

**A RETROSPECTIVE STUDY ON THE OUTCOMES OF PERITONEAL DIALYSIS
AMONG PEDIATRIC PATIENTS WITH ACUTE KIDNEY INJURY AT THE
KENYATTA NATIONAL HOSPITAL.**

BY

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DECLARATION

I declare that this is my original work that has never been presented to any other educational institution for any award. Any other Authors' work utilized herein is accordingly acknowledged.

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CERTIFICATE OF APPROVAL

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DEDICATION

This work is dedicated to my dearest family.

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ABSTRACT

Background: Epidemiological evidence supports the view that even mild, reversible acute kidney injury (AKI), has important clinical consequences that may include increased risk of death. The management of AKI is directed towards restoring normal chemical balance with the dialytic interventions for infants and children taking different forms but peritoneal dialysis (PD) has been preferred because of its efficacy.

Aim of the study: To establish the outcomes of PD on pediatric patients in Kenyatta National Hospital (KNH).

Methodology: The study design was a retrospective cohort study. The study population was pediatric patients managed on PD due to AKI for the period, January 2017 to December 2017. The sample size was 102 files calculated using Yamene Taros formula. Convenience sampling method was used. Data was collected using a structured checklist, then entered, cleaned and analyzed using a computer software package, SPSS. Paired t-test was used to determine biochemistry parameter before commencement of PD and on discontinuation of PD. The statistical significance was set up at $p < 0.005$.

Results: The survival rate was 58.8% and mortality rate 41.2%. None of the participants progressed to chronic renal disease. The mean Serum Creatinine was higher (602) prior to PD and lower on discontinuation (243). Serum urea level was higher prior to PD and lower on discontinuation of PD (51.49 > 14.58).

Conclusion: A higher percentage of the participants had successful restoration of kidney functions however the mortality rate at 41.2% is still a high percentage. There is evidence that PD is an effective modality in reduction of elevated serum urea and creatinine in treatment of AKI in pediatric patients.

Recommendations: There is need to carry out a random controlled study in pediatric patients on PD due to AKI to determine the outcomes after PD therapy.

LIST OF ABBREVIATIONS/ACRONYMS

ACE-I- Angiotensin converting enzyme inhibitors

ADL- Activities of Daily living

AKI - Acute Kidney Injury

ATN- Acute Tubular Necrosis

BUN- Blood Urea Nitrogen

CKD -Chronic Kidney Disease

GFR- Glomerular filtration rate

HD -Hemodialysis

KDIGO -Kidney Disease Improving Global Outcome

NSAID-Non steroidal anti-inflammatory drugs

PD - Peritoneal Dialysis

PRU- Pediatric Renal Unit

PSU- Pediatric Specialized Unit

OPERATIONAL DEFINATIONS

Acute kidney injury – it is an increase in blood concentration of creatinine and other nitrogenous waste products with the inability of the kidneys to regulate fluid and electrolyte hemostasis.

Azotemia- high levels of urea, when the abnormality can be measured chemically but not yet so severe as to produce symptoms.

Uremia- serious condition in which nitrogen based toxins such as urea and creatinine, the primary waste products of metabolism, accumulate in the blood because the kidneys are unable to filter them out and pass them from the body via the urine.

Renal replacement therapy-is a therapy which replaces some or most of the kidney functions, does not replace endocrine kidney function in patients with renal failure. Techniques include intermittent hemodialysis, continuous hemofiltration and hemodialysis, peritoneal dialysis and kidney transplant. All modalities exchange solute and remove fluid from the blood, using dialysis and filtration across permeable membranes.

Dialysis- The process of removing waste products and excess fluid from the body necessary when the kidneys are not able to adequately filter the blood.

Peritoneal dialysis- dialysis in which the peritoneum surrounding the abdominal cavity is used as a dialyzing membrane utilizing a solution which is intermittently introduced into and removed from the peritoneal cavity for removal of waste products or toxins accumulated as a result of renal failure.

Chronic kidney disease- gradual loss of kidney function over a period of time usually three or more months.

Pediatric patient- in this study infants and children in the ages of a day old to twelve years who are being managed on dialysis in the pediatric renal unit for acute kidney injury.

