
| No | 31 | 44.3% |

**Figure 1:**

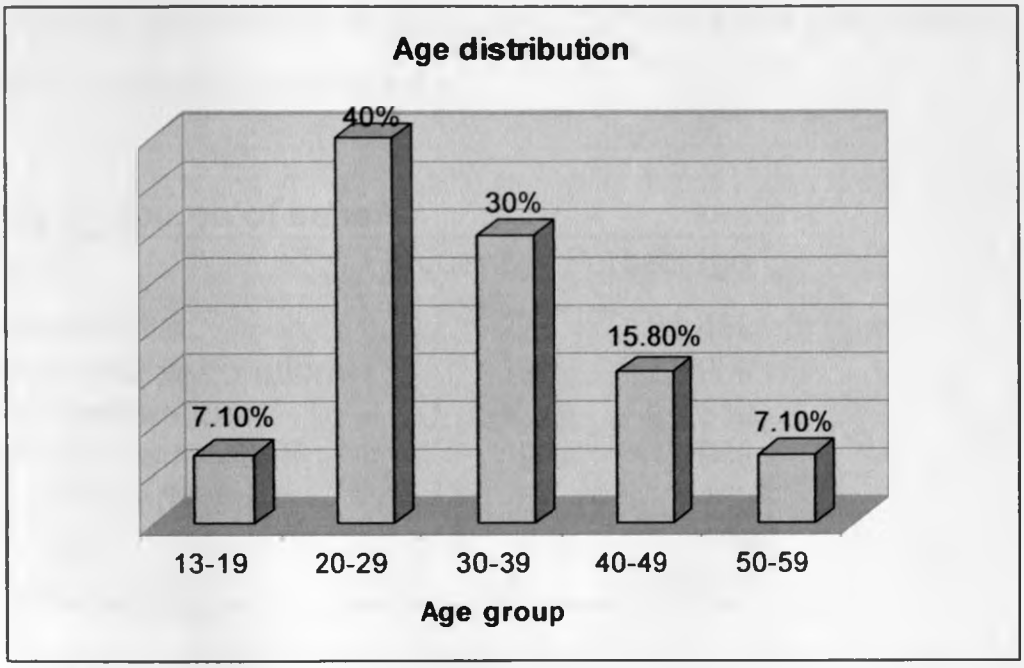
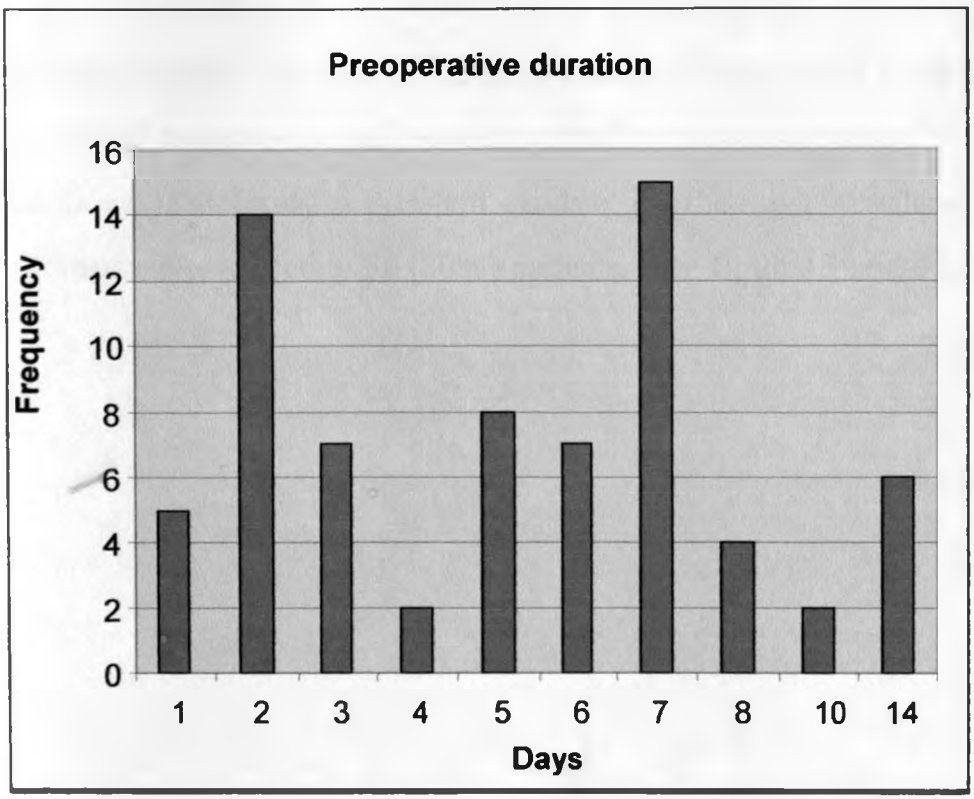



**Figure 2:**



The most common source of sepsis was perforated appendicitis (31.4%) followed by perforated duodenal ulcer at 22.9% and ileal perforation at 18.6% as depicted in table 4 below.

**Table 4: Source of sepsis**

| Source | Frequency | Percentage |
|---|---|---|
| Appendicitis | 22 | 31.4% |
| Duodenal perforation | 16 | 22.9% |
| Ileal perforation | 13 | 18.6% |
| Colonic perforation | 9 | 12.9% |
| Gastric perforation | 5 | 7.1% |
| Pelvic | 5 | 7.1% |
| Total | 70 | 100.0% |

Generalised peritonitis was found in 46 (70%) patients while 9 (14%) patients had focal peritonitis. Faecal peritonitis was observed in 12 (17%) patients while a cloudy or purulent exudate was the most prevalent form of peritonitis encountered in 56 (80%) patients. See figures 3 and 4 below.

