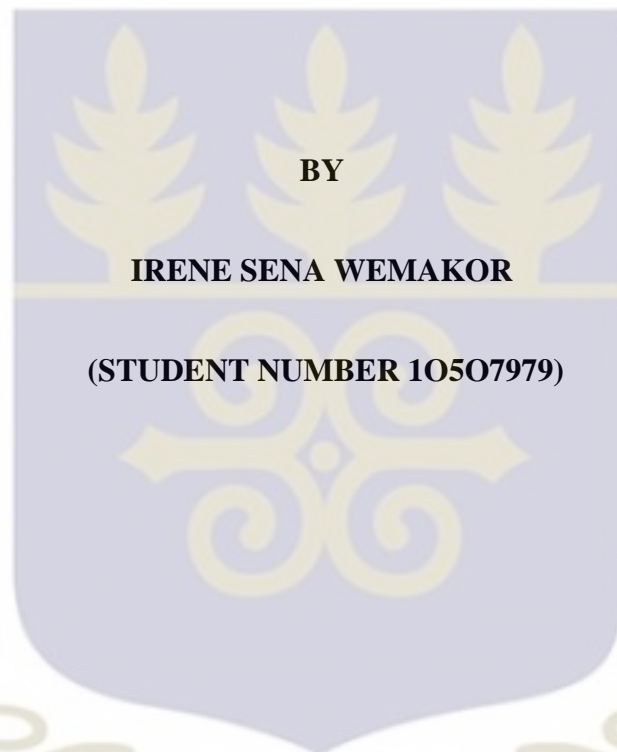


**RISK FACTORS FOR POSTOPERATIVE ACUTE KIDNEY INJURY (AKI)
FOLLOWING LAPAROTOMY FOR ABDOMINAL EMERGENCIES AT THE
KORLE- BU TEACHING HOSPITAL**



**THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN
PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF
MPHIL. PHYSIOLOGY DEGREE**

JULY 2016

DECLARATION

I IRENE SENA WEMAKOR author of this dissertation do hereby declare that, with the exception of references to other people's work which has been duly cited. This work has entirely resulted from my original research under the supervision of Dr. Rev. Charles Antwi – Boasiako and Dr.Bart Dzudzor and has not been presented for another degree elsewhere.

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Irene SenaWemakor Date

(Student)

This dissertation has been submitted for examination with our approval as members of the advisory committee

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School of Biomedical and Allied health Sciences)

DEDICATION

I dedicate this thesis to Mr Charles Yaw Torku.

Your integrity and spirit of excellence is a model to me and several others.



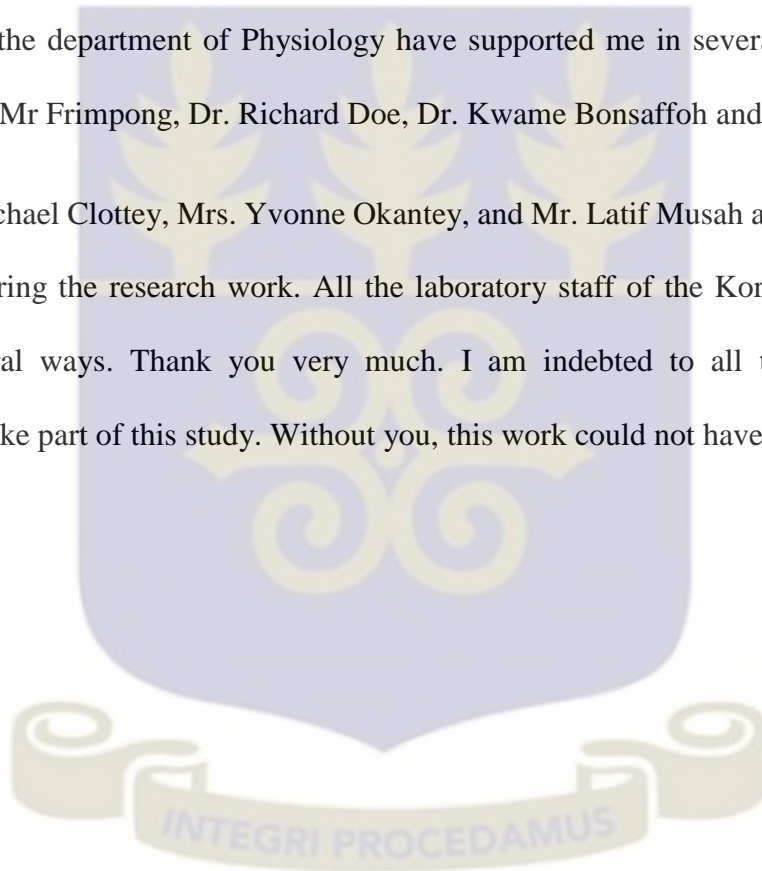
ACKNOWLEDGEMENT

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LIST OF ABBREVIATIONS

ADQI	Acute Dialysis Quality Initiative
AKI	Acute Kidney Injury
AKIN	Acute Kidney Injury Network
APACHE	Acute Physiologic and Chronic Health Evaluation
ARDS	Acute Respiratory Distress Syndrome
BEST KIDNEY	Beginning and Ending Supportive Therapy for the Kidney
BUN/Cr	Blood Urea Nitrogen and Creatinine ratio
CABG	Coronary Artery Bypass Graft
CKD	Chronic Kidney Disease
CPB	Cardiopulmonary Bypass
GFR	Glomerular Filtration Rate
MACE	Major Adverse Cardiac Event
NELA	National Emergency Laparotomy Audit
NHS	National Health Service
RIFLE	Risk, Injury, Failure, Loss and End –Stage
RRT	Renal Replacement Therapy
KBTH	Korle-Bu Teaching Hospital
RBF	Renal Blood Flow

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ABSTRACT

Background:

Postoperative acute kidney injury (AKI) is associated with increased morbidity, cost, prolonged hospital stay, and greater than 50% mortality rate in abdominal surgery. Among abdominal procedures, open surgical technique has the highest risk of postoperative AKI as compared to the laparoscopic approach. Postoperative AKI is a common condition in laparotomy patients. In patients with emergency abdominal conditions, laparotomy offers the only chance for cure. Various complications (such as pneumonia, wound infection, deep vein thrombosis, and impaired renal function) occur in these patients. However, the risk factors for postoperative acute kidney injury (AKI) and its effects on the clinical outcomes at the Korle-Bu Teaching Hospital are not well understood. There is therefore the need to collate data

General Aim:

To determine the incidence and risk factors of postoperative AKI following laparotomy for abdominal emergencies in patients with previously normal renal function at the Korle-Bu Teaching Hospital.

Methodology: This was a prospective cohort study that was carried out on 200 patients undergoing emergency (100 patients) and elective (100 patients) laparotomy following abdominal emergencies at the surgical department of Korle Bu Teaching Hospital from June 2015 to June 2016 with a mean age of (41 ± 17.41) years. Five (5) mls of venous blood sample was drawn from each patient pre and post operation. Serum urea, nitrogen and creatinine were determined by modified Jaffe reaction method using Pentra C200 auto analyzer. Serum Potassium, Chloride and Sodium levels were determined using a flow technique by an Idexx VetLyte electrolyte auto analyzer. Full blood count was determined by an automated Mindary BC-6800 haematology analyzer. The 24 hours post-operative urine output was measured using

a calibrated urine cup. Blood pressure was measured using an osillometric Omron device validated in adults while a digital thermometer was used in measuring body temperature. An Omron digital scale was also used to measure patient weight. Using the ratio of blood urea nitrogen (BUN, mg/dl) over serum creatinine level (Cr, mg/dl) as a marker of relative renal function and KDIGO classification which define postoperative AKI as an increase in absolute serum creatinine of at least 0.3 mg/dL or by a percentual increase in serum creatinine equal to or higher than 50% (1.5X baseline value) and/or by a decrease in urine output lower than 0.5 mL/kg/hour for more than 6 hours.

Results: The mean age of the 200 patients who underwent laparotomy was 41 ± 17.41 years; the majority of the patients were males 133 (66.5 %) while 67 (33.5%) were females. The incidence of postoperative AKI following laparotomy is approximately is 4.5%. Multivariate analysis using logistic regression was performed to quantify the association of BUN/Cr ratio with AKI. The development of postoperative AKI was significantly associated with advanced age ($p=0.01$), emergency laparotomy ($p=0.02$), pre-operative anaemia ($p=0.01$) an adjusted R-Square of 0.286 shows that comorbidity and postoperative BUN/Cr jointly determine 28.6% of the variance risk for AKI.

Conclusion:

The incidence of postoperative AKI following laparotomy is high in korle-Bu Teaching Hospital. Old age, emergency laparotomy surgery, male gender, pre-operative anaemia and comorbidity such as diabetes and hypertension are predictive factors associated with postoperative AKI. Appreciation of these factors may help to identify high-risk laparotomy surgical populations to reduce the risk of postoperative AKI and to achieve optimal treatment in the event of occurrence of postoperative AKI.

CHAPTER ONE

INTRODUCTION

1.1 Background

Acute kidney injury (AKI) is defined as a sudden sustained fall in glomerular filtration rate (GFR) associated with accumulation of metabolic waste products and water (Thakar, *et al.* 2007). It is a major postoperative complication in surgical patients with a quoted incidence of 10–23 %. (Metnitz *et al.*, 2002). Acute kidney injury occurs in approximately 1–5% of all hospitalized patients and is increasing in prevalence (Hoste *et al.*, 2003). The development of AKI is known to increase cost, duration of stay, and mortality (Metnitz *et al.*, 2002).

Predisposing factors include severity of physiological insult, pre-existing comorbidity, age, gender, resection type, dehydration and sepsis. Despite improvements in recognition and management, e.g. renal replacement therapy (RRT), mortality remains high (Butkus *et al.*, 1983). This high mortality and a variety of complication warrant further attention if understanding of AKI and improvements in management are to be developed.

The study of renal dysfunction is challenged by the wide variation in definitions. Clear endpoints such as renal replacement therapy underestimate the clinical impact of reduced glomerular filtration rate. Serum creatinine struggles to reflect variations due to rapidly changing renal status, ethnic background, sex, and age. Nevertheless, calculated creatinine clearance has been shown to be a more accurate measure of renal function that incorporates some inter-patient variations (Thakar *et al.*, 2005).

Acute kidney injury is devastating to both patients and anaesthesiologists, when patients with no evidence of renal dysfunction preoperatively develop AKI after surgery. A study conducted by Seong kim (2013) revealed that male gender; hypertension; chronic obstructive pulmonary

disease hypoalbuminemia (<4 g/dl), use of diuretics, vasopressors, and contrast agents, and packed red blood cell transfusion were independent predictors for AKI after gastric surgery. There have not been studies at the Korle Bu Teaching Hospital addressing renal dysfunction after emergency laparotomy and even focusing on patients with previously normal measured renal function. A study on the predictive factors of AKI following laparotomy for abdominal emergencies is therefore necessary to provide more information and understanding of the condition in Ghana

1.2 Problem Statement

Acute kidney injury is common in hospitalised patients and also has a poor prognosis with the mortality ranging from 10%-80% dependent upon the patient population studied. Patients who present with uncomplicated AKI, have a mortality rate of up to 10% while patients presenting with AKI and multi organ failure have been reported to have mortality rates of over 50%. If renal replacement therapy is required the mortality rate rises further to as high as 80% (Svensson *et al.*, 1993) (Cosentio *et al.*, 1994).

Despite the significant improvement in medical practice, the prognosis in AKI remains poor with mortality rates ranging from 40% to 60%. Out of 4,000 surgeries performed at the 1st floor theatre of the Korle-bu Teaching Hospital between August 2014 to August 2015, abdominal surgeries were 2,047. 30 patients developed AKI post-surgery and 12 died from other complications (KBTH 1st floor theatre recovery admission and discharge book).

Acute kidney injury has been demonstrated to be an independent risk factor for mortality (Liano *et al.*, 1998). The cause of this is unclear but is possibly associated with an increased risk of “non-renal” complications such as dehydration and sepsis (Chertow *et al.*, 1998)

Successful strategies to provide renal protection or strategies for ‘rescue therapy’ are either lacking, unsubstantiated by randomized clinical trials, or show no significant efficacy. The present study shall consider the causes of postoperative acute kidney injury by evaluating the BUN/Cr of patients.

1.3 Relevance of the study /Justification

A number of patient with previously normal renal function develop impaired renal function postoperatively for this reason AKI is no longer considered to be an innocent bystander merely reflecting co-existent pathologies. The predictive factors of acute kidney injury (AKI) following emergency laparotomy are also not well understood and have received little attention. Findings of the study will help educate clinicians and inform their decisions to objectively assess patients so as to identify those at risk of developing AKI.