CHAPTER ONE: INTRODUCTION

This chapter gives the background of the study with the problem statements, justification of the study, the study objectives and the study questions. Hypothesis to be tested in the study is also stated as well as a conceptual framework and theoretical framework.

1.1 BACKGROUND OF THE STUDY

Acute kidney injury (AKI) is a disease of acute onset with specific characteristics. According to Malkina (2017), AKI is a renal disease characterized by a reversible rapid decrease in renal function over days to weeks, causing an accumulation of nitrogenous products in the blood with or without reduction in amount of urine output. AKI can therefore be classified into different categories depending on the specific cause.

Acute Kidney injury has been classified into three categories. Prerenal AKI caused by decreased renal perfusion often because of volume depletion, intrinsic renal AKI caused by a process within the kidneys and post renal AKI caused by inadequate drainage of urine distal to the kidneys (Rahman, Fariha & Smith, 2012). Either of the categories of AKI will results in some adverse effects in the body.

Available literature provides a number of adverse outcomes. According to Khwaja (2012), AKI poses some adverse outcomes some of which are short term while others are long term adverse effects. Chronic kidney disease (CKD) is increasingly recognized as a common sequel of AKI. Epidemiological evidence supports the view that the mild, reversible AKI also has important clinical consequences that include increased risk of death (Kellum, 2013). These adverse outcomes could however be avoided by proper and timely management of AKI.

Renal replacement therapy is among the management modalities of AKI. Smeltzer and Bare (2010) discussed that management of AKI is directed towards restoring normal chemical balance and prevents complications until repair of renal tissue and restoration of renal function

can occur. This includes eliminating the underlying cause, maintaining fluid balance, avoiding fluid excesses and when indicated, providing renal replacement therapy. When renal replacement therapy is indicated, a choice of one specific RRT is made as there are different modalities available.

Dialytic intervention for infants and children with AKI can take many forms. These include intermittent hemodialysis, peritoneal dialysis or continuous renal replacement therapy. The modality of choice is determined by specific patient characteristics, preference of the provider, available institutional resources, dialytic goals and the specific advantages or disadvantages of each modality (Walter, Porter & Brophy 2009). An informed choice on RRT by the parent or the guardian after offering necessary information regarding the disease and the treatment modality is also necessary.

Among the different dialytic interventions available peritoneal dialysis (PD) has been embraced widely. According to Gokal, Khanna, Krediet & Noph (2017), PD either manually or with an automated machine uses the peritoneal membrane as a filter to clear wastes and excess water from the body and return electrolyte level to normal. Mishra, Gupta, Pooniya, Prasad, Tiwary & Schaefer (2012) found out that peritoneal dialysis remains the predominant acute dialysis modality in developing countries. Warady & Buchman, (2000) indicated that PD has been chosen because of its efficacy, its ease of implementation and the lack of need for vascular access. According to Abraham, Varughese, Mathew & Vijayan (2015), PD has a better preservation of local renal hemodynamics and also may be more physiologic and less inflammatory than HD. This is due to the absence of contact between blood and synthetic membrane. In a related study, Lim et al., (2017) found out that PD offers good patient survival and renal outcomes hence it is a viable first line RRT in severe AKI for young children with low body weight even if they are critically ill. As a result PD assures better outcome for the pediatric patient.

Peritoneal access is established for commencement of PD by inserting a peritoneal catheter. According to Jenkins, Arutyunova and Curnow, (2017), a successful technique for catheter placement which allows for urgent initiation of PD in children within 24 hours was developed. This technique prevents omental encasement of the catheter; it is associated with low leak rate and has a low modality failure rate. This ensures that peritoneal dialysis is initiated as soon as it is prescribed while the low modality failure enhances positive outcome.

1.2 PROBLEM STATEMENT

In the global perspective, large database studies show that AKI pervades health care systems worldwide with poor outcomes and an increasing use of RRT. In many health systems, kidney function data are increasingly available either in integrated electronic health records or through data linkage. In high income countries, these developments have led to recognition that even small changes in creatinine carry an adverse prognosis and that some poor outcomes after AKI are preventable. According to Susantitaphong, Cruz, Cerda, Abulfaraj, Koulouridis & Jaber (2013), AKI affects one in every five hospitalized adults and one in every three hospitalized children worldwide. Over 2.3 million people worldwide are estimated to die yearly from AKI and more than 30% of survivors' progress to end stage renal disease that often necessitates dialysis or transplantation (Mehta, Bagga, Patibanala and Chakrarathi 2017). This affirms the burden of AKI globally which is also experienced in the Africa continent.