**Figure 3:**

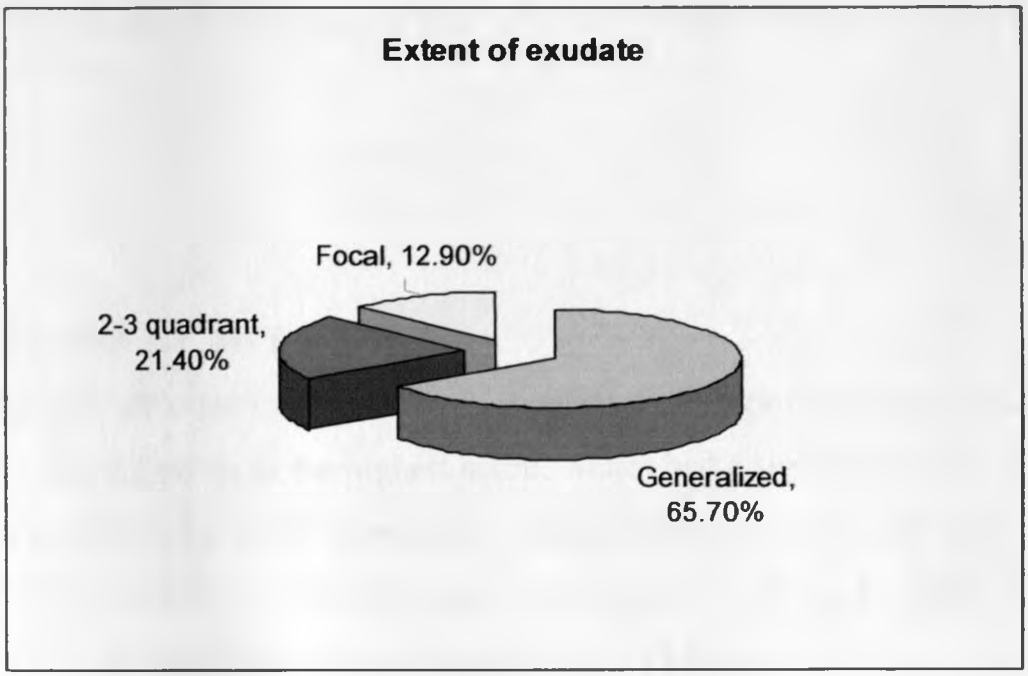
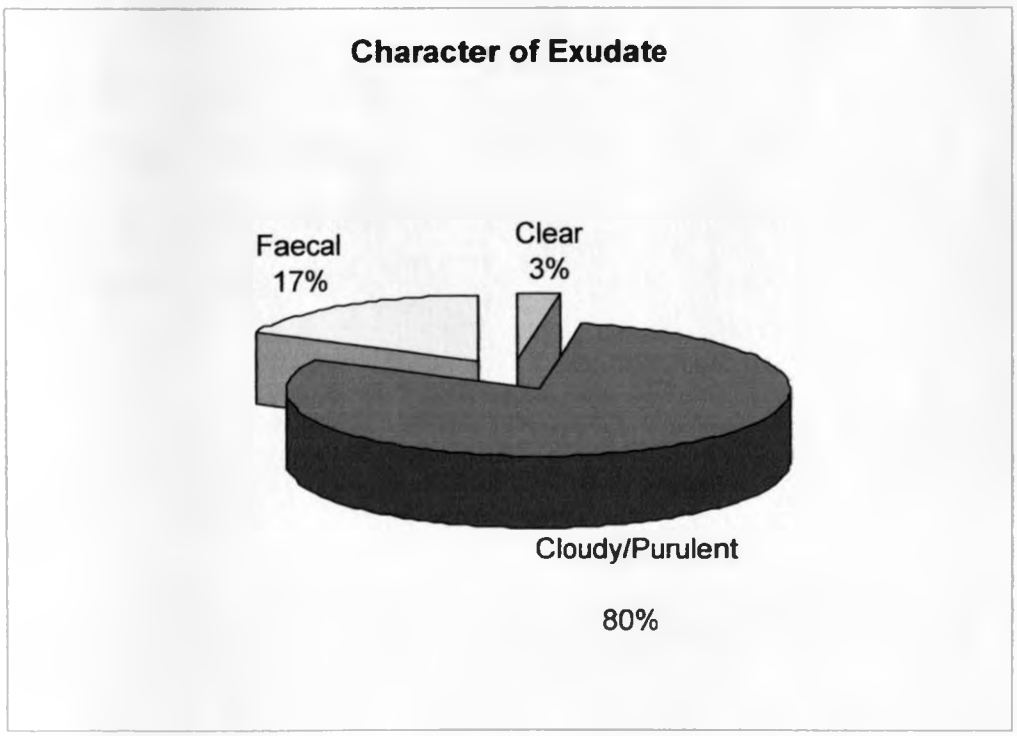



**Figure 4:**



Three patients had malignant bowel perforation; one male with colonic perforation and two females with colonic and ileal perforation.

**ANALYSIS OF MPI SCORES:**

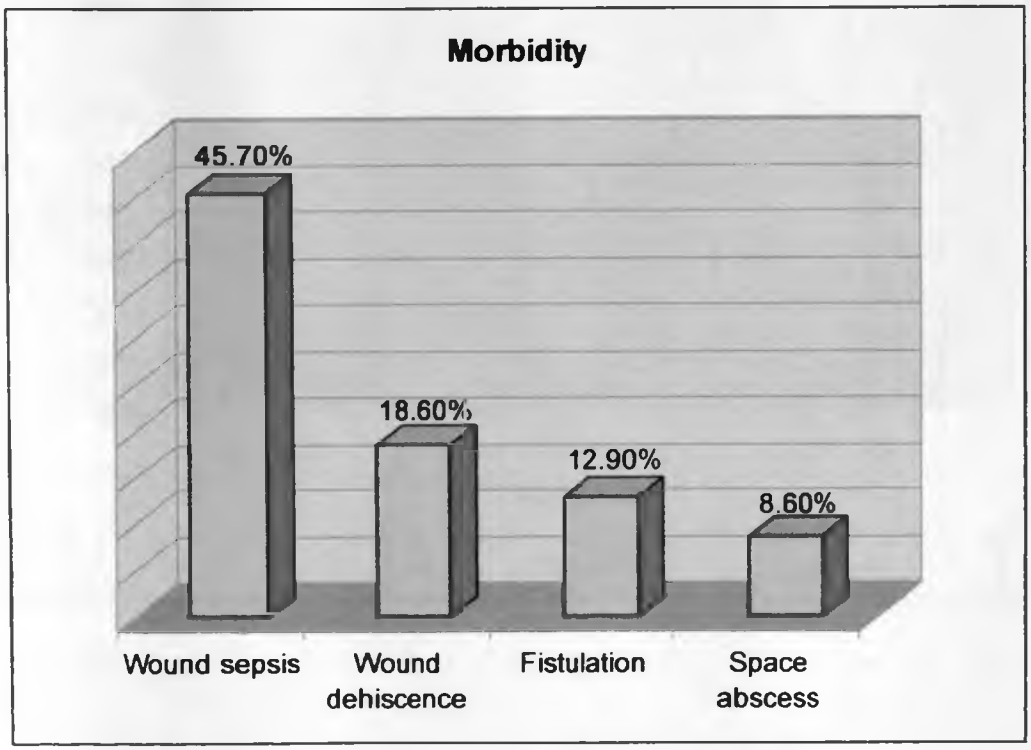
The mean MPI was 24.7 (Std dev 7.4) points with 10 points as the lowest score and 42 points as the highest score. Males had a significantly lower mean MPI of 23.7 points compared to females who scored a mean of 31 points ($p<0.0001$). 17 (24.3%) patients had an MPI >29 points. Table 5 shows the distribution of patients across the MPI groups.

**Table 5: MPI distribution by group**

| MPI Group | N | Percentage |
|---|---|---|
| <21 | 29 | 41.4% |
| 21-29 | 24 | 34.3% |
| >29 | 17 | 24.3% |
| Total | 70 | 100% |