1.4 Aim

To determine the incidence and risk factors of postoperative AKI following laparotomy for abdominal emergencies in patients with previously normal renal function at the Korle-Bu Teaching Hospital.

1.5 Specific Objectives

The Specific objectives of this study is to determine

1. The incidence of postoperative AKI in the first 48hours after abdominal laparotomy surgery
2. The risk factors of AKI in the first 48hours after abdominal laparotomy surgery.
3. The age groups likely to develop AKI postoperatively.
4. The relationship between co morbidities and the development of postoperative AKI

CHAPTER TWO

LITERATURE REVIEW

2.1 Definition of Acute kidney injury (AKI)

The British Renal Association defines AKI as a person having serum creatinine level greater than 300 $\mu\text{mol/l}$ (greater than 3.3 mg/dl) and/or a blood urea nitrogen value greater than 40 mmol/l (240 mg/dl) with previously normal values (Loef *et al.*, 2005). The critical illness scoring system, APACHE III, defines AKI as a serum creatinine elevation greater than 136 $\mu\text{mol/l}$ per day (less than 1.5 mg/dl), with a urine output less greater 410 ml/day and no pre-existing chronic dialysis (Loef *et al.*, 2005). A review on publications on AKI found 26 different definitions of postoperative AKI in 26 studies (Lassnig *et al.*, 2005). This absence of consensus reflects the condition's complexity. Definitions tend to emphasise individual factors such as biochemistry, pre-existing impairment, resuscitation measures, nephrotoxic drugs and pathophysiology, with most having common elements, e.g. serum creatinine and urine output (Loef *et al.*, 2005).

2.1.1 Incidence Acute Kidney Injury

Acute kidney injury occurs in 1% to 5% of all hospital admissions, and in the postoperative period has serious implications, being consistently associated with (unacceptably) high mortality, morbidity and a more complicated hospital course with associated high cost implications (Uchino *et al.*, 2005). This is particularly the case when renal replacement therapy (RRT) is required (Uchino *et al.*, 2005). It is widely recognized that AKI requiring dialysis is an independent risk factor for death (Thaker *et al.*, 2007); more recently, however, even minimal increases in serum creatinine have been associated with an increase in both short and long-term mortality, regardless of whether partial or full recovery of renal function has

occurred at the time of discharge (Loef *et al.*, 2005). This risk of death is independent from other postoperative complications and co-morbidities (Hobson *et al.*, 2009). Acute Kidney Injury is related to the subsequent development and progression of chronic kidney disease (CKD) and the need for future dialysis, most notably in those with a degree of pre-existing renal impairment (Druml,2005), but also in those who have apparent recovery following an episode of AKI (Hobson *et al.*,2009).

Despite an increase in knowledge of AKI and advances in other relevant areas over the last two decades (including intensive care, delivery of dialysis and surgical techniques), a significant changes in these outcome has not been made (Carmichael *et al.*, 2003). As such, identification of risk factors, close monitoring of renal function and early adoption of both preventive measures and treatments remain important considerations for those taking care of pre-operative and post-operative patients. Surgery remains a leading cause of AKI in hospitalized patients (the incidence ranges from 18% to 47% depending on the definition used) (Shusterman *et al.*, 1987).

This has been best researched in the cardiac surgery setting where it has been shown that up to 15% of patients exposed to cardiopulmonary Bypass (CPB) will develop AKI, with 2% requiring RRT (Kheterpal S, 2009). Depending on the criteria used to define AKI and the postoperative period studied, mortality ranges from 1% to 30% (Chertow *et al.*, 1997) although this is consistently higher, approaching 80%, if RRT is required (Carmichael *et al.*, 2003). AKI is not limited to cardiac surgery although its incidence outside of this setting is often underappreciated. Kheterpal and associates demonstrated that in patients without pre-existing renal disease, approximately 1% of major non-cardiac surgery was complicated by AKI, with an eight-fold increase in 30-day mortality.

This incidence is comparable to other notable postoperative complications including major adverse cardiac events (MACE) and venous thromboembolism. In the intensive care setting, the Beginning and Ending Supportive Therapy for the Kidney (BEST Kidney) investigators confirmed major surgery as the second leading cause of AKI (in 34%) in cohort of patients, with overall hospital mortality of 60.3% (Uchino *et al.*, 2005). Analysis of data from the United Kingdom Intensive Care National Audit and Research Centre Case Mix program supports this, showing surgical admissions accounted for 16.4% of admissions with severe AKI in the first 24 hours (with elective and emergency cases accounting for 5.6% and 10.8%, respectively). In that study, defining severe AKI as creatinine $>300 \mu\text{mol/l}$ and/or urea $>40 \text{ mmol/l}$ has restricted the patient cohort and potentially, therefore, may limit its generalizability (Kolhe *et al.*, 2008). Elsewhere, it has been reported that one third of patients with AKI require a critical care admission at some point in their care (Liano *et al.*, 1998).

2.1.2 Classification

Although AKI has been the focus of much research over the past decades, lack of a consensus definition has been a major factor hampering clinical research and comparison of trial data (Bellomo *et al.*, 2009). There are now two major classifications of AKI in use. The Acute Dialysis Quality Initiative (ADQI) Group introduced the RIFLE (Risk, Injury, Failure, Loss and End-stage) classification System in 2004, which defines three grades of severity and two outcomes, in an effort to standardize the definition (Bagshaw *et al.*, 2008). This has subsequently been validated in a number of studies (Osterman *et al.*, 2007). The Acute Kidney Injury Network (AKIN) group proposed refinements to this criteria, outlining AKI as abrupt (occurring within 48 hours) and using a smaller change in serum creatinine from baseline in patients who are optimally hydrated to define AKI (Bagshaw *et al.*, 2008), following recognition of emerging evidence demonstrating the clinical importance of small increases in serum creatinine (Lafrance *et al.*, 2010).

No clear advantages between these criteria have been demonstrated and despite these recommendations, definitions of AKI continue to vary (Bagshaw *et al.*, 2008). The Kidney Disease: Improving Global Outcomes (KDIGO) workgroup has recently reviewed these criteria and published a single definition for use in both clinical practice and research. AKI is defined when any of the following three criteria are met; an increase in serum creatinine by 50% in seven days, an increase in serum creatinine >0.3 mg/dL in 48 hours or oliguria. The severity is staged according to the criteria outlined in Table 1 (KDIGO, 2012).

Recognition is often still delayed and more recently, the role of electronic reporting systems has been successfully tested in the UK with the aim of alerting clinicians early to the presence of AKI, appreciating the impact of small increases in creatinine from baseline that previously may have been considered as fluctuations remaining within the normal range. In turn, this should allow for timely intervention and improved overall patient care (Selby *et al.*, 2012).

RIFLE, AKIN and KDIGO all diagnose AKI according to serum creatinine and urine output as outlined in Table 1. This, however, is not without its limitations, as serum creatinine is neither sensitive nor specific, tending to represent a functional change rather than being a true marker of kidney injury and is well known to be affected by multiple factors including age, ethnicity, gender, muscle mass, total body volume, medications and protein intake

**Table 1: Classification of Acute Kidney Injury by Rifle, Akin and Kidgo Criteria Stage
Glomerular Filtration Rate (GFR) Criteria Urine Output Criteria.**

Rifle Classification

Risk	Serum creatinine increased x 1.5 or GFR decrease >25% <0.5 ml/kg/hr for ≥6 hours
Injury	Serum creatinine increased x 2 or GFR decrease >50% <0.5 ml/kg/hr for ≥12 hours
Failure	Serum $\mu\text{mol/L}$ with an acute rise $\geq 4 \mu\text{mol/L}$ <0.3 ml/kg/hr for ≥ 24 hours or anuria for ≥ 12 creatinine increased x 3 or GFR decrease $\geq 75\%$ or an absolute serum creatinine ≥ 354
Loss	Persistent AKI, requiring RRT for >4 weeks
End-stage	kidney disease requiring dialysis >3 months

2.1.3 AKIN Classification

Stage 1 Serum creatinine increased $\geq 26.2 \mu\text{mol/L}$ or x 0.5 to 2 baseline <0.5 ml/kg/hr for ≥ 6 hours

Stage 2 Serum creatinine increased x 2 to 3 baseline <0.5 ml/kg/hr for ≥ 12 hours

Stage 3 Serum creatinine increased >x 3 baseline or serum

creatinine $\geq 354 \mu\text{mol/L}$ with an acute rise $\geq 44 \mu\text{mol/L}$ or initiation of RRT

<0.3 ml/kg/hr for ≥ 24 hours or anuria for ≥ 12 hours

2.1.4 KDIGO Classification

Stage 1 Serum creatinine increased x 1.5 to 1.9 baseline or by $\geq 26.2 \mu\text{mol/L}$ $< 0.5 \text{ ml/kg/hr}$ for 6 to 12 hours

Stage 2 Serum creatinine increased x 2 to 2.9 baseline $< 0.5 \text{ ml/kg/hr}$ for ≥ 12 hours

Stage 3 Serum creatinine increased $> x 3$ baseline or serum

creatinine $\geq 354 \mu\text{mol/L}$ with an acute rise $\geq 44 \mu\text{mol/L}$ or initiation of RRT

$< 0.3 \text{ ml/kg/hr}$ for ≥ 24 hours or anuria for ≥ 12 hours

AKIN, Acute Kidney Injury Network; KDIGO, Kidney Disease: Improving Global Outcomes. (Coca *et al.*, 2012). Given that a reduction in glomerular filtration rate

(GFR) greater than 50% can occur before this is reflected in serum creatinine, the ability to detect AKI prior to a change in serum creatinine would represent a significant advance in the management of AKI (Herget-Rosenthal, 2004). As such, the American Society of Nephrology set identification and characterization of biomarkers for AKI as a key research area in 2005 (Thakar *et al.*, 2005).

2.1.5 Risk Factors

There have been a number of studies investigating the risk factors associated with the development of AKI, from which several factors, both patient and procedure related, have been consistently associated in both cardiac and non-cardiac surgery (Eriksen *et al.*, 2003). Patient related factors are often more strongly associated with postoperative mortality than surgical factors. These include older age, hypertension, diabetes mellitus, cardiac failure, peripheral vascular disease, cerebrovascular disease, dehydration and pre-existing chronic kidney disease (Eriksen *et al.*, 2003). Perhaps the most important of these is the latter, with rates of AKI

requiring dialysis approaching 30% in patients with pre-existing kidney disease undergoing cardiac surgery (Thakar *et al.*, 2003). That said, there remain risk factors specific to certain types of surgery which are associated with postoperative AKI, including prolonged CPB time, combined valve and coronary artery bypass graft (CABG) surgery, increased aortic cross-clamp time during vascular surgery and increased intra-abdominal pressure in major abdominal surgery (Brienza *et al.*, 2009). Unsurprisingly, many of these risk factors are associated with either poor renal perfusion or decreased renal reserve and few are correctable prior to surgery. Integral to improving outcomes however, is the ability to identify high risk patients, not only allowing for earlier intervention and optimal subsequent management.

2.1.6 Pathophysiology of AKI

Etiologically, AKI is divided into pre-renal, intrinsic or renal, and post-renal causes, representing 30 to 60%, 20% to 40% and 1% to 10% of cases, respectively (Carmichael *et al.*, 2003). Renal hypo perfusion is often the initial insult in postoperative AKI, which importantly can lead to a reduction in medullary blood flow (Brienza *et al.*, 2009).

The outer medulla with its high metabolic demands (medullary oxygen extraction approaches 90%) is particularly vulnerable to both hypo perfusion and hypoxia, both in patients with known CKD whose underlying reserve is reduced but also in patients with normal preoperative renal function (Bonventre *et al.*, 2003).

Interestingly, in acute respiratory distress syndrome (ARDS) it is increasingly recognized that the disease process, for example, pulmonary versus extra-pulmonary causes, impacts the course of the disease and whether the same could be said for AKI remains to be seen (Callister *et al.*, 2012). It is important to understand the pathogenesis of acute renal failure. Though the kidneys receive 25% of the cardiac output, they only get 10% of the total body oxygen uptake. Renal auto regulation does take care of the GFR over a wide range of blood pressures and glomerular

ultra-filtration is a balance between vasodilators and vasoconstrictors. However, of the blood that the kidneys receive the glomeruli receive 90-95% while the medulla only receives 5-10% reabsorption. Thus the medulla is more prone to hypoxic damage.