The challenge posed by AKI in Africa is due to several factors. Naicker, Aboud and Gharbi, (2008) discussed that AKI is a challenging problem in Africa due to the burden of diseases especially HIV related AKI in Sub-Saharan Africa, obstetric complications, surgical complications, severe malaria, nephrotoxins and diarrhea diseases. The challenge comes in because of the late presentation of patients to the health care facilities and these facilities lack the resources to support patients with established AKI. The pattern of AKI in Africa is more different from the pattern in developed countries and there is also lack of reliable statistics

regarding the incidence of AKI in African regions. The burden and challenges has also been identified in other regions in Africa.

In the Sub-Saharan Africa, treatment of AKI has been a major challenge. Olowu, Niang, Osafa, Ashuntantang, Porter & Arogundade (2016) indicated that quite a large number of patients with AKI did not receive dialysis in time of need and this resulted to very high mortality rates. This high mortality rates indicates the severity of AKI and the problems encountered in accessing dialysis to include erratic infrastructure and lack of funds to pay for the hospital bills. Resources required for the management of AKI might also be inconsistency as a survey by Schmitt (2011) reported that dialysis was not available in any unit that was under study. Availing affordable and easy dialysis services at the tertiary hospitals could probably reduce the mortality rates.

A lot of work has been done to describe the epidemiology of AKI in developed countries but the same does not apply for developing countries. In a study done to evaluate AKI in a tertiary hospital in Nairobi, Kenya, Munyu (2015), established that majority of patients who were above 12 years with AKI were managed conservatively and the minority managed on 9dialysis specifically hemodialysis. Not much has been researched on PD in pediatric in Kenya and it is not also widely used in our health facilities as compared to HD. According to Smith (2015), PD avoids the challenges associated with vascular access in children, and is a relatively inexpensive, safe and effective lifesaving treatment. This affirms its advantages especially in pediatrics population as it will on positive outcomes, enhancing resolution of AKI while avoiding progression to end stage renal disease and deaths.

KNH, the biggest referral hospital in East Africa adopted PD modality in treatment of AKI and a special pediatric unit- pediatric renal unit admits pediatrics in need of initiation of PD and also those in need of inpatient PD care. According to Kellum (2013), PD in management of children with AKI necessitating RRT is the preferred modality according. Studies have been

conducted on peritonitis and catheter blockade post-surgical insertion of the PD catheter as these have been drawbacks with PD therapy but no data is available on the outcomes of PD in pediatric patients with AKI. This study therefore sought to determine the outcomes of peritoneal dialysis on pediatric patients in KNH in order to yield important information that will assist in policy development at KNH and in Kenya.

1.3 JUSTIFICATION

Understanding the outcomes of care will help identify areas of improvement in pediatric population on PD in management of AKI as no data is available on the outcomes of PD in pediatric patients with AKI.

As available literature advocates for PD in managing AKI in pediatric population, KNH has since 1979 offered this service and this places the importance of conducting a research on the outcomes. The findings will assist the medical practitioners in making the best choice of care and management to the pediatric patients receiving peritoneal dialysis based on the summary of the outcome of this research, enhancing survival rate and preventing mortality and will also come as an outline data for further research

Peritoneal dialysis has several advantages in the pediatric patients. According to Ansari (2011), PD is an effective therapy which is simple and easy to use especially the case for infants and children with AKI both in ICU and non-ICU settings. PD use is less preferable in western countries especially with advent of newer options available for CRRT. In the developing countries, PD is the most often used RRT because availability of resources and cost are the major issues hindering RRT. In these developing countries, the advantages include cost and infrastructural benefits since PD does not require sophisticated machines as it is the case with other RRT modalities (Cullis, 2014). With all these advantages, PD thus remains a viable

treatment modality that the medical team should embrace and practice to bring down the mortality rate of pediatric with AKI and also prevent progression to ESRD.