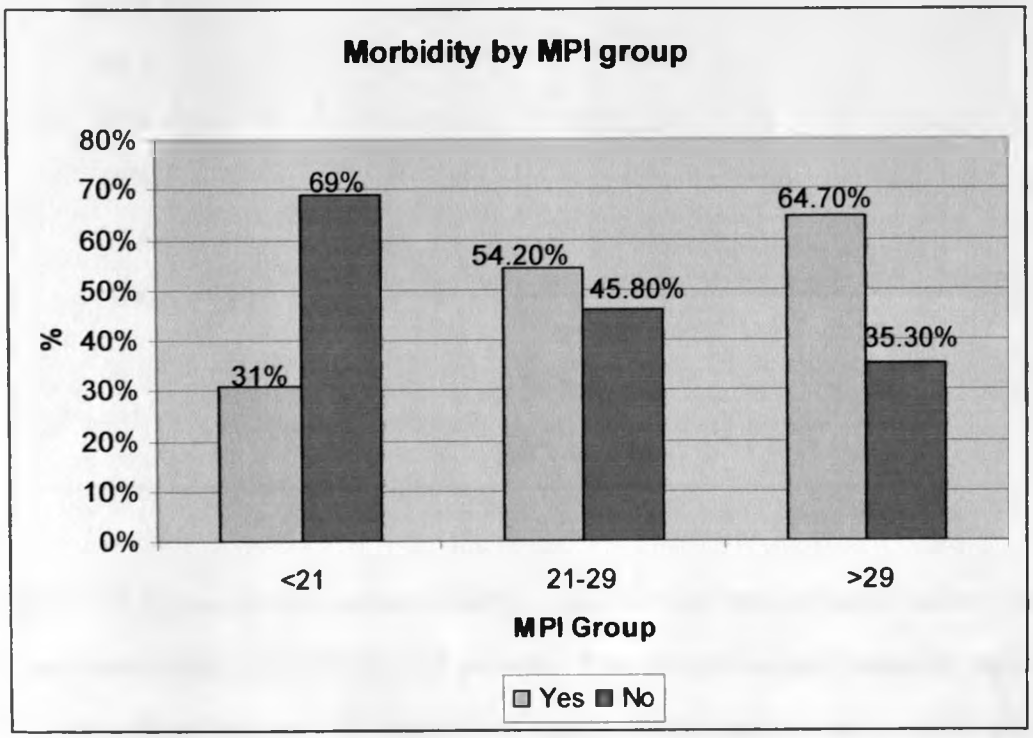
The overall morbidity rate was 47.1% with wound sepsis predominating at 45%. Two patients developed a chest infection that was successfully treated with antibiotics while another two developed gastrointestinal haemorrhage following fistulation and eventually succumbed. Only three patients were admitted to the ICU postoperatively for mechanical ventilation out of which one succumbed. The most common complications (morbidity) were local as shown in figure 5 below.

**Figure 5:**



Patients with morbidity had a significantly higher mean MPI of 26.9 points compared to those without who scored a mean MPI of 22.8 points ($p=0.018$). Morbidity rate within group increased with rising MPI scores as shown in figure 6.

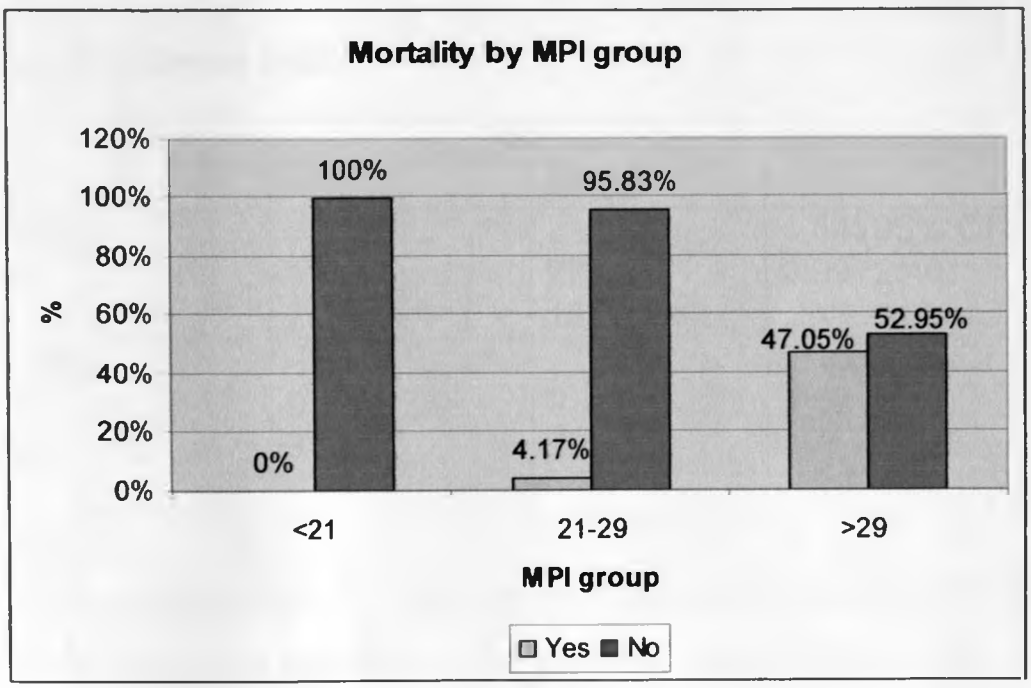
**Figure 6:**




Nine patients (six males and two females) died giving a 12.9% overall mortality rate. Mortality by gender was 10.7% for males and 21.4% for females. The mean MPI for non survivors was 33.8 points compared to 23.4 points for survivors ($p<0.0001$). Of all the non survivors, only one patient

(4.2%) had an MPI of <29 points (27 points). Figure 7 below depicts mortality trends across the MPI groups.

**Figure 7:**




All the nine patients in whom source control was not achieved after initial laparotomy had an MPI of ≥27 points. The overall mean hospital stay was 14±10.4 days (range 1-45 days) but significantly higher with morbidity at 22 days compared to 7 days with no morbidity (p=0.01). There was no significant difference in duration of hospital stay between survivors and non survivors.

## RISK EVALUATION

An MPI score of ≥26 points carried an associated x2.1 risk of in hospital death (95% CI 1.62-2.4) and x1.54 risk of morbidity. This is summarised in table 6 below.

**Table 6: Relative Risk**

| | MPI | | Relative Risk |
|---|---|---|---|
| | <26 | >/=26 | |
| Morbidity<br>Yes<br>No | <br>11<br>21 | <br>22<br>16 | 1.54 (95% CI 0.99- 2.40) |
| Mortality<br>Yes<br>No | <br>0<br>32 | <br>9<br>29 | 2.10 (95% CI 1.62 -2.40) |

Analysis of individual risk factors for correlation with increasing MPI scores using the Chi-square and Mann Whitney U-tests showed that age >50 years, presence of organ dysfunction, character and extent of exudate were significantly associated with an MPI score of ≥26. These are depicted in the tables 7 and 8, and figure 8 below.

**Table 7: Chi-square tests**

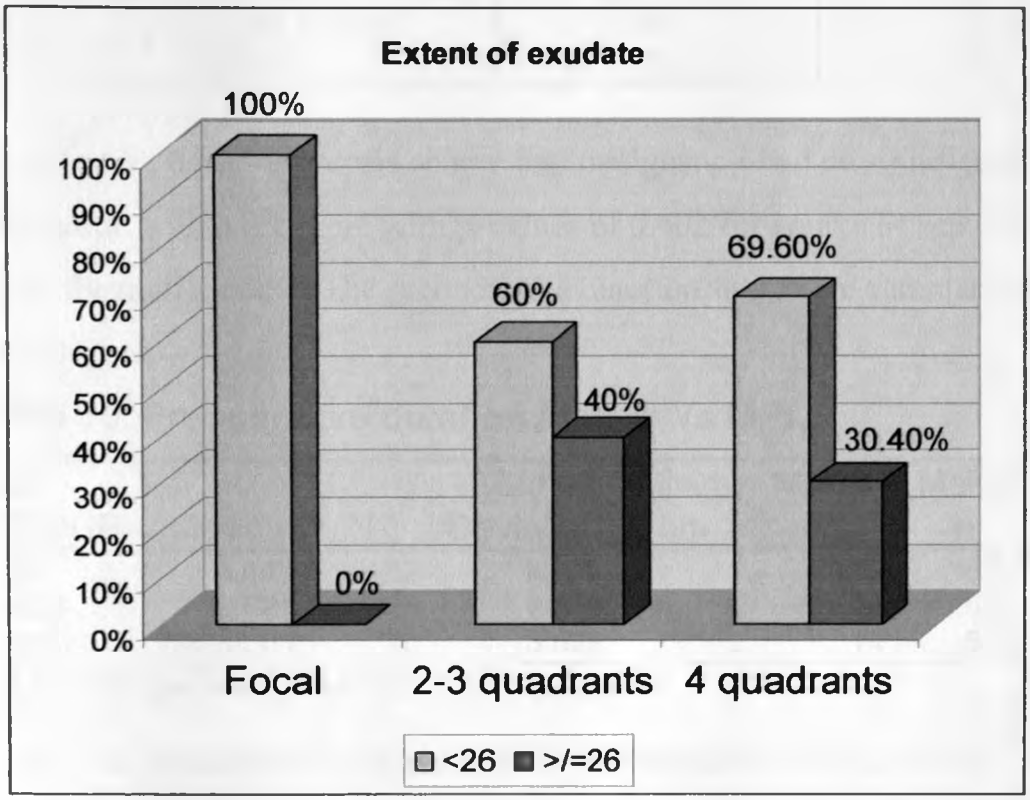
| Risk factor | Disease (MPI) | | Statistical test |
|---|---|---|---|
| | <26 | >/=26 | |
| Age group<br><50<br>>/=50 | <br>32 (49.2%)<br>0(0%) | <br>33 (50.8%)<br>5 (100%) | $\chi 2$=4.534: 1df: P<0.05 (0.033) |
| Organ dysfunction<br>Yes<br>No | <br>2 (5.1%)<br>30 (96.8%) | <br>37 (94.9%)<br>1 (3.2%) | $\chi 2$=58.454: 1df: P<0.05 (0.000) |