The occurrence of acute kidney injury depends upon the type of surgery, preoperative and intraoperative haemodynamic and renal conditions (diabetic patients have a 10 fold greater risk of renal deterioration in the presence of hypovolemia). All intravenous and volatile induction agents affect renal function by decreasing cardiac output and blood pressure. Extradural block (or high spinal) up to the level of T4 reduces sympathetic tone to the kidneys, resulting in a decrease in renal blood flow and GFR. Mechanical ventilation with positive pressure also decreases renal blood flow.

Major surgery with extensive third space losses can lead to hypovolemia and renal hypo perfusion. Thus the progression of acute kidney injury may take one of three paths. Apart from the general mechanisms that are common to AKI from various causes, other specific contributions to postoperative AKI are of special note in the surgical patient. These include:

2.1.7 Co-Morbidities

With the development of surgical techniques and advanced anaesthesia delivery and monitoring, surgery on sicker and older patients is more common. These patients suffer from co-morbidities, such as chronic kidney disease, metabolic syndrome, diabetes mellitus, and cardiovascular and hepatobiliary disease, all of which are well-documented risk factors predisposing to AKI (Biteker *et al.*, 2009). Male sex is also a risk factor of AKI (Kheterpal *et al.*, 2009). Other reported risk factors in surgical patients are functional dependence, ventilator dependence, chronic obstructive pulmonary disease, smoking, bleeding disorders, chronic steroid use, and cancer. A retrospective cohort study evaluated the incidence of AKI in patients admitted to the ICU beds of the post anaesthesia care unit. Independent risk factors of AKI

included ASA physical status, Revised Cardiac Risk Index, high-risk surgery, and congestive heart failure (Abelha *et al.*, 2009). A prospective cohort study conducted in non-vascular, non-cardiac surgery patients identified age, diabetes mellitus, Revised Cardiac Risk Index, and ASA status as independent risk factors of AKI.

2.1.8 Obesity

Obesity is an excessive accumulation of adipose tissue. Obesity is an epidemic with profound effect on morbidity and mortality. Worldwide, the prevalence of BMI $>25 \text{ kg m}^{-2}$ is estimated to be 37% in men and 38% in women (Abelha *et al.*, 2009). Obesity is a risk factor for AKI in general and for postoperative AKI in particular, it is associated with metabolic syndrome and can alter renal hemodynamics (Kwakernaak *et al.*, 2013). The special characteristics of the kidney in the obese, known as obesity-related glomerulopathy, include changes in GFR and glomerulomegaly (Suneja *et al.*, 2014). A different understanding of the correlation between obesity and atherosclerotic morbidity can be achieved when the different types and spread of adipose tissue are taken into consideration (Romero *et al.*, 2010). Recently, a study on ICU trauma patients showed AKI to be correlated with abdominal fat in particular, as measured by computed tomography.

2.1.9 Surgery

In every major operation, a risk for reduction in effective blood volume or mechanical obstruction exists. Hypovolaemia, low systemic vascular resistance because of anaesthesia or caval compression, and direct injury to the renal system are all common events during surgery that can harm the kidney. Emergency laparotomy is a high-risk surgical operation that involves making an incision to operate inside the abdomen to treat life threatening conditions. The National Emergency Laparotomy Audit (NELA) shows that 11% of patients who undergo emergency laparotomy die within 30 days of their operation. Despite being one of the most

common urgent surgical procedures in the Ghana, there is a scarcity of outcome data concerning postoperative complication. The term ‘emergency laparotomy’ describes an exploratory procedure for which the clinical presentation, underlying pathology, anatomical site of surgery, and perioperative management vary considerably. The variation in surgical pathology, coupled with the limited time period in which to optimize co-morbidities, is likely to contribute significantly to postoperative morbidity and mortality. Emergency surgical conditions remain a common reason for hospital admission, and a large proportion of National Health Service (NHS) resources are directed towards managing these patients. Patients presenting for emergency surgery represent a category at high risk of complications, with substantial morbidity and mortality whose management may be extremely challenging. Emergency surgery is a risk factor for AKI. Patients with sepsis presenting to the operating room are at increased risk of AKI, as are patients arriving in the emergency room with sepsis (Medeiros *et al.*, 2015). Major vascular surgery, and cardiac surgery in particular are well-known risk factors for AKI (Vives *et al.*, 2014). Patients undergoing intraperitoneal surgery in general and exploratory laparotomy and small bowel resections in particular, are more prone to developing AKI. Lung resection also has a relatively high incidence of AKI (Ishikaw *et al.*, 2012).

2.1.10 Pre-Operative Anaemia and Peri-Operative Blood Transfusion

A study carried out by from Karkouti *et al.* observed a relationship between pre-operative haemoglobin and AKI after cardiopulmonary bypass. The reasons for such an association are likely multifactorial. Several experimental studies have stressed on the susceptibility of the kidney to anaemia, and the occurrence of renal hypoxia after decrease of haemoglobin level due to maintenance of high oxygen consumption and intra-renal oxygen shunting (Legrand *et al.*, 2008). In a rat model where renal oxygen tension was altered by hemodilution despite normal arterial blood pressure a specific contribution of anaemia to kidney damage through

oxidative stress was proposed (Legrand *et al.*, 2010). Several authors have previously identified the negative impact of RBC transfusion on renal function after cardiac surgery.

One of the reasons could be the inability of RBC transfusion to restore adequate microcirculatory oxygenation because of the multiple morphological and functional changes (Less deformability, depletion of 2,3-diphosphoglycerate, inflammation, decrease of bioavailability of nitric oxide with liberation of free haemoglobin) occurring during blood storage.

2.1.11 Intra-Abdominal Pressure

Increased intra-abdominal pressure is common in ICU patients after abdominal surgery (Malbrain *et al.*, 2004). Increased intra-abdominal pressure, which is frequently explained by excessive administration of fluids, can cause abdominal compartment syndrome, mechanically compress the renal veins and constrict the renal arteries via activation of the sympathetic system (Dalfino *et al.*, 2008). Increased intra-abdominal pressure can ultimately lead to reduced renal perfusion and create an ischaemic insult to the kidney and AKI. Laparoscopy can also lead to a transient increase in intra-abdominal pressure. As a result, during laparoscopy the recorded urine output is significantly reduced, and patients can become oliguric despite normovolaemia and normotension. Several studies have shown that the observed reduction in urine output during an ailment and in patients' suffering from chronic kidney disease, the duration of pneumoperitoneum should be minimized (Joshi *et al.*, 2013).

BUN/Cr ratio has been previously introduced as a marker of relative dehydration and renal function (Juarado *et al.*, 1998). It can estimate the hydration status of patients and help determine the type of azotaemia in patients with renal dysfunction and predict mortality of hospitalized patients (Feinfeld *et al.*, 2002). In considering BUN/Cr ratio as a relative marker

of renal function and the KDIGO guideline, the researcher aim to report the risk factors of postoperative AKI in patients undergoing emergency laparotomy.



CHAPTER THREE

METHODOLOGY

3.1 Study design

This was a prospective cohort study that was carried out on 200 patients made up of 100 patients undergoing abdominal emergency laparotomy and 100 patients undergoing elective abdominal laparotomy from June 2015 to June 2016.

3.2 Study Site

The study was conducted at the surgical wards of the Korle-Bu Teaching Hospital located in the south Ablekuma municipality in the Greater Accra region in Ghana. The Korle-bu teaching hospital is one of the three teaching hospitals in Ghana .It was established in 1923. It is the referral hospital for regional and district hospitals in the country. It also caters for patients from other West African countries. The hospital has seventeen departments which provides 24 hour services. Being the largest hospital and the premier teaching University hospital in the country, the Korle-Bu Teaching Hospital attracts referral cases from all over the country. It is affiliated to the University of Ghana Medical School. About 4,000 to 6,000 patients are admitted yearly through the surgical-medical emergency and the outpatient department.

3.3 Study Population

Patients of 18 years and above admitted to the general surgical wards for emergency laparotomy were be recruited for this study.

3.4.1 Inclusion Criteria

Patients aged 18 years and above of either sex admitted into the surgical wards for emergency laparotomy from June 2015 to June 2016 with normal renal function preoperatively were

enrolled in the study. The most recent preoperative serum creatinine was used to derive an estimated creatinine clearance using the Cockcroft-Gault formula, $[(140 - \text{age in years}) \times (\text{weight in kilograms})] / [72 \times \text{serum creatinine in mg/dl}] \times (0.85 \text{ for females})$. Patients with a preoperative estimated creatinine clearance more than 80 ml/min were included. The ratio of blood urea nitrogen (BUN, mg/dl) over serum creatinine level (Cr, mg/dl) as a marker of renal function was also used. Considering BUN not more than 20 and serum creatinine not more than 115 $\mu\text{mol/L}$ as the normal level.

3.4.2 Exclusion Criteria

The Exclusion criteria will be age < 18 years, patients with known renal diseases, established diabetic or hypertensive nephropathy, bilateral small shrunken kidneys, disparity of renal sizes of more than 2.0 cm or polycystic kidney disease. Patients with a preoperative estimated creatinine clearance less than 80 ml/min were also excluded.

3.5 Sample Size Determination: In the Determination of the minimum sample size, the following assumptions were made:

1. Null Hypothesis: Comorbidities do not influence the risk for AKI following emergency laparotomy.
2. A prevalence of 2% was adopted.
3. Rationale: In literature review of papers published on postoperative AKI following hospital admission available in PUBMED database, Hoste et al (2003) found that prevalence rate ranged from 1-5%.

The minimum sample size for each group was calculated using the formula below

$$N = (t^2 \times P(1-P)) / (m^2)$$

N= required sample size

t= confidence level at 95% (standard value= 1.96)

P= estimated prevalence

m= margin of error at 5% (standard value of 0.05)

Data for 100 emergency patients and 100 elective patients (controls) meeting the eligibility criteria were used in the study.

3.6 Sampling Technique

A systematic sampling procedure was used. Using a sampling interval $k=3$, 10 Patients were chosen each weekday by selecting every 3rd patient that met the eligibility criteria.

Eligible subjects were educated in their various wards on the procedures and tests to be used as well as the possible risks and benefits explained. The concerns of the subjects were addressed and questions answered. The subjects who were willing to participate were handed over a consent form to read through and duly sign and a questionnaire to complete. Each questionnaire was coded and had the subject identification number.

3.7 Questionnaire Administration

A structured questionnaire was used to collate data from the study subjects. The questionnaire had 30 questions covering demographic information, alcohol use, tobacco use, past medical history, comorbidity, vital signs, type of surgery, duration of surgery, hydration status and laboratory measurement. Information on the questionnaire was read and explained to the subjects in their preferred language. In most cases, this was their mother tongue.

3.8 Haematological and Biochemical analysis

3.8.1 Full Blood Count

Adequate blood sample (3mls) was taken into the EDTA tubes for the full blood count analysis, sample was analysed within some few hours of collection. The collection tubes containing the

blood samples were immediately chilled on ice prior to centrifugation. The Mindray BC- 6800 Auto Haematology Analyzer (Sysmex KX21 N, Japan) was used for the full blood count analysis. The Mindray BC- 6800 Auto Haematology Analyzer is a quantitative, automated haematology analyzer for In-Vitro diagnostic use in clinical laboratories. It provides complete blood count, leukocyte 5-part Differential, Haemoglobin concentration measurement, Reticulocyte and Nucleated Red blood cell measurement. This was done preoperatively.

3.8.2 Blood Urea Nitrogen and Creatinine Analysis

Blood sample (5mls) was drawn from each of the consented participants into plain tubes and transported to the laboratories in an ice-chest for analysis. The sample was centrifuged at 3000g and the serum kept at -80°C until analyzed. Serum urea, nitrogen and creatinine were determined by modified jaffe reaction method using Pentra C200 autoanalyzer. Assayed multiserum normal will be used for the quality control of analytical work. This was done preoperatively and postoperatively.

3.8.3 Urinary Output

Urine volume 24 hours post-surgery was measured using a calibrated urine cup. This was done by emptying patients urine output hourly from the urine bag.

3.8.4 Anthropometric Measurements

Weight was measured with subjects barefoot but with light clothing using the Omron digital scale (HN-288), and was recorded to the nearest 0.1kg.

3.8.5 Blood Pressure

Blood pressure readings in the right brachial artery was measured after an initial rest of 10minutes and repeated at 5minutes intervals for three (3) consecutive times. Measurement

was be made by auscultation with a mercury column sphygmomanometer (osillometric Omron device validated in adults) and a cuff appropriately sized for the arm of the participant. The average of three measurement was used as the final reading preoperatively.