Health has since been devolved in Kenya and most of the centralized specialized diagnostic and treatment modalities are now decentralized to include hemodialysis but peritoneal dialysis has not yet been considered in the priority list. The government has also invested in training medical professionals especially nurses on renal nursing at higher diploma level and a master's degree in nephrology is now available in a few universities and this translates to knowledgeable medical workers on PD who can utilize the expertise in other health care facilities in the country.

The study on outcomes at KNH will serve as a platform for the duplication of this service to the county hospitals as most of them are not offering PD. This will enhance early initiation of PD as a more recent study by Jenkins, Arutyunova and Curnow, (2017) demonstrated that urgent initiation of PD can be accomplished with relatively low complication rate of modality failure. With the wide use of PD, more research will be done on any setback encountered of the modality. The results of this research will also generate areas of future research that will better the practice with the aim of preventing complications and death while enhancing resolution of AKI.

1.4 OBJECTIVES OF THE STUDY

1.4.1 BROAD OBJECTIVE

To establish the outcomes of peritoneal dialysis among pediatric patients with acute kidney injury at Kenyatta National Hospital.

1.4.2 SPECIFIC OBJECTIVES

1. To determine the occurrence of successful restoration of kidney functions after peritoneal dialysis among pediatric patients diagnosed with AKI.
2. To determine the prevalence of progression to chronic kidney disease among the pediatric patients with AKI on PD.
3. To establish the mortality rate among pediatric patients with AKI on PD.

1.5 HYPOTHESIS

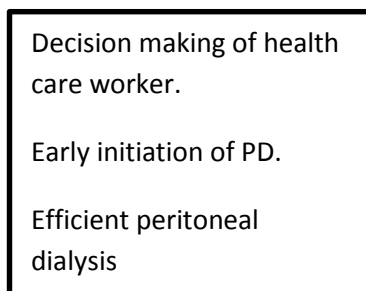
PD is not an effective modality in reducing the serum creatinine levels and blood urea nitrogen levels in pediatric patients with AKI.

1.6 RESEARCH QUESTION

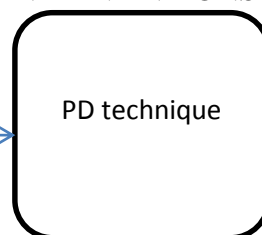
1. What is the occurrence of successful restoration of kidney functions after peritoneal dialysis among pediatric patients diagnosed with AKI
2. What is the prevalence of progression to chronic kidney disease among the pediatric patients with AKI on PD?
3. What is the mortality rate among pediatric patients with AKI on PD?