**Table 8: Character of exudate**

| MPI GROUP | Mean | N | Std. Deviation | Minimum | Maximum | Median |
|---|---|---|---|---|---|---|
| <26 | 5.8125 | 32 | 1.85677 | .00 | 12.00 | 6.0000 |
| >/=26 | 7.7368 | 38 | 2.75764 | 6.00 | 12.00 | 6.0000 |
| Total | 6.8571 | 70 | 2.56106 | .00 | 12.00 | 6.0000 |

Mann Whitney U-test, Z=-3.121: P<0.05 (0.002)

**Figure 8:**



Pearson correlation ($p<0.0001$) test showed that gender was significantly associated with higher MPI scores (table 9).

**Table 9: Pearson gender Vs MPI correlation:**

| | | Female gender score | Total MPI score |
|---|---|---|---|
| Female gender score | Pearson Correlation | 1 | .429(**) |
| | Sig. (2-tailed) | | 000 |
| | N | 70 | 70 |
| Total MPI score | Pearson Correlation | .429(**) | 1 |
| | Sig. (2-tailed) | .000 | |
| | N | 70 | 70 |

Preoperative duration, sepsis source and malignancy had no significant correlation with MPI score with p-values of 0.402 for source of sepsis and 0.590 for malignancy. The preoperative duration scores are summarised in table 10 below.

**Table 10: Preoperative duration in days Vs MPI**

| MPI GROUP | Mean | N | Std. Deviation | Minimum | Maximum | Median |
|---|---|---|---|---|---|---|
| <26 | 5.41 | 32 | 3.416 | 1 | 14 | 6.00 |
| >/=26 | 5.58 | 38 | 3.659 | 1 | 14 | 5.00 |
| Total | 5.50 | 70 | 3.525 | 1 | 14 | 5.00 |

Mann Whitney U-test, Z=-0.072: P>0.05 (0.943)

Of the five patients who presented and were operated within 24 hours, two had an MPI of 21-29 points while three had an MPI <21 points. Three patients developed wound sepsis, one of them associated with fistulation. Their mean hospital stay was 16 days. No mortality occurred in this subgroup of patients although outcome in terms of morbidity and hospital stay was no better than for late presenters. Tables 11 and 12 depict Pearson correlation for sepsis source and malignancy with MPI score.

**Table 11: Sepsis source Vs MPI correlation**

| | | Source of sepsis | Total MPI score |
|---|---|---|---|
| Source of sepsis | Pearson Correlation | 1 | -.102 |
| | Sig. (2-tailed) | . | .402 |
| | N | 70 | 70 |
| Total MPI score | Pearson Correlation | -.102 | 1 |
| | Sig. (2-tailed) | .402 | . |
| | N | 70 | 70 |

**Table 12: Malignancy Vs MPI correlation**

| | | Malignancy score | Total MPI score |
|---|---|---|---|
| Malignancy score | Pearson Correlation | 1 | .065 |
| | Sig. (2-tailed) | . | .590 |
| | N | 70 | 70 |
| Total MPI score | Pearson Correlation | .065 | 1 |
| | Sig. (2-tailed) | .590 | . |
| | N | 70 | 70 |

Prolonged hospital stay strongly correlated with an MPI of ≥26 points (p=0.016) (table 13).

**Table 13: Hospital stay in days Vs MPI**

| MPI GROUP | Mean | N | Std. Deviation | Median | Minimum | Maximum |
|---|---|---|---|---|---|---|
| <26 | 11.2813 | 32 | 7.04014 | 8.5000 | 5.00 | 36.00 |
| >/=26 | 17.7105 | 38 | 11.82966 | 14.0000 | 1.00 | 45.00 |
| Total | 14.7714 | 70 | 10.37859 | 10.0000 | 1.00 | 45.00 |

Mann Whitney U-test, Z=-2.417: P<0.05 (0.016)

Only 4 out 17 (23.5%) patients with an MPI ≥29 had no adverse outcome at discharge.

## ROC CURVES FOR MORBIDITY AND MORTALITY

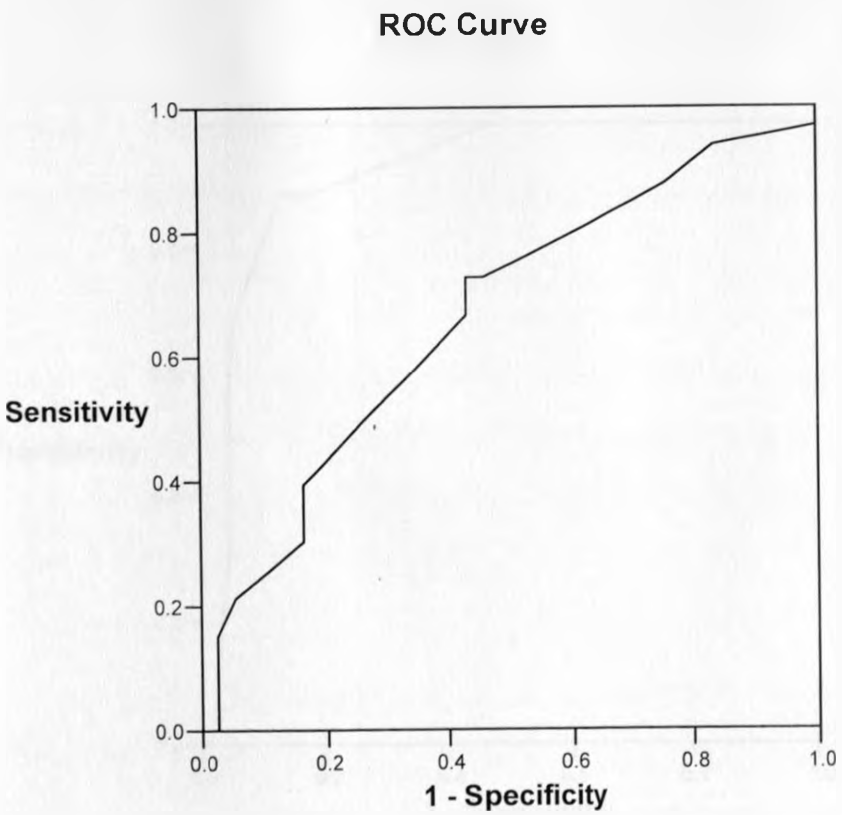
The predictive power of the MPI for morbidity in this study was 0.663 with a sensitivity of 33.3% and specificity of 83.8% at a score of 29 points as shown in table 12 and figure 9 below.