3.8.6 Pulse Pressure

This was calculated by subtracting the systolic blood pressure from the diastolic blood pressure.

3.8.7 Temperature

Body temperature was measured using the axillary route using a calibrated digital thermometer. Temperature was measured by placing the thermometer in the central position of the armpit and adducting the arm close to the chest wall for one minute.

3.9 Data Handling

Data collection was accurately done using a data collection form and coding done appropriately. It was entered into an Excel spreadsheet and cleaned for export into SPSS database. Adequate file security was put in place to ensure confidentiality. The hard copies of the questionnaire and patient test results were kept secure and confidential.

3.10 Statistical Analysis

The data was analysed using Statistical Package for Social Sciences (SPSS) for Windows® Version 20.0 (SPSS Inc, Chicago, IL, USA). Data for continuous variables Will be presented as means \pm standard deviations (SD) or adjusted means \pm standard error of the mean (SEM) and as frequency for categorical variables. The normality of distributions of continuous variables was tested with the Kolmogorov-Smirnov test and variables that were not distributed normally will be log-transformed prior to statistical analysis. Age, gender, and occupation was assessed for association using χ^2 test while Student's t test or analysis of covariance using general linear

model will be performed for continuous variables. A p -value of less than 0.05 was considered to be statistically significant. Statistical power calculation will be performed to ensure the study has adequate sample size to detect the association between predictive factors and postoperative renal function and its outcome by using Quanto version 1 .2.4.

3.11 Ethical Approval

Ethical guidance was sought from the Ethics and Protocol Review Committee of the University of Ghana Medical School. The study was conducted in conformity with the Helsinki Declaration on Human Experimentation, 1964 with subsequent revisions, latest Seoul, October 2008 (World Medical Association, 2008).

Only subjects meeting the eligibility criteria were recruited for the study. All study subjects were adequately informed of the purpose, nature, procedures, risks and hazards of the study. Points emphasized included anonymity, confidentiality and the freedom to decline to participate or withdraw from the study at any time without penalty. Refusal to participate did not affect clinical management of a patient's condition. A written informed consent was obtained from all the patients who were included in the study.

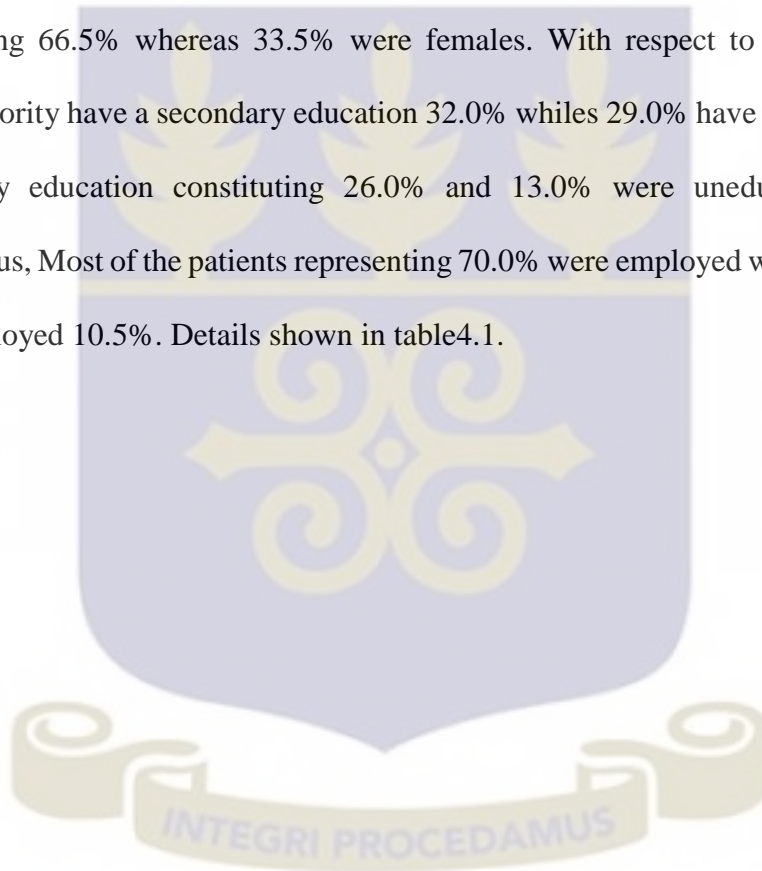


CHAPTER FOUR

RESULTS

4.1 General Characteristics

The mean age of the subjects studied was (41.75 ± 17.41) years with a range of 18 to 87 years made up of 100 patients undergoing abdominal emergency laparotomy and 100 patients undergoing elective abdominal laparotomy as shown in figure 1. Majority of the patients were males constituting 66.5% whereas 33.5% were females. With respect to their educational background, majority have a secondary education 32.0% while 29.0% have tertiary education whereas primary education constituting 26.0% and 13.0% were uneducated. For their employment status, Most of the patients representing 70.0% were employed while 19.5% were students, unemployed 10.5%. Details shown in table 4.1.



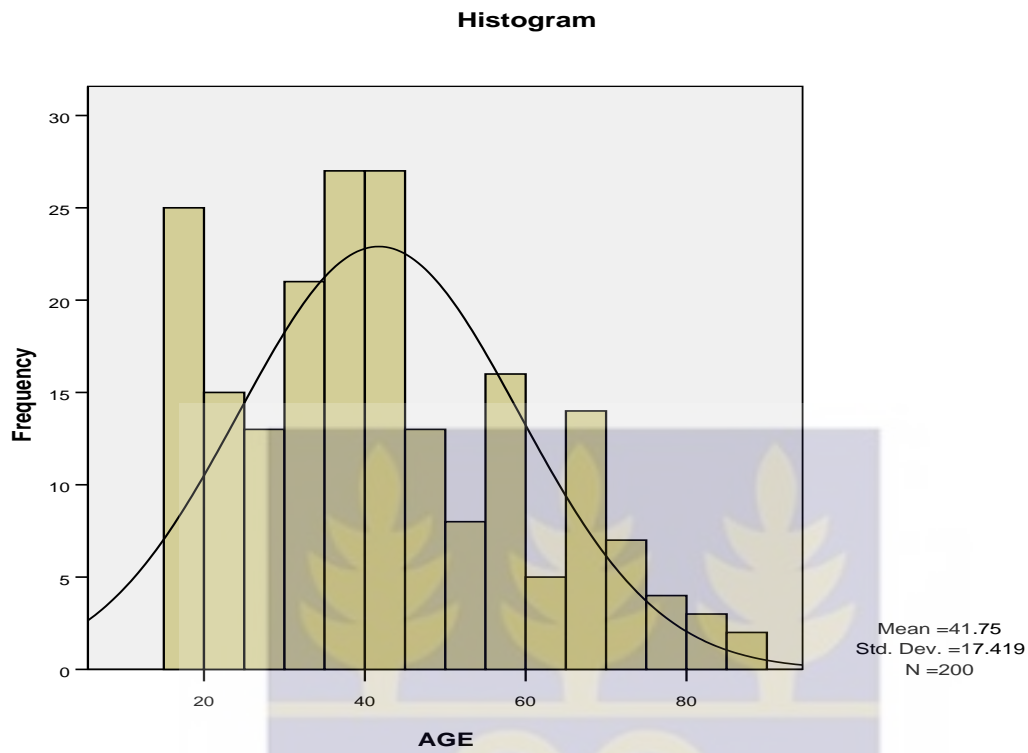


Figure 4.1: A Histogram Illustrating the Age Ranges of Study Subjects



Table 4.1: Background Information of Respondents

Characteristics		Frequency	Percent (%)
Gender	Male	133	66.5
	Female	67	33.5
Educational attainment	Secondary	64	32.0
	Tertiary	58	29.0
	Primary	52	26.0
	Uneducated	26	13.0
Employment Status	Employed	140	70.0
	Unemployed	21	10.5
	Students	39	19.5



4.2: Smoke Status of Study Subjects

Further inquiries into the smoking status of study subjects, the study revealed that, majority of the patients representing 91.5% don't smoke whereas 8.5% do smoke. The details are shown in table 4. 2.

Table 4.2: Smoke Status

Smoking status of subject	Number of subjects	Percentages
Yes	17	8.5
No	183	91.5



4.3 Alcohol consumption status of study subjects

The data revealed that the most of the patients representing 63.0% said they consume alcohol occasionally whereas 33.5% do not consume alcohol while 3.5% consume alcohol regularly.

Details illustrated in Table 4.3.

Table 4.3: Alcohol Consumption Frequency

Frequency of alcohol consumption	Percentage of subjects
Occasionally	63
Regularly	3.5
Not at all	33.5



4.4 Medical condition of study subjects at recruitment

The results revealed that, 74.5% of the patients did not have any medical condition whereas 25.5% came with various ailments. Out of the 25.5% with medical conditions, 11.0% were diagnosed to have Hypertension and 4.5% had Diabetes Mellitus. Details shown in table 4.4.

Table 4.4: Present Medical Condition

	Frequency	Percent
No medical condition	149	74.5
Hypertension	22	11.0
Diabetes Mellitus	9	4.5
Osteoarthritis	2	1.0
Asthmatic	2	1.0
Hypertension & diabetes	4	2.0
HIV	4	2.0
Peptic Ulcer	3	1.5
Sickle cell Disease	5	2.5
Total	200	100.0

4.5 Pre- Existing Kidney Problem

All the study subjects representing 100.0% did not have any pre-existing kidney problem.

Details shown table4.3.

Table 4.5: Pre-Existing Kidney Problem

	Frequency	Percent
No	200	100.0

4.6 Previous Surgical Procedure

The study also showed that 92.5% of the patients had not undergone any previous surgical procedure, whereas 7.5% had been previously surgically operated on. It was also revealed that, Out of the 7.5% previous surgical patients, 3.5% of them were as a result of Hernia Repair and Caesarean section and Appendicitis represented 1.5%. Details shown in table 4.6.

Table 4.6 Previous Surgical Procedure

Medical condition	Frequency	Percent (%)
Appendicitis	3	1.5
Hernia Repair	7	3.5
No	185	92.5
Craniotomy	1	.5
Caesarean section	3	1.5
Myomectomy	1	.5
Total	200	100.0

4.7 Blood Pressure

The data revealed that large percentage of the patients representing 79.5% had normal blood pressure (a systolic blood pressure of <140 mmHg and diastolic blood pressure of <90 mmHg) while 12% had high blood pressure (a systolic blood pressure of >140 mmHg and diastolic blood pressure of >90 mmHg) and 8.5% had low blood pressure (a systolic blood pressure of <100 mmHg, a diastolic blood pressure of <60 mmHg). This shown in table 4.7 below

Table 4.7: A Pie Chart Illustrating The Blood Pressure Of Patients

Blood pressure status	Percentage patients
High	12
Normal	79.5
Low	8.5



4.8 Duration of Surgery

The data revealed the duration of surgery for patients with two hours representing 43.0% while other patients surgery lasted for two and half hours constituting 15.0%, 14.5% three hours, One and half hours 11.0%. This shown in table 8 below

Table 4.8: Duration of Surgery

Duration	Frequency	Percent (%)
1 hour	30	15.0
Two hours	86	43.0
One and half hours	22	11.0
Two and half hours	31	15.5
Three hours	29	14.5
Three and half hours	2	1.0
Total	200	100.0



4.10 Hydration Status

The hydration status which determine the level of fluids in a patient was assessed using parameters such as the pulse, blood pressure, capillary filling, skin turgor, mucus membrane, and urine output. The assessment found 83.0% of the patients were hydrated with 17.0% dehydrated. The results is shown in figure 4.2.