1.7 CONCEPTUAL FRAMEWORK

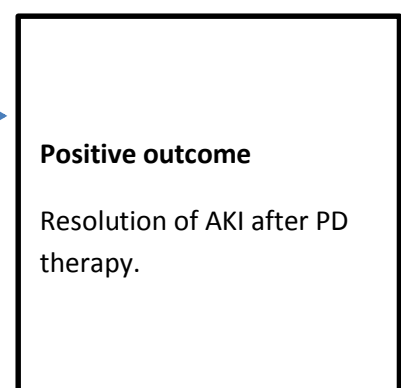
INDEPENDENT VARIABLES

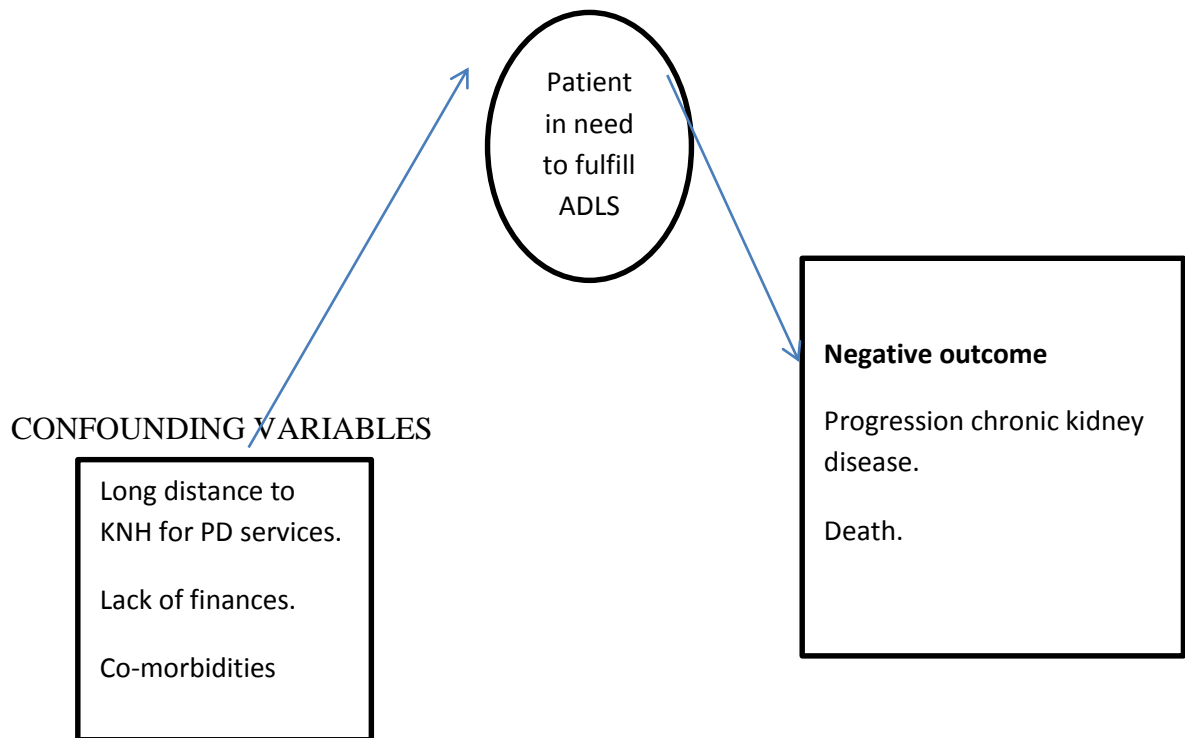


INTERVENTIONS



DEPENDENT VARIABLE





1.8 THEORETICAL FRAMEWORK

According to Roper, Logan and Tierney (2000), the Roper-Logan- Tierney model for nursing is a theory based on activities of daily living often abbreviate as ADLs or ALs. The theory views health as independent functioning in the pivotal ADLs which all people engage in as part

of life and growing. Roper initially identified 16 ADLs some of which are essential for maintenance life while others increase the quality of life.

Essential ADLs include, breathing, eating, elimination, controlling body temperature, mobilizing, sleeping and fulfilling safety and security needs. ADLs that increase quality of life include; personal cleansing and dressing, communicating, learning, working and playing, sexualizing & procreating and dying to reduce human suffering.

The researcher therefore views the pediatric patient as a person who should carry out the ADLs especially those essential to life for them to grow. With AKI, most of the essential ADLs if not all will need to be supported as the patient cannot fulfill them by self-due to azotemia.

This theory is thus an assessment used throughout the patients care and it is used to assess how life of a patient has changed due to illness, injury, or admission to a hospital. It attempts to define what living means and categorizes the discoveries into activities of living through complete assessment. This leads to interventions that support independence in areas that that may be difficult for the patient to address alone. Therefore the goal of assessment and intervention is to promote maximum independence for the patient and in this study, the pediatric patient with AKI. The researcher thus relates this theory to the assessment, planning and evaluation in pediatric patient in need of PD due to AKI and the outcomes of care.

The nurse uses the model to assess patient's level of independence and the potential for independence in the performance of the ADLs. The nurse is therefore able to draw interventions that will result to dependence or interventions to support the existing dependence. In this study, continuous assessment is therefore important to determine the immediate needs of the pediatric patient with AKI and thus offer PD as soon as necessary with adequacy to get the best of outcome.

Lopers-Logan -Tierney model highlights five factors that influence the ADLs and incorporation of these factors in this model makes it a holistic model. These include biological, psychological, sociocultural, environmental and politico-economic factors. They determine the individual patient's relative independence in regards to ADLs. If the nurse does not consider them in assessment of the patient, the resulting assessment is incomplete and flawed.

With the 5 factors put into consideration in pediatric population with AKI, it will ensure the patient gets the right diagnosis and staging and the correct choice of care which is delivered timely to enhance growth at a considerable cost.