**Table 14:**

**Morbidity table: AUC=0.663**

| MPI | Sensitivity | Specificity |
|---|---|---|
| 26 | 66.7% | 56.8% |
| 29 | 33.3% | 83.3% |

**Figure 9: Morbidity ROC Curve**



**Mortality ROC Curve**

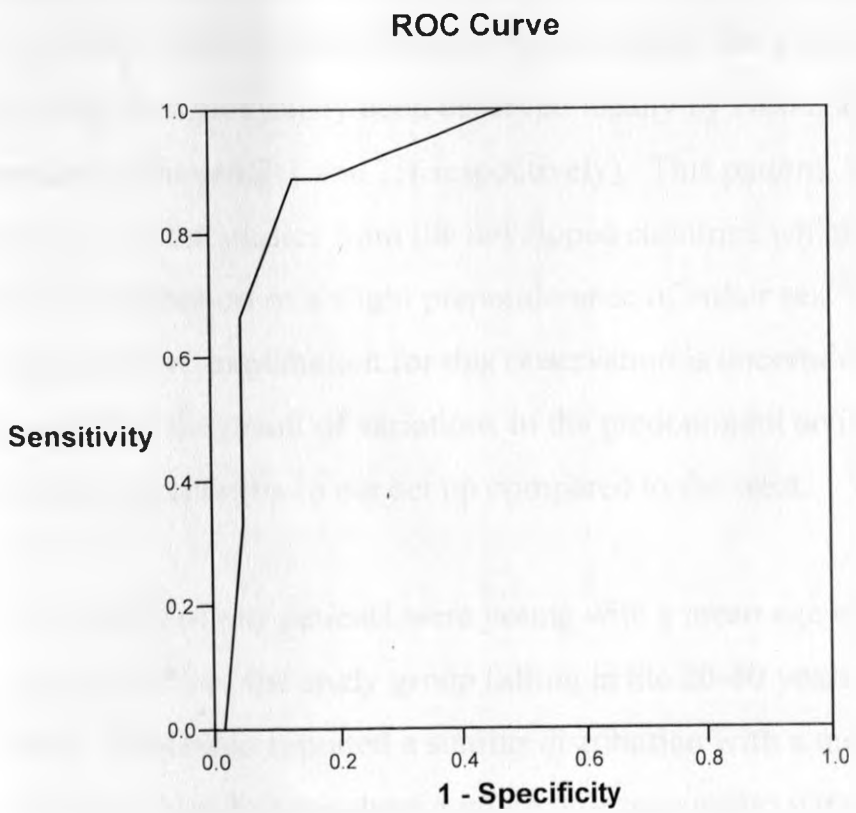
The ROC curve for mortality showed a predictive power of 0.916 with a sensitivity of 88.9% and specificity of 85.2% at an MPI of 29 points. These are shown in table 13 and figure 10 below.

**Table 15:**

**Mortality table: AUC=0.916**

| MPI | Sensitivity | Specificity |
|---|---|---|
| 26 | 100% | 53% |
| 29 | 88.9% | 85.2% |

**Figure 10: Mortality ROC Curve**



## DISCUSSION

Successful management of a heterogeneous condition like peritonitis has for decades presented a challenge to the surgeon despite advancements in medical sciences. This led to the need of development of disease severity grading systems that would aid in stratifying patients by individual risk variables and hence appropriately predict possible outcome. Prognostication has become part and parcel of modern medical practice.

In this study, it was set out to stratify the severity of peritonitis and predict outcome using the MPI at KNH. Of the seventy patients recruited, an unequal sex distribution was observed giving a male to female ratio of 4:1. This pattern of male preponderance in laparotomy for general surgical pathology had previously been observed locally by Ndonga[1] and Kimani[2] in separate studies (6.7:1 and 2:1 respectively). This pattern, however seems to sharply contrast studies from the developed countries which show an even gender distribution or a slight preponderance of either sex.[3, 6, 7, 18, 21, 38] A comprehensive explanation for this observation is uncertain from our data but could be the result of variations in the predominant aetiologies of secondary peritonitis in our set up compared to the west.

The majority of our patients were young with a mean age of 32.17±10.8 years and 74% of the study group falling in the 20-40 years age category. Melero[7] in Mexico reported a similar distribution with a mean of 34.6 years but studies from Europe show a much older age group with a range of 44-64.8 years even in centres where source spectrum closely resembles our findings.[3, 6, 21, 23, 38]

Only 5 of the 70 patients in this study presented to hospital and were treated within 24 hours of onset of symptoms. Sixty percent of the patients presented to hospital and were operated at least 5 days after onset of symptoms. In the final analysis, there was no significant difference in outcome between those who presented within 24 hours and the late presenters. The two peaks of presentation observed on the 2nd and 7th days is a pattern that had previously been noted by Ndonga[1] in his study on jejunoileal perforations. This trend may be a reflection of local health seeking behavioural patterns that require further evaluation for a comprehensive explanation.

Although ileus was the most frequent organ dysfunction encountered, it is the number of failing organs which eventually affected outcome. Two out of 3 of our patients who had 4 dysfunctioning organs died while 2 of the 5 patients who had 3 failing organs died. The rest of this sub group of patients had morbidity with prolonged hospital stay. The influence of number of failing organs on outcome has been highlighted in previous studies with mortality as high as 100% reported where 4 organs were failing.[7, 3, 23] This study appears to validate this observation and indeed an increase in number of failing organs implies poor prognosis.

In a previous study at KNH, Ndonga[1] found that perforated duodenal ulcer was the commonest cause of generalized peritonitis at 28% followed by jejunoileal perforations (19.5%) and perforated appendicitis (14.6%). This study, which included patients with focal peritonitis shows that perforated appendicitis (31.4%) is the commonest source of peritoneal sepsis at KNH. However, considering that most patients with focal peritonitis had a

diagnosis of appendicitis, perforated gastro duodenal peptic ulcers (30%) remain the commonest cause of generalized peritonitis at KNH followed by ileal perforation at 18.6% in keeping with the above findings. Studies from Europe show a different picture with colonic perforation due to diverticular disease and cancer (16-70%) the leading causes followed by gastro duodenal peptic ulcer perforation (16%) and perforated appendicitis (8%).[3, 6, 21, 24] Only 3 patients in this study had tumour perforation causing peritonitis with all surviving and only one developing a local complication (wound sepsis). Due to the small numbers and hence lack of statistical significance, this study did not find this diagnosis predictive of eventual outcome despite findings that suggest a strong correlation elsewhere.[6, 7]

The primary source of peritonitis often dictates the type of exudate one would find at laparotomy. This explains why the majority of patients (80%) had a cloudy/purulent exudate at operation. The character of exudate has a direct impact on eventual total MPI score and hence influenced stratification of disease severity.