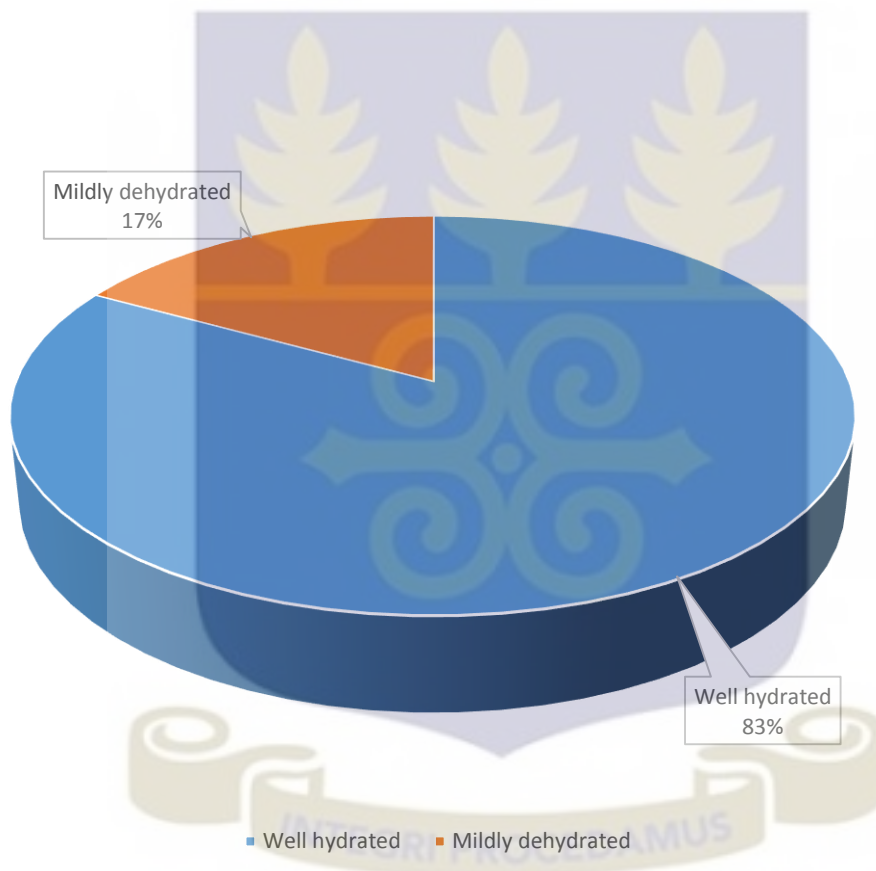


Figure 4. 2: Hydration Status

4.11 Blood Transfusion

Further inquiry sought to know if the patients received blood transfusion during surgery. The study shows that 78.0% of patients received blood transfusion but 22.0% did not. See figure 4.8 for details.

Table 4. 9: Blood Transfusion

Patient blood transfusion status	frequency	Percentage
Yes	156	22
No	44	78



4.13 Pre-Operative Bun/Cr Ratio

All the study subjects representing 100.0% have a normal BUN/Cr ratio hence they have no pre-existing Acute Kidney Injury (AKI).

4.14 24-hour urine volume

Further analysis of 24hr urine volume after surgery, showed 95.5% had normal urine output after surgery with 4.5% having low urine output. The percentage of patients with low 24hr urine output developed AKI postoperatively. Findings shown in table 4.10.

Table 4.10: 24hr Urine Volume

Urine Volume	Frequency	Percent (%)
Low urine output	9	4.5
normal urine output	191	95.5
Total	200	100.0



4.15 Post-Operative Bun/Cr

Majority of the patients representing 95.5% had no AKI whereas 4.5% had it. Details shown in Table 4.9.

4.15 Type of Surgery

The studies revealed that the two type of surgery were used for the study. This is shown in table 4.11 below.

Table 4.11 Correlation of Predictive Variables

		AGE	Gender	Present Medical Condition	Post-operative BUN/Cr	Type of Surgery
AGE	Pearson Correlation	1	-.140(*)	.146(*)	-.170(*)	-.129
	Sig. (2-tailed)		.049	.039	.016	.068
	Sum of Squares and Cross-products	60377.995	-228.915	943.545	-122.295	-224.500
	Covariance	303.407	-1.150	4.741	-.615	-1.128
	N	200	200	200	200	200
Gender	Pearson Correlation	-.140(*)	1	-.036	.001	-.074
	Sig. (2-tailed)	.049		.616	.991	.297
	Sum of Squares and Cross-products	-228.915	44.555	-6.265	.015	-3.500
	Covariance	-1.150	.224	-.031	.000	-.018
	N	200	200	200	200	200
Present Medical Condition	Pearson Correlation	.146(*)	-.036	1	-.218(**)	.051
	Sig. (2-tailed)	.039	.616		.002	.473
	Sum of Squares and Cross-products	943.545	-6.265	692.595	-16.845	9.500
	Covariance	4.741	-.031	3.480	-.085	.048
	N	200	200	200	200	200
Post-operative BUN/Cr	Pearson Correlation	-.170(*)	.001	-.218(**)	1	-.217(**)

	Sig. (2-tailed)	.016	.991	.002		.002
	Sum of Squares and Cross-products	-122.295	.015	-16.845	8.595	-4.500
	Covariance	-.615	.000	-.085	.043	-.023
	N	200	200	200	200	200
Type of Surgery	Pearson Correlation	-.129	-.074	.051	-.217(**)	1
	Sig. (2-tailed)	.068	.297	.473	.002	
	Sum of Squares and Cross-products	-224.500	-3.500	9.500	-4.500	50.000
	Covariance	-1.128	-.018	.048	-.023	.251
	N	200	200	200	200	200

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Table 4.12 Post-Operative Bun/Cr * 24hr Urine Volume Cross Tabulation Count

		24hr Urine Volume		
		Low urine output	normal urine output	Total
Post-operative BUN/Cr	AKI	9	0	9
	No AKI	0	191	191
Total		9	191	200

Table 4.13 Post-Operative Bun/Cr * Type of Surgery Cross tabulationcount

		Type of Surgery		Total
		Elective	Emergency	
Post-operative BUN/Cr	AKI	0	9	9
	No	100	91	191
	AKI			
Total		100	100	200

Table 4.14 Post-Operative Bun/Cr * Gender Cross Tabulation Count

		Gender		
		Male	Female	Total
Post-operative BUN/Cr	AKI	6	3	9
	No	127	64	191
	AKI			
Total		133	67	200

4.17 Haemoglobin status of AKI patients

Among the study subjects who had surgery, 4.0% of them who developed postoperative AKI were anaemic and 0.5% had normal haemoglobin level. Within the group that did not develop AKI, 58% were anaemic and 37% had normal haemoglobin level.

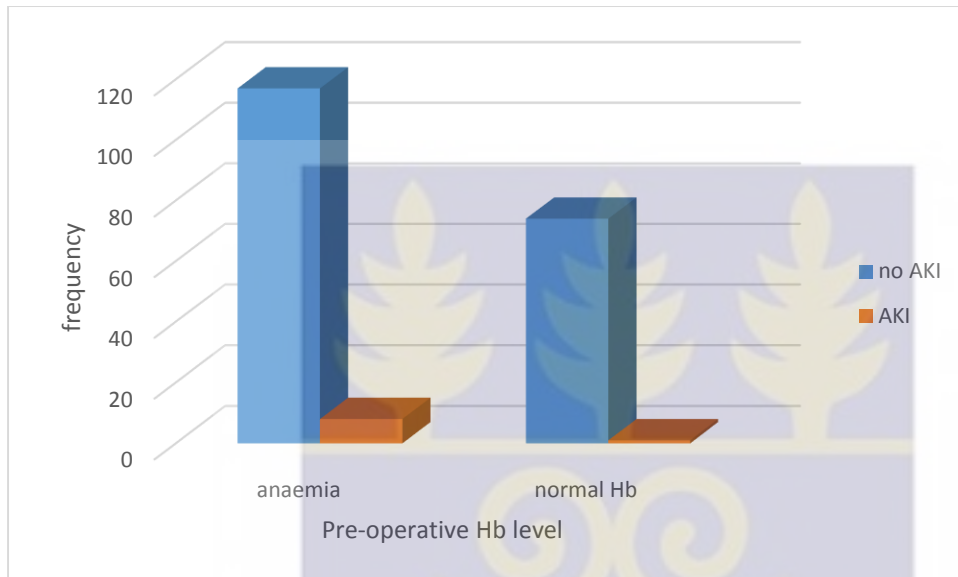


Figure 4.3: Haemoglobin Status of AKI Patients



4.18 Regression analysis for relationship between comorbidities and risk for AKI following emergency laparotomy

From the regression analysis, there was a significant relationship between motivation and productivity ($F=13.22$, $p<0.01$). This means Present Medical Condition and Post-operative BUN/Cr jointly determine patient risk for AKI. An adjusted R-Square of 0.286 shows that Present Medical Condition and Post-operative BUN/Cr jointly determine 28.6% of the variance in risk for AKI.

Comparatively, Post-operative BUN/Cr ($\beta=0.46$) is a bigger determinant of risk for AKI than Present Medical Condition, a Present Medical Condition will lead to a corresponding risk for AKI following emergency laparotomy. See table 2 for details.

Table 4.15: Regression Results For Present Medical Condition and Post-Operative Bun/Cr

Variable	B	B	S.E	T	Prob.
Constant	1.374		0.358	3.835	0.00**
Present Medical Condition	0.141	0.162	0.109	1.295	0.200
Post-operative BUN/Cr	0.459	0.456	0.126	3.643	0.00**
S.E of estimate	0.405				
R-Square				F-	13.22
	0.309			statistic	
Adj. R-square	0.286			Prob.(F-stats.)	0.00**

Note: **significant at $p<0.01$;

CHAPTER FIVE

DISCUSSION, RECOMMENDATIONS AND CONCLUSIONS

A Prospective study was carried out among 200 patients who underwent abdominal surgery from 2015 to 2016. Majority of the patients were male. Demographic data of patients are reported in Table 1. All patients sampled had BUN ≤ 20 , and Cr ≤ 115 and creatinine clearance more than 80 ml/min before operation. Postoperatively diagnostic criteria require a 0.3 mg/dL or a 50% or higher change in serum creatinine from baseline within a 48-hour period or a reduction in urine output of less than 0.5 ml/kg/hr over a 24-hour interval and BUN >20 and Cr >115

5.1 Incidence of Postoperative Acute Kidney Injury

This study revealed a high incidence (4.5%) of postoperative AKI among patients with normal preoperative renal function. This result is consistent with a report of a study conducted among general hospitalized patients, ranging from 1 to 5% (Kheterpal *et al.*, 2007) and other studies that reported incidence of postoperative AKI as varying from 1.1 to 17% (Mehta *et al.*, 2008).

However, a recent study showed a relatively low incidence of postoperative AKI ($< 1\%$) in patients with normal kidney function undergoing noncardiac surgery. In that study, AKI was defined by an absolute level of estimated GFR (50 mL/min) within the first 7 postoperative days, which is a highly restrictive criterion for the detection of AKI. Consequently, the underestimation of the incidence of postoperative AKI in the abovementioned study compared to this study may be attributed to the difference in the definitions of AKI in both the studies.

Acute Kidney Injury remains a medical problem with a daunting outcome: even the best centres typically report mortalities of 50 to 80% (Ali *et al.*, 2007). A study conducted by Thakar and colleagues among patients after gastric bypass with previously normal renal function revealed

an incidence of 8.5% for postoperative AKI. Another study by Calbezuelo et al. reported an incidence of 30% for AKI in patients undergoing liver transplantation and indicated that the frequency of severe AKI requiring dialysis can be as high as 17%.

5.2 Advanced Age and Postoperative Aki

This study revealed old age as predictive factor for postoperative AKI. This report is consistent with a study by Kheterpal *et al.* 2009 who reported old age as one of the preoperative AKI risk factors for postoperative AKI (Kheterpal *et al.* 2009). Another report by Kim *et al.*, in patients with previously normal renal function which also found advanced old age as one of the predictors of postoperative AKI (Kim *et al.*, 2013). This is due to the fact that renal mass decreases with aging, reaching approximately 75–80% of young adulthood weight by the age of 80 to 90 years (Lindeman *et al* 1986). At age 70 years, the kidneys have lost between 30% to 50% of their cortical glomeruli due to ischemic changes and a significant number of the remaining glomeruli manifest some degree of sclerosis (Lindeman et al., 1986) Some have posited that the glomerulosclerosis of aging is dependent on subclinical injury to the kidney from comorbidities, including hypertension and vascular disease (Tauchi et al., 1971). Other morphologic changes that occur with aging include a reduction in the number and size of tubules, increasing tubulointerstitial fibrosis, a decrease in glomerular filtering surface area due to an increasing proportion of mesangial cells, thickening of glomerular and tubular basement membranes, arteriosclerosis (even in healthy non-hypertensive elderly patients), and decreased afferent arteriolar luminal area (Fliser et al., 2005). The structural changes that occur with aging contribute to functional alterations. The most salient of these include a reduction in renal blood flow (RBF) of up to 50% from age 20 to age 80 and a progressive decline in glomerular filtration rate (GFR) (Fliser et al., 2005). Based on longitudinal studies of healthy patients without hypertension, diabetes, heart disease, or clinically apparent atherosclerosis, a progressive decline in GFR of 0.75 ml/min/1.73m² per year was observed after the age of 30.