In assessing the patient, the two key methods of obtaining information are observation and interview which should be systemic to ensure nothing is missed. The nurse obtains both objective and subjective data by conducting informal discussions with the patient or the guardian or any other significant person, carries out a physical examination and reviews medical reports available.

To plan the care, the actual and potential problems identified by the nurse are key. The nurse must therefore have adequate knowledge for the appropriate care to given for the specific patient's needs. The nurse together with the patient or parent/guardian thus sets the goals for both short term and long term actual and potential problems identified.

In implementation of phase, the nurse intervenes to solve the actual or potential problems the patient/client may experience. The nurse plans and carries out the interventions by drawing upon a range of knowledge, skills and expertise in caring for patients in her own field of practice.

Evaluation of care given in the implementation phase is therefore a basis for ongoing assessment and preplanning as the patients problems changes. The nurse evaluates whether

the care given is effective or if it has met the goals that were set by the nurse in collaboration with the patient. For the goals that are not met, re-planning is done based on evidence presented and also looking at the dependency level of the patient. This is to enhance dependence in the performance of the ADLs.

In this study evaluation of care clearly gives the researcher the outcomes which can either be positive or negative. The aim is to have a patient who can fulfill the ADLs independently and in this study a patient with AKI should therefore be able to carry out the essential ADLs independently following management on PD.

CHAPTER TWO: LITERATURE REVIEW

2.1 INTRODUCTION

This chapter focuses on acute kidney injury definition, staging, causes in children, phases of the disease and the pathophysiology. Further discussed are the renal replacement modalities to include peritoneal dialysis, the techniques of PD, types, advantages, disadvantages, complications, limitations and outcomes in children with AKI. The data bases searched include

PubMed, web of science and cinhal. The key words used are acute kidney injury, renal replacement therapies, peritoneal dialysis and outcomes.

AKI previously known as acute renal failure is characterized by the abrupt onset of renal dysfunction resulting from injurious endogenous processes leading to decrease in glomerular filtration rate with rise in serum creatinine, inability to regulate acid and electrolyte balance, and excrete wastes and fluid (Ashraf, Shahzad, Irshad, Hussein & Ahmed 2014). The decrease in GFR will thus render the kidneys ineffective in maintenance of fluid and electrolyte balance.

There are different causes of AKI. In developing countries, AKI is the disease of younger subjects and community acquired cases are common. Acute diarrheal diseases, acute glomerulonephritis, topical infections to include malaria, environmental agents and snake bites are the common causes (Soni, 2009). AKI therefore requires prevention and proper management to prevent the heavy burden of the disease in the society and health care systems.

AKI is a common condition and it imposes a heavy burden of illness in terms of morbidity and mortality with the cost of managing it being high and there is also considerable variability in practice but despite this, AKI is amenable to prevention, early detection and treatment (Schmitt et al., 2011). The kidneys have the ability to recover from insult if treatment is instituted and this restores the normal chemical balance in the body and prevents complications that may arise to enable repair of the renal tissue enhance restoration of renal function (Kellum, Lameire and KDIGO AKI Guideline Work Group, 2013). AKI is thus a reversible disease and efforts to prevent and treat will lessen the rate of mortality and the burden of treating ESRD.

2.2 ACUTE KIDNEY INJURY

2.2.1 DEFINITION

Over time the definition of AKI has evolved. According to Duthie & Hughes (2014), AKI, formerly known as acute renal failure (ARF) is defined as an abrupt decline in renal function and this manifests functionally as a reversible acute increase in nitrogenous waste products measured by serum creatinine levels and blood urea nitrogen levels (BUN) over a period of hours to weeks. For the purpose of streamlining clinical practice and research with respect to AKI, several classification systems have been developed. Kidney disease improving global outcome in their clinical disease outcome defined AKI as an increase in serum creatinine by 0.3mg/dl or more within 48 hours, or increase in serum creatinine to 1.5 times baseline or more within the last 7 days, or urine output of less than 0.5mls/kg/hour for 6 hours. Kellum, Lameire and KDIGO AKI Guideline Work Group (2013) recommended a staging system according to severity of AKI as follows;

Stage 1; Serum creatinine 1.5-1.9 times baseline or ≥ 0.3 g/dl increase

Urine output less than 0.5ml/kg/hour for 6 hours

Stage 2; Serum creatinine 2-2.9 times baseline

Urine output less than 0.5ml/kg/hour for 12 hours

Stage 3; Serum creatinine 3 times baseline or, increase to ≥ 4 g/dl or, initiation of RRT.