The mean MPI of 24.7±7.4 points in this study compares well with previous studies. Sailer et al[3] analyzed 258 patients with an exclusive diagnosis of generalized peritonitis and reported so far the highest mean of 27.1 points. Bielecki et al[6] found a mean of 24.2 points amongst patients with large bowel perforation, whereas Pacelli et al[38] reported a mean of 20±8 points in a multivariate analysis of 604 patients with peritonitis varied sources. In this study, the mean male MPI score of 23.7 points was close to the overall study mean compared to females whose mean of 31 points stratified them into a high risk group for both morbidity and mortality. Females did actually fair

poorly compared to their male counterparts recording higher gender morbidity (65%) and mortality (21.4%) rates. Although female sex is one of the risk factors in the MPI, this study did not find previous researches that compare differences in gender mean MPI scores.

Morbidity rates in surgery for peritonitis vary worldwide with reports ranging from 18% to 67%.[3, 6, 7, 21, 38] Locally, Ndonga[1] found a rate of 61.1% in jejunoileal perforations while Kimani[2] and Mwendwa[40] whose study populations had varied laparotomy indications reported rates of 52% and 22.4% respectively. This study found an overall morbidity rate of 47.1% with wound sepsis the most common complication. Although localised complications replicate patterns observed in other studies, it is noteworthy that systemic complications were less observed in this study than one would have expected.[3, 6, 7, 21 38] Gastrointestinal haemorrhage complicating surgery for peritonitis in this study occurred following fistulation in two patients. Only Biondo et al[21] reports this complication amongst our references. The fatality for this complication in this study was 100% and thus its occurrence may call for a more aggressive management approach.
The mean MPI for morbidity in this study was 26.9 points (22.8 points for no morbidity) with group morbidity rates rising progressively from 33% at MPI 21 points to 65% at MPI >29 points. Based on disease severity stratification, this would be the expected pattern although previous studies only stratified scores for mortality rates.

The overall mortality rate of 12.9% is in keeping with rates from referenced studies. Rates from European studies range from 6% to 42%.[3, 6, 7, 18, 21, 22] Locally, a rate of 22% in patients with generalized peritonitis due to

jejunoileal perforations has been reported.[1] The mean MPI for non survivors was 33.8 points (23.4 points in survivors) and compares favourably with other studies that give a range of 26.37-32.7 points.[3, 6, 21]

In a meta-analysis of results from 7 centres involving 2003 patients, Billing et al[22] reported an average group mortality rate of 2.3% for MPI <21 points, 22.5% at MPI of 21-29 points and 59% with MPI of >29 points. In this study, the group mortality rate albeit lower appear to follow this pattern as no mortality occurred at MPI <21 points, was 4% with MPI 21-29 points and was 47% with MPI >29points. Differences in patient demographics, sepsis source and co morbidities between our study population and international reports already alluded to above may be responsible for the lower mortality rates observed in this study.

Multiorgan failure is the most common cause of death in peritonitis. It is often a sequel of severe sepsis, the progenitor of systemic inflammatory response syndrome (SIRS) in this setting, which culminates in multiorgan dysfunction syndrome (MODS) and eventually multiorgan failure (MOF).[3, 6, 7, 21, 24] Failure to achieve source control results in persisting peritonitis and sepsis leading to continuing evolution of this fatal pathway. Sailer et al[3] reported a mortality rate of 27% where source control was not achieved whereas Koperna et al[24] found a 52.4% rate. In this study, all the patients in whom source control was not achieved scored at least 27 points and had a mortality rate of 77%, way above those mentioned above. Attaining source control is thus critical in successful management of peritonitis.

Morbidity increased hospital stay significantly to a mean of 22 days (7 without morbidity) eventually pushing the overall mean hospital stay to 14 days, a finding that was in keeping with other studies.[6, 8, 21] Higher mean

MPI scores as previously seen correlate with increased morbidity rates and by extrapolation imply prolonged hospital stay. Prolonged hospital stay did indeed strongly correlate with MPI ≥26 points.

Patients who scored at least 26 points in this study had twice as much risk of in hospital death compared to their counterparts who scored fewer points. Sailer et al[3], Bielecki et al[6], and Qureshi et al[39] had already shown that patients who scored ≥26 points had a significantly higher mortality rate than their counterparts scoring <26 points.

The most significant predictive factors for morbidity/mortality in this study were female gender, age above 50 years, presence and number of organ dysfunction, character of and exudate extent. Melero[7] found a similar pattern but notes that gender was not a significant factor. Malignancy, preoperative duration, and source of sepsis had no significant influence on eventual MPI score in this study. Sailer et al[3] whose study focussed on generalized peritonitis reports similar findings only that he found preoperative duration to significantly influence eventual mean MPI from 23.2 to 29 points. That this study included patients with focal peritonitis coupled by large numbers of late presenters may explain lack of statistical significance. Studies by Anaya et al[18], Billing et al[22] and Notash et al[23] showed that peritonitis of appendicular or colonic origin carries a lesser risk than those from other sources. Correlation between sepsis source and eventual MPI score in our study did not attain statistical significance. There were only 3 patients who were admitted to the intensive care unit (ICU) postoperatively out of which one died. Other studies show admission rates as high as 62%.[24] MPI scores higher than 29 often signify severe

disease process with possible profound physiological derangements that would call for intensive care in an ICU. The fewer admissions here could have been due to unavailability of space in an ICU already burdened by other critically ill patients. It is uncertain however if admitting patients with higher scores to the ICU could have significantly changed overall outcome since our numbers were too few for statistical significance and overall study results favourably compare with other studies.[6, 21, 22, 23, 38]

This study attained a morbidity predictive power of 0.663 by ROC curve analysis. Although low, it did attain statistical significance albeit with a low sensitivity of 33% but good specificity of 83.3% at a score of 29 points. This may be due to the fact that 60% of all patients with morbidity had an MPI ≤29 points. Reports on ROC curve analysis for morbidity were lacking in our references.

In analysis of ROC curve for mortality, Biondo et al[21] reported a predictive power of 0.725 at an MPI score of 26 points, while Notash et al[23] found a predictive power of 0.972 with 79% sensitivity and 96% specificity at an MPI of 29 points. Billing et al[22] in a meta analysis of 2003 patients reported a mean sensitivity of 86% (54%-98%) and specificity of 74% (58%-97%) at a score of 26 points. Our study attained a mortality predictive power of 0.916 with a sensitivity of 88.9% and specificity of 85.2% at an MPI of 29 points. This result compares favourably with what has already been reported in literature.

Studies evaluating the usefulness of the MPI in outcome prediction in comparison with other risk stratification studies have shown that it compares

well with most of them, if not superior. Validation studies comparing its strength in outcome prediction with established scoring systems like acute physiology and chronic health evaluation (APACHE) II have shown that the two are accurate predictors of early outcome in peritonitis.[8, 21, 22, 24] Overall, our results validate its usefulness in risk stratification and outcome prediction.

This study had its own limitations. Being an observational study, we assumed that all patients received standard and adequate therapy commensurate with the diagnosis. Inadequate therapy contributing to either morbidity or mortality could be confounding factors. The exclusion of children less than 13 years also renders the results inapplicable to this group of patients.

## CONCLUSION

The results of this study are in keeping with previous studies else where and show that the MPI score is predictive of outcome.

It is concluded that the MPI score is a useful disease severity stratification tool and can be used to prognosticate early outcome in patients managed for secondary peritonitis at KNH.

## RECOMMENDATIONS

From the findings of this study, it is recommended that:-

1) The MPI score be adopted as a risk stratifying tool in management of patients with secondary peritonitis at KNH with the aim of identifying and aggressively managing high risk patients so as to improve outcome
2) Efforts be made by surgeons to attain source control at initial laparotomy to minimize complications, especially fistulation which had a significant influence on outcome
3) Longer duration similar study be done to further investigate the influence of time factor and malignancy on outcome since the corresponding numbers in this study were few for statistically significant conclusions to be made
4) Similar study (with may be some modifications) be carried out in children <13 years since this study did not include this age category.