However, approximately 30% of patients did not manifest this age-related GFR decline, making it unclear whether genetic, dietary, metabolic, or other factors contribute to this process. Taken together, the decrease in RBF and GFR represent a loss of renal functional reserve in the elderly and contribute to an increased risk for development of AKI (Fliser et al., 2005).

5.3 Gender and Postoperative AKI

The male gender was significantly associated with the development of postoperative AKI in this study. This result agrees with a previous study conducted by Kim *et al.* (2013) identified the male sex as risk factor for postoperative AKI (Kim *et al.* 2013). However, the female gender was reported to be as an independent risk factor for postoperative renal injury in study conducted Marcia *et al.*, (Vives *et al.*, 2014) which is not consistent to finding of this study. As compared to men, women normally have less muscle mass and are typically older at the time of surgery. These two factors can affect serum creatinine levels. In this study, the male gender was predominant and such evidence can be a factor to justify the significant percentage of renal injury. Women have physiologically lower glomerular filtration rates than men use of potent vasoconstrictor drugs (norepinephrine and vasopressin) may be an aggravating additional for kidney dysfunction (Karkouti *et al.*, 2015).

5.4 Emergency laparotomy Surgery and Postoperative AKI

In this study emergency laparotomy was strongly associated with postoperative AKI. Out of the 200 patients studied, all those who developed postoperative AKI were the emergency cases. This result is supported by previous studies (Kheterpal et al., 2009; Kim et al., 2014; Vives et al., 2014). In every major operation, a risk for reduction in effective blood volume or mechanical obstruction exists. Hypovolaemia, low systemic vascular resistance because of anaesthesia or caval compression, and direct injury to the renal system are all common events

during surgery that can harm the kidney. Emergency surgery is a risk factor for AKI (Kheterpal *et al.*, 2009) Major vascular surgery, and cardiac surgery in particular are well-known risk factors for postoperative AKI (Vives *et al.*, 2014). Patients undergoing intraperitoneal surgery in general, exploratory laparotomy and small bowel resections in particular, are more prone to develop AKI. (Kim *et al.*, 2014).

5.5 Co-Morbidities and Postoperative AKI

The data presented in this study revealed that all cases of postoperative AKI had co-morbidities. This result agrees with (Bennet *et al.*, 2010; Biteker *et al.*, 2014).

With the development of surgical techniques and advanced anaesthesia delivery and monitoring, surgery on sicker and older patients is more common. These patients suffer from co-morbidities, such as chronic kidney disease, metabolic syndrome, hypertension, diabetes mellitus, and cardiovascular and hepatobiliary disease, all of which are well-documented risk factors predisposing to AKI (Biteker *et al.*, 2014). Damage to the kidneys, as a result of AKI, may be enhanced with the presence of co-morbidities and thereby complicate the treatment procedure. This study highlights the co-morbidities associated with the development of postoperative AKI to be diabetes mellitus and hypertension.

5.6 Anaemia and Postoperative AKI

The study identified pre-operative anaemia as a risk factor for post-operative AKI. This finding is in agreement with the study by Karkouti and colleagues who observed a relationship between pre-operative haemoglobin and AKI after cardiopulmonary bypass (Karbouti *et al.*, 2009). The reasons for such an association are likely multifactorial. Several experimental studies have stressed the susceptibility of the kidney to anaemia, and the occurrence of renal hypoxia after

decrease of haemoglobin level due to maintenance of high oxygen consumption and intra-renal oxygen shunting (Legrand *et al.*, 2008).

In a rat model where renal oxygen tension was altered by hemodilution despite normal arterial blood pressure (Legrand *et al.*, 2010), a specific contribution of anaemia to kidney damage through oxidative stress has been proposed (Nangaku *et al.*, 2006). Moreover, they found that red blood cell (RBC) transfusion per se was also a risk factor. Several authors have previously identified the negative impact of RBC transfusion on renal function after cardiac surgery. One of the reasons could be the inability of RBC transfusion to restore adequate microcirculatory oxygenation because of the multiple morphological and functional changes (less deformability, depletion of 2,3-diphosphoglycerate, inflammation, decrease of bioavailability of nitric oxide with liberation of free haemoglobin) occurring during blood storage.

5.7 Conclusions

From the discussion above it is concluded that:

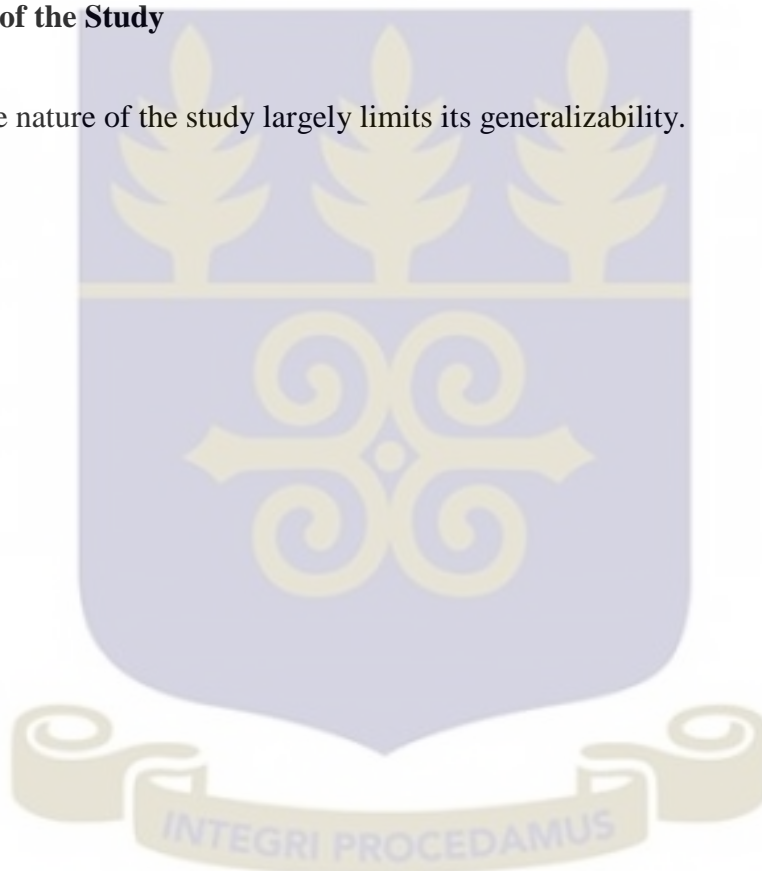
- The incidence of postoperative AKI following laparotomy is high in Korle-Bu Teaching Hospital.
- Old age, emergency laparotomy surgery, male gender, pre-operative anaemia and comorbidity such as diabetes and hypertension are the predictive factors for postoperative AKI.
- Appreciation of these factors may help to identify high-risk laparotomy surgical populations to reduce the risk of postoperative AKI and to achieve optimal treatment in the event of occurrence of postoperative AKI.

5.8 Clinical Relevance of Key Findings

This study adds evidence to the current literature suggesting the risk factors of postoperative AKI following laparotomy for abdominal emergencies. Findings of the study will help educate clinicians and influence them to objectively assess all surgical patients because identifying risk factors and preventing the development of postoperative AKI are essential for improving patient survival.

5.9 Limitations of the Study

The single-centre nature of the study largely limits its generalizability.

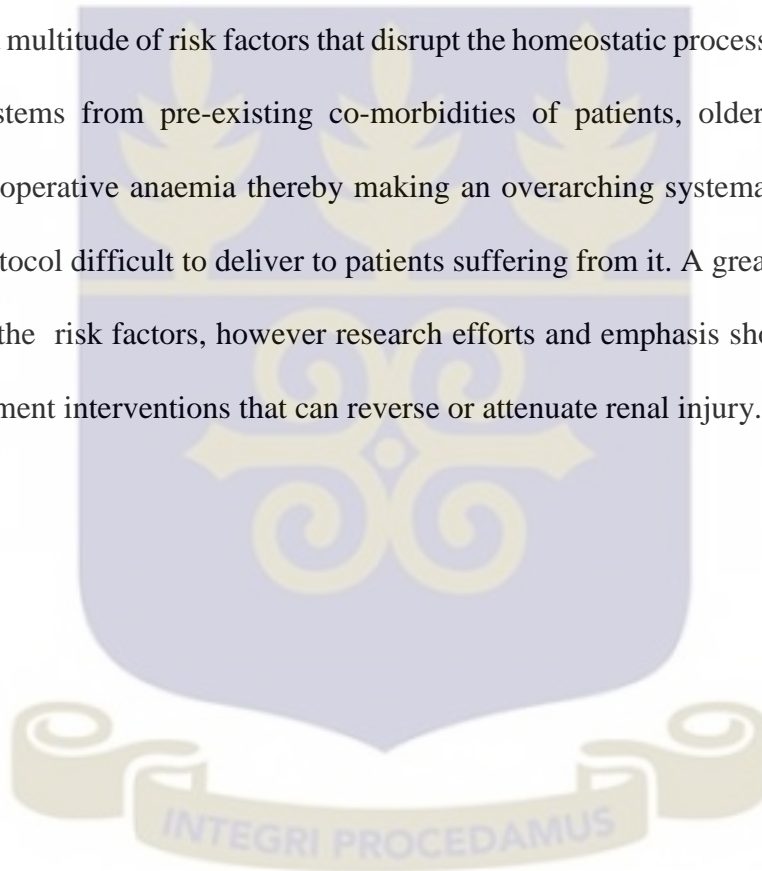


5.10 Recommendations

A multi-centre nature of the study should be carried out to determine more precisely the risk factors of postoperative AKI following laparotomy in the Ghanaian population for more generalization.

5.11 Conclusion

Postoperative AKI is an important clinical event that manifests in surgical patients. AKI is associated with a multitude of risk factors that disrupt the homeostatic processes of the kidneys. Its complexity stems from pre-existing co-morbidities of patients, older age, emergency surgery and pre-operative anaemia thereby making an overarching systematic treatment and management protocol difficult to deliver to patients suffering from it. A great deal of light has been shed upon the risk factors, however research efforts and emphasis should be placed on developing treatment interventions that can reverse or attenuate renal injury.



REFERENCES

- Abelha, F. J., Botelho, M., Fernandes, V. & Barros, H. (2009). Determinants of postoperative acute kidney injury. *Crit Care* 13: R79.
- Ali, T., Khan, I., Simpson, W., Prescott, G., Townend, J., Smith, W., Macleod, A. (2007). Incidence and outcomes in acute kidney injury: a comprehensive population-based study. *J Am Soc Nephrol*, 18:1292-1298.
- American Society of Nephrology Renal Research Report. (2005) *J Am Soc Nephrol*, 16:1886–1890.
- Bagshaw, S.M., George, C., Bellomo, R. (2008). A comparison of the RIFLE and AKIN criteria for acute kidney injury in critically ill patients. *Nephrol Dial Transplant*, 23:1569–1574.
- Bellomo, R., Kellum, J.A., Ronco, C. (2009). Defining and classifying acute renal failure: from advocacy to consensus and validation of the RIFLE criteria. *Intensive Care Med*, 11:409–413.
- Bellomo, R., Ronco, C., Kellum, J.A., Mehta, R.L., Palevsky, P. (2009). Acute renal failure: definition, outcome measures, animal models, fluid therapy and information technology needs: the Second International Consensus.
- Biteker, M., Dayan, A., Tekkeşin, A.I. (2014). Incidence, risk factors, and outcomes of perioperative acute kidney injury in noncardiac and nonvascular surgery. *Am J Surg*; 207: 53–9

Bonventre, J.V, Weinberg, J.M. (2003). Recent advances in the pathophysiology of ischemic acute renal failure. *J Am Soc Nephrol*, 14:2199–2210.

Brady, J. E. & Li, G. (2014). Variations in the risk of acute kidney injury across intraabdominal surgery procedures. *Anesth Analg* , 119: 1121–32

Brienza, N., Giglio, M.T., Marucci, M., Fiore, T. (2009). Does perioperative hemodynamic optimization protect renal function in surgical patients? A meta-analytic study. *Crit Care Med*, 37:2079–2090.

Butkus, D. E. (1983). Persistent high mortality in acute renal failure. Are we asking the right questions? *Arch Intern Med*.143:209–12. [PubMed

Cabezuelo, J, B., Ramirez, P., Rios, A., Acosta, F. & Torres, D. (2006). Risk factors of acute renal failure after liver transplantation. *Kidney Int*, 69: 1073–1080

Callister, M.E.J., Evans, T.W. (2002). Pulmonary vs extra-pulmonary ARDS: different disease or just a useful concept. *Curr Opin Crit Care*, 8:21–25.