## REFERENCES


1. Ndonga AK. A study of atraumatic jejunoileal perforations at Kenyatta National Hospital. M Med (Surgery) UoN dissertation 2002: 28-60
2. Kimani MM. Evaluation of the POSSUM and P-POSSUM system of surgical audit in patients undergoing laparotomy at Kenyatta National Hospital. M Med (Surgery) UoN dissertation 2007: 42-47
3. Seiler CA, Brugger L, Forssmann U, et al. Conservative surgical treatment of diffuse peritonitis. *Surgery* 2000; **127**: 178-184
4. Sendt W, Amberg R, Reinshagen K, et al. Secondary peritonitis: Severity of disease and activation of peritoneal cells. *Eur J Surg* 2001; **167**: 426-432
5. Steeb G, Wang YZ, Siegrist B, et al. Infections within the peritoneal cavity: A historical perspective. *Am Surg* 2000; **66**: 98-104
6. Bielecki K, Karminski P, Klukowski M. Large bowel perforation: morbidity and mortality. *Tech Coloproctol* 2002; **6**: 177-182
7. Melero A. Mannheim peritonitis index validation study at the Hospital General De Durango. *Cirugia Cirujianos* 2002; **70**: 217-225
8. Bosscha K, Reijnders K, Hulstaert PF, et al. Prognostic scoring systems to predict outcome in peritonitis and intra-abdominal sepsis. *Br J Surg* 1997; **84**: 1532-1534
9. Toni H. Biology and treatment of peritonitis: The historic development of current concepts. *J Am Coll Surg* 1998; **186**: 475-484
10. Bell RL, Neal ES. Abdominal wall, omentum, mesentery and retroperitoneum. In Brunicardi CF, Andersen DK, Billiar TR (Eds). *Schwartz's Principles of Surgery,* 8th edition; McGraw-Hill 2005: 1321-1323

11. Langford RM, Mythen MC. Acute life support and critical care: Fluid, electrolyte and acid base balance and blood transfusion. In Russell RCG, Norman SW, Christopher JKB (Eds). *Bailey and Love's Short Practice of Surgery,* 24th edition; Edward Arnold 2004: 55-77

12. Romanes GJ. The abdominal cavity. In Romanes GJ (Ed). *Cunningham's manual of practical anatomy. Volume 2. Thorax and abdomen,* 15th edition; Oxford University Press 2003: 113-125

13. Moore KL, Dalley AF. Peritoneum and peritoneal cavity. In Moore KL, Dalley AF (Eds). *Clinically oriented anatomy,* 4th edition; Lippincott Williams and Wilkins 1999: 209-218

14. Doherty GM, Boey JH. Peritoneal cavity. In Way LW, Doherty GM (Eds). *Current surgical diagnosis and treatment,* 11th edition; Lange Medical Publications 2003: 517-532

15. Skipworth RJE, Fearon KCH. Acute abdomen: Peritonitis. *Surgery* (Quarterly edition) 2005; **70**: 6-9

16. Turnage RH, Li DLB, McDonald CJ. Peritoneum and peritoneal cavity. In Townsend CM, Beauchamp DR, Evers MB, et al (Eds). *Sabiston textbook of surgery,* 17th edition; Elsevier 2004: pp 1180-1182

17. Sotto A, Lefrant J, Peray P, et al. Evaluation of antimicrobial therapy management of 120 consecutive patients with secondary peritonitis. *J Antimicrob Chemother* 2002; **50**: 569-576

18. Anaya DA, Nathens AB. Risk factors for severe sepsis in secondary peritonitis. *Surg Infect* 2003; **4**: 355-362

19. Zugel N, Siebeck M, Jochum M, et al. Circulating mediators and organ function in patients undergoing planned relaparotomy vs conventional surgical therapy in severe secondary peritonitis. *Arch Surg* 2002; **137**: 590-599

20. Thompson J. The peritoneum, omentum, mesentery and retroperitoneal space. In Russell RCG, Norman SW, Christopher JKB (Eds). *Bailey and Love's Short Practice of Surgery,* 24th edition; Edward Arnold 2004: 1133-1152

21. Biondo S, Ramos E, Fraccalvieri D, et al. Comparative study of left colonic peritonitis severity score and Mannheim peritonitis index. *Br J Surg* 2006; **93**: 616-622

22. Billing A, Frohlich D, Schildberg FW. Prediction of outcome using the Mannheim peritonitis index in 2003 patients. *Br J Surg* 1994; **81**: 209-213

23. Notash A, Salimi J, Rahimian H, et al. Evaluation of Mannheim peritonitis index and multiple organ failure score in patients with peritonitis. *Ind J Gastroenterol* 2005; **24**: 197-200

24. Koperna T, Schulz F. Prognosis and treatment of peritonitis: Do we need new scoring systems? *Arch Surg* 1996; **131**: 180-186

25. Mazuski JE, Sawyer RG, Nathens AB et al. The surgical infection society guidelines on antimicrobial therapy for intra-abdominal infections: An executive summary. *Surg Infect* 2002; **3**: 161-173

26. Vincent JL, Sun Q, Dubois MJ. Clinical trials of immunomodulatory therapies in severe sepsis and septic shock. *Clin Infect Dis* 2002; **34**: 1084-1093

27. Toni H, Ohmann C, Wacha H, et al. Planned relaparotomy vs relaparotomy on demand in the treatment of intra-abdominal infections. *Arch Surg* 1995; **130**: 1193-1197

28. Sokmen S, Atila K, Bora S, et al. Evaluation of prosthetic mesh closure in semiopen abdomen patients. *Hernia* 2002; **6**: 124-129

29. Zeitoun G, Laurent A, Rouffet F, et al. Multicentre randomized clinical trial of primary versus secondary sigmoid resection in generalized peritonitis complicating sigmoid diverticulitis. *Br J Surg* 2000; **87**: 1366-1374

30. Ngera SN. Emergency colonic surgery as seen at Kenyatta National Hospital. M Med (Surgery) UoN dissertation 2000: 58-77

31. Lamme B, Boermeester MA, Belt EJT, et al. Mortality and morbidity of planned relaparotomy versus relaparotomy on demand for secondary peritonitis. *Br J Surg* 2004; **91**: 1046-1054

32. Reitsma JB, Lamme B, Boermeester MA, et al. Meta-analysis of relaparotomy for secondary peritonitis. *Br J Surg* 2002; **89**: 1516-1524

33. Slade D, Scott N. Intestinal fistulas. *Surgery* (Quarterly edition) 2005; **71**: 40-43

34. Navez B, Xavier D, Emmanuel C, et al. Laparoscopic approach for acute appendicular peritonitis: Efficacy and safety: A report of 96 consecutive cases. *Surg Laparosc Endosc Percutan Tech* 2001; **11**: 313-316

35. Navez B, Tassetti V, Scohy JJ, et al. Laparoscopic management of acute peritonitis. *Br J Surg* 1998; **85**: 32-36

36. Wittmann DH, Schein M, Condon RE. Management of secondary peritonitis. *Ann Surg* 1996; **224**: 10-18

37. Linder MM, Wacha H, Feldmann U, et al. The Mannheim peritonitis index. An instrument for the intraoperative prognosis of peritonitis. *Chirurg* 1987; **58**: 84-92

38. Pacelli F, Battista DG, Sergio A, et al. Prognosis in intra-abdominal infections: Multivariate analysis on 604 patients. *Arch Surg* 1996; **131**: 641-645

39. Qureshi MA, Zafar A, Saeed K, et al. Predictive power of Mannheim peritonitis index. *J Coll Physic Surg Pakistan* 2005; **15**: 693-696

40. Mwendwa KM. Surgical site infection (SSI) in abdominal surgery at Kenyatta National Hospital. M Med (Surgery) UoN dissertation 2004: 28-34

## APPENDIX 1A

**Consent for inclusion in the study: Explanation**

My name is Dr Benjamin Wabwire and I am studying for a higher degree in surgery at the University of Nairobi. My work place is at Kenyatta National Hospital.