Candela-Toha A, Elias-Martin E, Abraira V, Tenorio MT, Parise D, de Pablo A, Centella T, Liano F. (2008). Predicting acute renal failure after cardiac surgery: external validation of two new clinical scores. *Clin J Am Soc Nephrol*, 3:1260–1265.

Carmichael, P., Carmichael, A.R. (2003) Acute renal failure in the surgical setting. *ANZ J Surg* , 73:144–153.

Chertow, G.M., Burdick, E., Honour, M., Bonventre, J.V., Bates, D.W. (2005). Acute kidney injury, mortality, length of stay, and costs in hospitalized patients. *J Am Soc Nephrol*, 16:3365–3370.

Chertow, G.M., Levy, E.M., Hammermeister, K.E., Grover, F., Daley, J. (1998). Independent association between acute renal failure and mortality following cardiac surgery. *Am J Med*, 104:343–348.

Chertow, G. M., Lazarus, J. M., Christiansen, C. L., Cook, E. F., Hammermeister, K. E., Grover, F. & Daley, J. (1997). Preoperative renal risk stratification. *Circulation*, 95:878-884

Clarke, A., Murdoch, H., Thomas, M.J, Cook TM, Peden CJ. (2011). Mortality and postoperative care after emergency laparotomy. *Eur J Anaesthesiol*; 28: 16–9.

Coca, S.G., Singanamala, S., Parikh, C.R. (2012). Chronic kidney disease after acute kidney injury: a systematic review and meta-analysis. *Kidney Int*; 81:442-8.

Cosentino, F., Chaff, C. & Piedmonte, M. (1994). Risk factors influencing survival in ICU acute renal failure. *Nephrol Dial Transplant*, 9:179-82

Dalino, L., Tullo, L., Donadio, I., Malcangi, V., Brienza, N. (2008). Intra-abdominal hypertension and acute renal failure in critically ill patients. *Intensive Care Med*; 34: 707–13

Disease, K. (2012). Improving Global Outcomes (KDIGO) Acute Kidney Injury Work

Group: KDIGO Clinical Practice Guidelines for Acute Kidney Injury. *Kidney Int Suppl*, 2:1–138.

Druml, W. (2005). Long term prognosis of patients with acute renal failure: is intensive care worth it? *Intensive Care Med*, 31:1145–1147.

Eriksen, B.O., Hoff, K.R.S., Solberg, S. (2003). Prediction of acute renal failure after cardiac surgery: retrospective cross-validation of a clinical algorithm. *Nephrol Dial Transplant*, 18:77–81.

Feinfeld, D. A., Bargouthi, H., Niaz, Q. & Carvounis, C. P. (2002). "Massive and disproportionate elevation of blood urea nitrogen in acute azotemia" (PDF). *Int Urol Nephrol*. 34: 143–5. PMID 12549657.

Fliser, D., & Kielstein, J. T. (2006). Technology Insight: treatment of renal failure in the intensive care unit with extended dialysis. *Nat Clin Pract Nephrol*, 2:32-39

General Surgery: The Future, Emergency Consensus Statement.2007. Available from http://www.asgbi.org.uk/download.cfm?do_id=3CBDAE30-8B61-492B-AABAE209BB5780AD (accessed 15th June 2012)

Herget-Rosenthal, S., Marggraf, G., Husing, J., Goring, F., Petruck, F., Janssen, O., Philipp, T. & Kribben, A. (2004). Early detection of acute renal failure by serum cystatin C. *Kidney Int*, 66:1115–1122.

Herget-Rosenthal S, Poppen D, Husing J, Marggraf G, Pietruck F, Jakob HG, Philipp T,

Kribben A: Prognostic value of tubular proteinuria and enzymuria in nonoliguric acute tubular necrosis. Clin Chem 50 :552– 558,2004

Hobson, C.E., Yavas, S., Segal, M.S., Schold, J.D., Tribble, C.G., Layon, A.J, Bihorac, A.

(2009). Acute kidney injury is associated with increased long-term mortality after cardiothoracic surgery. *Circulation*, 119:2444–2453.

Hoste, E.A., Clermont, G., Kerston, A., Ventataraman, R, Angus, D.C., De Bacquer, D.,

Kellum, J.A. (2006). RIFLE criteria for acute kidney injury are associated with hospital mortality in critically ill patients: a cohort analysis. *Crit Care*, 10:R73.

Ishani, A, Nelson, D., Clothier, B., Schult, T., Nugent, S., Greer, N., Slinin, Y., Ensrud, K.E.

(2013). The magnitude of acute serum creatinine increase after cardiac surgery and the risk of chronic kidney disease, progression of kidney disease, and death. *Arch Intern Med* 2011, 171:226–233.

Ishikawa, S., Griesdale, D.E., Lohser, J. (2012). Acute kidney injury after lung resection

surgery: incidence and perioperative risk factors. *AnesthAnalg*; 114: 1256–62

- Joshi, G. P. & Cunningham, A. Anesthesia for laparoscopic and robotic surgeries. In: Barash, P. B., Cullen, B. F., Stoelting, R. K., Cahalan, M. K., Stock, M. C., Ortega, R. eds. (2013). *Clinical Anesthesia*. Philadelphia, USA: *Lippincott Williams & Wilkins*, 1257–73
- Jurado, R. & Mattix, H. (1998). The decreased serum urea nitrogen-creatinine ratio. *Arch Intern Med*.158:2509–2511. [PubMed]
- Karkouti, K., Wijeyesundera, D.N., Yau, T.M., et al. (2009). Acute kidney injury after cardiac surgery. Focus on modifiable risk factors. *Circulation*; 119: 495–502
- Karkouti, K., Grocott, H.P., Hall, R., et al. (2014). Interrelationship of preoperative anemia, intraoperative anemia, and red blood cell transfusion as potentially modifiable risk factors for acute kidney injury in cardiac surgery: a historical multicentre cohort study. *Can J Anesth* 2014; 62: 377–84
- Kheterpal, S., Tremper, K.K., Englesbe, M.J., O'Reilly, M., Shanks, A.M., Fetterman, D.M., Rosenberg, A.L., Swartz, R.D. (2007). Predictors of postoperative acute renal failure after noncardiac surgery in patients with previously normal renal function. *Anesthesiology*, 107:892–902.
- Kheterpal, S., Tremper, K.K, Heung, M., Rosenberg, A.L., Englesbe, M., Shanks, A.M., Campbell, D.A. (2009). Development and validation of an acute kidney injury risk index for patients undergoing general surgery. *Anesthesiology*, 110:505–515.

- Kim, M., Brady, J.E., Li, G. (2009). Variations in the risk of acute kidney injury across intraabdominal surgery procedures. *AnesthAnalg* 2014; 119: 1121–32
- Abelha FJ, Botelho M, Fernandes V, Barros H. Determinants of postoperative acute kidney injury. *Crit Care*; 13: R79.
- Kolhe, N.V., Stevens, P.E., Crowe, A.V., Lipkin, G.W., Harrison, D.A. (2008). Case mix, outcome and activity for patients with severe acute kidney injury during the first 24 hours after admission to an adult general critical care unit: application of predictive models from a secondary analysis of the ICNARC Case Mix Programme database. *Crit Care*, 12(Suppl 1):S2.
- Kuitunen A., Vento, A., Suojaranta-Ylinen, R., Pettila, V. (2006). Acute renal failure after cardiac surgery: evaluation of the RIFLE criteria. *Ann Thorac Surg*, 81:542–546.
- Kwakernaak, A.J., Toering, T.J., Navi, G. (2013). Body mass index and body fat distribution as renal risk factors: a focus on the role of renal haemodynamics. *Nephrol Dial Transplant*; 28: 42–9.
- Lafrance, J.P, Miller, D.R. (2010). Acute kidney injury associates with increased long-term mortality. *J Am SocNephrol*, 21:345–352.
- Lassnigg, A., Schmidlin, D., Mouhieddine, M., Bachmann, L.M., Druml, W., Bauer, P., Hiesmayr, M. (2004). Minimal changes of serum creatinine predict poor prognosis in patients after cardiothoracic surgery: a prospective cohort study. *J Am SocNephrol*, 15:1597–1605.

Legrand, M., Pirracchio, R., Rosa, A, et al. (2013). Incidence, risk factors and prediction of post-operative acute kidney injury following cardiac surgery for active infective endocarditis: an observational study. *Crit Care*; 17: R220

Legrand, M., Mik, E. G., Balestra, G. M., Lutter, R., Pirracchio, R., Payen, D. & Ince, C. (2010). Fluid resuscitation does not improve renal oxygenation during hemorrhagic shock in rats. *Anesthesiology*, 112:119–127.

Legrand, M., Mik, E. G., Johannes, T., Payen, D. & Ince, C. (2008). Renal hypoxia and dysoxia after reperfusion of the ischemic kidney. *Mol Med*, 14:502–516

Liano, F., Junco, E., Pascual, J., Madero, R., Verde, E. (1998) The spectrum of acute renal failure in the intensive care unit compared with that seen in other settings. The Madrid Acute Renal Failure Study Group. *Kidney Int*, 66:S16–S24.

Lindeman, R.D., Goldman, R. (1986). Anatomic and physiologic age changes in the kidney. *Exp Gerontol.* ;21(4–5):379–406. [[PubMed](#)]

Loef, B.G., Epema, A.H, Smilde, T.D., Henning, R.H., Ebels, T., Navis, G., Stegeman, C.A. (2005). Immediate postoperative renal function deterioration in cardiac surgical patients predicts in-hospital mortality and long term survival. *J Am SocNephrol*, 16:195–200.

Malbrain, M.L., Chiumello, D., Pelosi, P. et al. (2004). Prevalence of intra-abdominal hypertension in critically ill patients: a multicentre epidemiological study. *Intensive Care Med* 2004; 30: 822-9.

- Medeiros, P, Nga, H.S., Menezes, P., Bridi, R., Balbi, A., Ponce, D. (2015). Acute kidney injury in septic patients admitted to emergency clinical room: risk factors and outcome. *Clin Exp Nephrol* 2015; 19: 859–66
- Mehta, R. L. (2008). From acute renal failure to acute kidney injury: emerging concepts. *Crit Care Med*, 36:1641-1642.
- Mehta, R.L., Chertow, G.M. (2003). Acute renal failure definitions and classification: time for change? *J Am SocNephrol*, 14:2178–2187.
- Mehta, R. L., Pascual, M. T., Soroko, S., Savage, B. R., Himmelfarb, J., Ikizler, T. A., Paganini, E. P. & Chertow, G. M. (2004). Spectrum of acute renal failure in the intensive care unit: the PICARD experience. *Kidney Int*, 66:1613-1621
- Metnitz, P.G., Krenn, C.G., Steltzer, H., Lang, T., Ploder, J., Lenz, K., Le Gall, J.R., Druml, W. (2002). Effect of acute renal failure requiring renal replacement therapy on outcome in critically ill patients. *Crit Care Med*, 30:2051–2058.
- Nangaku, M. (2006). Chronic hypoxia and tubulointerstitial injury: a final common pathway to end-stage renal failure. *J Am Soc Nephrol*, 17:17–25.
- Ostermann, M., Chang, R.W. (2007) Acute kidney injury in the intensive care unit according to RIFLE. *rit Care Med*, 35:1837–1845.
- Palevsky, P.M. (2006). Epidemiology of acute renal failure: the tip of the Iceberg. *Clin J Am SocNephrol* :6–7.