In order to improve the care we provide to patients, there is need to evaluate how the patients we treat respond to the care given. I am conducting one such evaluation to find out how patients treated for peritonitis respond to the treatment at KNH. Peritonitis is an infection which affects the inner lining of the abdomen when contents of the stomach or intestines leak out into the surrounding space.

To conduct this evaluation, I have to collect some information from the patients who are being treated for this condition. This information will consist of your age and gender, duration of your illness, what the doctors found during the operation and what was done to correct the problem.

During your hospital stay, I will visit you again to see how you respond to the treatment you receive until you leave hospital.

I will not release the information I gather from you to any other persons and neither will I interfere with the treatment you are receiving.

Your participation in this evaluation will be voluntary and should you choose not to be included, the treatment you are getting will not be interfered with in any way.

If you agree to be included in this evaluation, please sign the section below.

**CONSENT**

I .....

confirm that the purpose of this study and my role have been well explained to me by Dr Benjamin Wabwire. I agree to the conditions explained and give consent to be included, or for .....

who is my dependant by virtue of being a minor or unable to consent.

Name.....

Sign.....

IP No.....

Witness .....

Sign.....

Date.....

Contact: Dr Benjamin Wabwire

Telephone number: 0722 247 811

## APPENDIX 1B.

**Maelezo ya idhini ya kujumuishwa katika utafiti**

Jina langu ni dakitari Benjamin Wabwire. Mimi ni mwanafunzi wa shahada ya juu ya upasuaji katika chuo kikuu cha Nairobi. Mahali pa kazi ni hapa hosipitali kuu ya Kenyatta.

Ili kuimarisha matokeo ya huduma inayotolewa kwa wagonjwa, tunahitaji kufanya utafiti unaoangazia matokeo ya tiba iliyotolewa. Niko katika harakati za kutekeleza utafiti wa aina hii ambao utachunguza jinsi wagonjwa waliopata kupasuliwa kwa sababu ya maradhi kwenye tumbo hupata afueni. Haya ni maradhi ambayo husababishwa na utumbo kutoboka na kumwaga uchafu ambao husambaa tumbo nzima ikiambatana na uchungu pamoja na kudhoofisha mwili wote.

Ili nitekeleze huu utafiti, inabidi nichunguze vielelezo kadha wa kadha kwa wale wagonjwa wanao hudumiwa kwa maradhi haya. Vielelezo vitahusisha mambo kama umri na jinsia, muda ambao umeugua, kile madakitari wa upasuaji walitambua kama chanzo cha maradhi na walilofanya ili kurekebisha shida hiyo. Nitakutembelea baadaye kwa ajili ya kujua jinsi utakavyokuwa unaendelea kupata afueni hadi siku utakaporuhusiwa kutoka hosipitali.

Nitatunza habari yote nitakayopata kwako kwa siri na pia sitaingilia mpangilio wa matibabu utakayoendelea kupokea.

Kujumuishwa kwako kwa huu utafiti utakuwa kwa hiari yako na hata iwapo utakataa kujumuishwa, matibabu unayoendelea kupokea hayatadunishwa kwa vyovyote vile.

Iwapo unakubali kujumuishwa kwa huu utafiti, tafadhali tia sahihi kwa sehemu ifwatayo.

**Idhini**

Mimi.....

nadhibitisha kwamba nimeelezwa barabara juu ya lengo la utafiti huu pamoja na kushirikishwa kwangu kwenye utafiti.

Ninakubali kujumuishwa kwangu, au kwa mgonjwa wangu.....

kwenye utafiti huu.

Jina .....

Sahihi.....

Nambari ya mgonjwa.....

Shahidi.....

Sahihi ya shahidi.....

Tarehe.....

Mawasiliano: Dr Benjamin Wabwire

Nambari ya simu 0722 247 811

APPENDIX 2

**Data collection sheet** **Code**.....

1. IP NO.....
2. Age .....
3. Sex: Male ☐ Female ☐
4. Preoperative duration of symptoms.....
5. Pulse on admission.....
6. Postoperative pulse.....
7. Blood pressure on admission.....
8. Postoperative blood pressure.....
9. Creatinine.....
10. Urea.....
11. $PCO_2$.....
12. $PO_2$.....
13. Preoperative ileus: Yes ☐ No ☐
14. Organ dysfunction: Yes ☐ No ☐. If yes, number.....
15. Source of sepsis.....
16. Character of exudates:
    - Clear ☐
    - Cloudy/purulent ☐
    - Faecal ☐
17. Extent of exudate:
    - 4 quadrants ☐
    - 2-3 quadrants ☐
    - Focal/single quadrant ☐
18. Malignancy suspected: Yes ☐ No ☐

If yes, histological findings: Ca ☐ Benign ☐

19. Total MPI:

| Risk factor | Score |
|---|---|
| Age >50 years | |
| Female gender | |
| Organ failure | |
| Malignancy | |
| Preoperative duration >24 hours | |
| Origin of sepsis not colonic | |
| Diffuse peritonitis | |
| Exudates: Clear<br>Cloudy/purulent<br>Faecal | |
| Total MPI score | |

20. MPI group: <21 ☐ 21-29 ☐ >29 ☐

21. Source control achieved: Yes ☐ No☐

22. Morbidity: Yes ☐ No ☐

23. If yes, specify.....

24. Mortality: Yes ☐ No ☐

25. Hospital stay.....

KENYATTA NATIONAL HOSPITAL
Hospital Rd. along, Ngong Rd.
P.O. Box 20723, Nairobi.
Tel: 726300-9
Fax: 725272
Telegrams: MEDSUP", Nairobi.
Email: KNHplan@Ken.Healthnet.org

5th December 2007

Ref: KNH-ERC/ 01/ 4004

Dr. Benjamin Wabwire
Dept. of Surgery
School of Medicine
University of Nairobi

Dear Dr. Wabwire

RESEARCH PROPOSAL: "STRATIFIED OUTCOME EVALUATION IN PERITONITIS" (P284/09/2007)

This is to inform you that the Kenyatta National Hospital Ethics and Research Committee has reviewed and **approved** your above revised research proposal for the period 5th December 2007 – 4th December 2008.

You will be required to request for a renewal of the approval if you intend to continue with the study beyond the deadline given. Clearance for export of biological specimen must also be obtained from KNH-ERC for each batch.

On behalf of the Committee, I wish you fruitful research and look forward to receiving a summary of the research findings upon completion of the study.

This information will form part of database that will be consulted in future when processing related research study so as to minimize chances of study duplication.

Yours sincerely

PROF C. KIGONDU
AG. SECRETARY, KNH-ERC

c.c. Prof. K.M. Bhatt, Chairperson, KNH-ERC
The Deputy Director CS, KNH
The Dean, School of Medicine, UON
The Chairman, Dept. of Surgery, UON
Supervisor: Dr. Hassan Said, Dept. of Surgery, UON