- Pearse, R.M., Harrison, D.A., James, P. (2006). et al. Identification and characterisation of the high-risk surgical population in the United Kingdom. *Crit Care*; 10: R81
- Peden, C.J. (2011) Emergency surgery in the elderly patient: a quality improvement approach. *Anaesthesia*; 66: 440–5 Emergency Laparotomy Network. Available from http://www.networks.nhs.uk/nhs-networks/emergency-laparotomy-network/network_profile_view (accessed 15th June 2012).
- Romero-Corral, A., Sert-Kuniyoshi, F. H. & Sierra-Johnson, J., (2010). Modest visceral fat gain causes endothelial dysfunction in healthy humans. *J Am Coll Cardiol*; 56: 662–6
- Selby, N. M., Crowley, L., Fluck, R. J., McIntyre, C. W., Monaghan, J., Lawson, H. & Kohle, N. V. (2012). Use of electronic results reporting to diagnose and monitor AKI in hospitalized patients. *Clin J Am Soc Nephrol*, 7:533–540
- Shashaty, M.G., Kalkan, E., Bellamy, S.L., et al. (2014). Computed tomography-defined abdominal adiposity is associated with acute kidney injury in critically ill trauma patients. *Crit Care Med*; 42: 1619–28
- Shusterman, N., Strom, B.L, Murray, T.G., Morrison, G., West, S.L., Maislin, G. (1987). Risk factors and outcome of hospital acquired acute renal failure. Clinical epidemiologic study. *Am J Med*, 83:65–71.
- Suneja M., Kumar, A.B. (2014). Obesity and perioperative acute kidney injury: a focused review. *J Crit Care*; 29: 694.e1–6

Svensson, J. S., Coselli, H. J., Safi, K. R., Hess, and E. S. Crawford, (1989). "Appraisal of adjuncts to prevent acute renal failure after surgery on the thoracic or thoracoabdominal aorta," *Journal of Vascular Surgery*, vol. 10, no. 3, pp. 230–239.

[View at Google Scholar](#) · [View at Scopus](#)

Svensson, L. S., Crawford, E. S. & Hess, K. R. (1993) "Experience with 1509 patients undergoing thoracoabdominal aortic operations," *Journal of Vascular Surgery*, vol. 17, no. 2, pp. 357–370, 1993

Tauchi, H., Tsuboi, K., Okutomi, J. (1971). Age changes in the human kidney of the different races. *Gerontologia.*;17(2):87–97. [[PubMed](#)]

Thakar, C.V., Arrigain, S., Worley, S., Yared, J.P., Paganini, E.P. (2005). A clinical score to predict acute renal failure after cardiac surgery. *J Am Soc Nephrol*, 16:162–168.

Thakar, C.V., Liangos, O., Yared, J.P., Nelson, D.A., Hariachar, S., Paganini, E.P. (2003). Validation and re-definition of a risk stratification algorithm. *HemodialInt*, 7:143–147.

Thaker, C.V., Kharat, V., Blanck, S., Leonard, A.C. (2007). Acute kidney injury after gastric bypass surgery. *Clin J Am Soc Nephrol* , 2:426–430.

Uchino, S., Bellomo, R., Goldsmith, D., Bates, S., Ronco, C. (2006). An assessment of RIFLE criteria for acute renal failure in hospitalized patients. *Crit Care Med*, 34:1913–1917.

Uchino, S., Bellomo, R., Goldsmith, D., Bates, S., Ronco, C. (2006). An assessment of the

RIFLE criteria for acute renal failure in hospitalized patients. *Crit Care Med*, **34**:1913-1917

Uchino, S., Kellum, J.A., Bellomo, R., Doig, G.S., Morimatsu, H., Morgera, S., Schetz, M.,

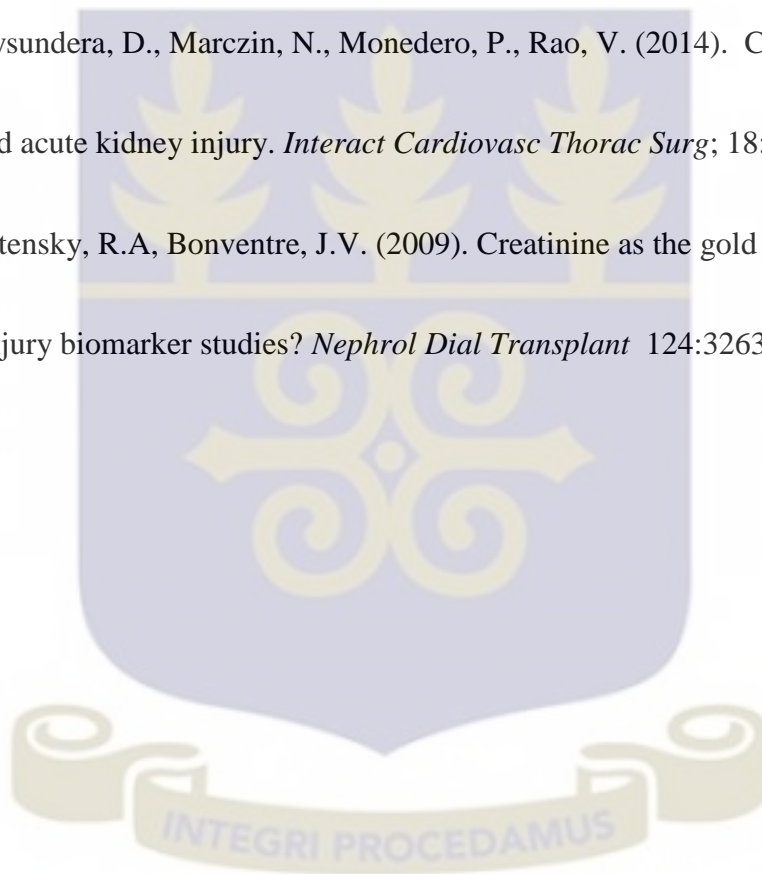
Tan, I., Bouman, C., Macedo, E., Gibney, N., Tolwani, A., Ronco, C. (2005). Acute renal failure in critically ill patients: a multinational, multicenter study. *JAMA* 2005, 294:813–818.

Vives, M., Wijesundera, D., Marczin, N., Monedero, P., Rao, V. (2014). Cardiac surgery-

associated acute kidney injury. *Interact Cardiovasc Thorac Surg*; 18: 637–45

Waiker, S.S., Betensky, R.A, Bonventre, J.V. (2009). Creatinine as the gold standard for

kidney injury biomarker studies? *Nephrol Dial Transplant* 124:3263–3265.



APPENDIX I

INFORMED CONSENT FORM

PROJECT TITLE: Risk factors for postoperative acute kidney injury following laparotomy for abdominal emergencies.

NAME, POSITION, AND CONTACT INFORMATION OF RESEARCHER

Irene SenaWemakor; MPHIL. Physiology, Department of Physiology, School of Biomedical and Allied Health Sciences, College of Health science, University of Ghana, Korle-Bu, Accra, Ghana.

Tel.0243444931

SUPERVISORS

Principal supervisor: Dr. Rev. Charles Antwi-Boasiako; Department of Physiology, School of Biomedical and Allied Health Sciences, University of Ghana, Korle-Bu, Accra, Ghana.

CO-SUPERVISOR

Dr. Bart Dzudzor; Department of Biochemistry, School of Biomedical and Allied Health Sciences, University of Ghana, Korle-Bu, Accra, Ghana.

I.....have been invited to take part in this research. I have been told the research study is: to determine the risk factors for postoperative acute kidney injury in patients undergoing emergency laparotomy.

I will be interviewed using an anonymous structured questionnaire to obtain information on socio-demographic, medical, and diet history. In addition I would be asked to provide blood sample (about 5 ml).

The risk or dangers and discomforts are:

By participating in this research, I am likely to have some discomforts. This includes the discomfort of questioning and the pain of blood collection. The investigator will try and decrease the chances of those risks/dangers happening, but if an untoward event happens, I will be provided with medical care which would be catered for by the investigator in the hospital.

Confidentiality: The information that is collected from this research project will be kept confidential. Information about me that will be collected from the study will be stored in a file which will not have any name on it, but a number assigned to it. Which number belongs to which name will not be disclosed to anyone except the principal investigator. Results of this study will be compiled into a thesis and presented for the award of Master of Philosophy degree. Copies will be available at designated libraries for reference. Result will be presented at the Annual Scientific Conference, M.Phil.

I. Seminar and also it will be published in local or International Journals.

My right to refuse or withdraw:

I do not have to take part in this research if I do not wish to do so. I may stop participating in this research at any time that I wish to.

Who may I contact? :

I have been told that this proposal has been reviewed and approved by the Ethical and protocol Review Committee, College of Health Sciences, University of Ghana. This is a committee whose job is to make sure that research participants are protected from harm.

Contact Information:

If I have any questions I may ask those now or later. If I wish to ask questions later, I may contact any of the following:

Irene SenaWemakor, MPHIL. Physiology, Department of Physiology, School of Biomedical and Allied Health Sciences, College of Health science, University of Ghana, Korle-Bu, Accra, Ghana. Tel. 0243444931

Dr. Rev. Charles Antwi-Boasiako; Department of Physiology, School of Biomedical and Allied Health Sciences, University of Ghana, Korle-Bu, Accra, Ghana. Tel. 0244729026



APPENDIX II

QUESTIONNAIRE

SECTION A (DEMOGRAPHIC DATA)

Age.....

1. Gender

Male []

Female []

2. Educational Status

Primary []

Secondary []

Tertiary []

Others (specify).....

SECTION B (SOCIAL DATA)

3. Occupation.....

4. Do you smoke?

Yes []

No []

5. Do you consume alcohol?

Yes occasionally []

Yes regularly []

No []

6. Do you consume fatty foods?

Yes []

No []

7. Does your diet contain high fibre?

Yes []

No []

SECTION C (MEDICAL DATA)

8. Do you have any present medical condition?

Yes []

No []

If Yes (please specify.....)

9. Do you have any pre-existing kidney problem?

Yes []

No []

10. Have you undergone any surgical procedure before?

Yes []

No []

SECTION D

To be completed by the researcher

1. Patient's body weight.....(kg)
2. Patient's height.....
3. Patient's BMI.....
4. Patient's Systolic blood pressure
5. Patient's diastolic blood pressure.....
6. Patient's pulse pressure.....
7. Patients body temperature.....

Name of Surgery.....

Type of Surgery.....

Diagnosis.....

Hydration Status.....

8. Type of Anaesthesia.....
9. Duration of surgery.....
10. Amount of fluids given during surgery.....
11. Name of anaesthetic drugs used

.....
.....

12. Estimated amount of blood loss during surgery.....

13. Pre-operative laboratory results

Full Blood Count; Haemoglobin level.....

White blood cell count.....

Platelet count

Serum Urea.....

Serum Creatinine (Cr).....

Serum Potassium.....

Serum Sodium.....

Chloride ion.....

Blood Urea Nitrogen (BUN).....

Preoperative BUN/Cr ratio.....

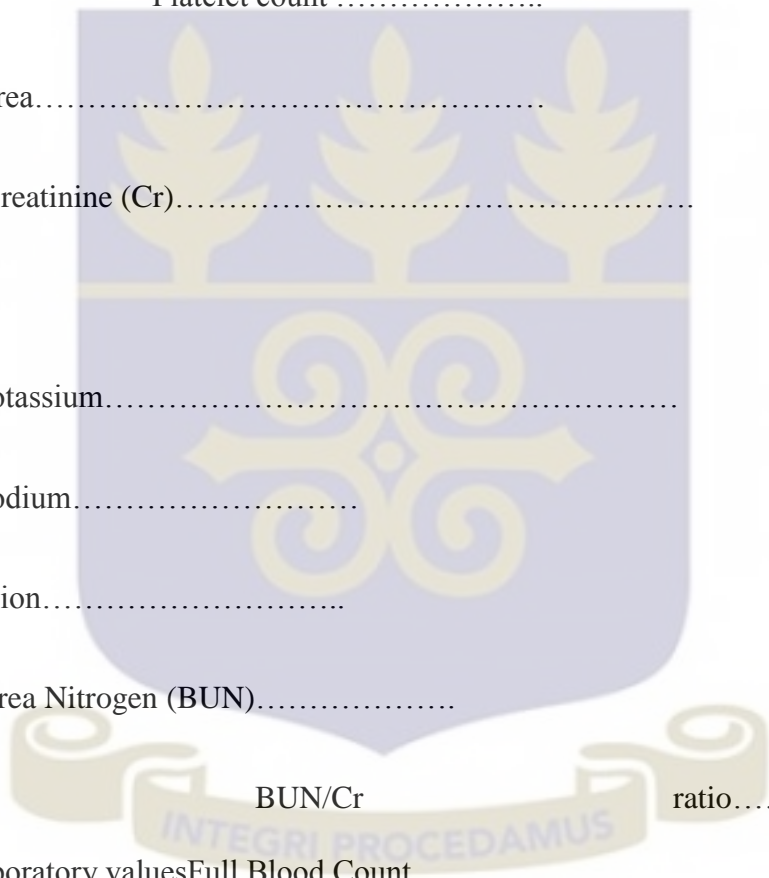
Postoperative laboratory values Full Blood Count.....

Serum Urea.....

Serum Creatinine.....

Serum Potassium.....

Serum Sodium.....



Chloride ion.....

BUN.....

14. Total urine volume (24HRS) after surgery.....

15. Post-operative BUN/Cr ratio.....