Urine output less than 0.3m/kg/hour for 24 hours or anuria for ≥ 12 hours

2.2.2 NORMAL VALUES OF BIOCHEMICALS

Creatinine levels have been a common practice of estimating the renal functions for over 60 years. According to Sirota, Klawitter & Edelstein (2011), evaluation and diagnostic criteria of

AKI rely on the measurement of serum creatinine levels. Creatinine derived from phosphocreatine is a product of creatine metabolism from the muscles. It is freely filtered by the glomerulus and excreted without significant metabolism or reabsorption by the kidneys. It is due to these properties that have made it a useful surrogate for determining kidney function. Therefore the rationale of using creatinine or urea measurement to assess renal function is that the serum levels of each of them reflect the glomerular filtration rate (GFR) which is a parameter that defines kidney function with the normal GFR at approximately 125ml/min. Normal levels for adults are 60 -124 millimoles per litre(mmols/l).

There are other biochemical used to evaluate kidney function and these include;

- Serum Potassium- 3.5 -4.9mmols/L
- Blood urea nitrogen-2.5-6.7mmols/L
- The normal urine output - more than 0.5ml/kg/hour

Normal values in pediatrics are;

- Serum Creatinine: 27 to 62 millimoles per litre (mmols/L)
- Serum urea; 1.8-6.4 mmols/L
- The potassium; 3.5-4.9mmols/l
- The normal urine output is 1ml/kg/hour and above, neonates less than I year old more than 2ml/kg/hour. Loss of kidney functions is therefore based on biochemical results that deviate from the normal values.

2.2.3 ETIOLOGY OF COMMON CAUSES AKI

Acute kidney injury is a broad clinical syndrome encompassing various etiologies. According to Smeltzer et al., (2010), the etiologies include pre-renal, intra-renal and post-renal causes.

Pre-renal causes results from impaired blood flow to the kidneys leading to hypoperfusion in the kidneys with a significant drop in GFR. Decreased blood flow to the kidneys can be caused by impaired cardiac performance seen in heart failure myocardial infarction, cardiogenic shock and vasodilation due to anaphylaxis or sepsis. Other causes include hemorrhage and dehydration that lead to volume depletion in the body.

Second is intrinsic acute renal failure. According to Basile, Anderson and Sutton (2002), intrinsic AKI results from damage in 4 major structures of the kidney which include the tubules, the glomeruli, the interstitium and the internal blood vessels and this result to actual parenchyma damage to the kidney. Tubular damage is designated by acute tubular necrosis (ATN) and the two major causes are ischemia resulting from severe or protracted decrease in renal perfusion and nephrotoxic resulting from a variety of exogenous compounds example radio contrast media, aminoglycosides and amphotericin. Endogenous compounds causing tubular damage include hemoglobin in hemolysis and myoglobin in rhabdomyolysis and are all toxic or potentially toxic to the kidney.

More so, glomerular damage occurs in severe cases of acute glomerulonephritis which can be due to primary renal disease or part of a systemic disease like lupus erythromatosus and bacterial endocarditis. Interstitial damage can result from acute interstitial nephritis as a result of allergic reaction to a variety of medications like penicillin, cephalosporin and sulfonamides or may be due to bacterial infections like pyelonephritis. Vascular damage is due to injury in intrarenal vessels which decreases renal perfusion and diminishes GFR. It could occur in malignant hypertension, eclampsia, hemolytic uremic syndrome (HUS) and atheroembolic conditions.

Medications also predispose a patient to intrarenal damage. These include non-steroidal anti-inflammatory drugs (NSAIDs) and angiotensin converting enzyme inhibitors (ACEI) as they

interfere with the normal auto regulatory mechanisms of the kidney that lead to hypoperfusion and eventually, ischemia (Smelter et al., 2010). Intrinsic cause is therefore a major contributor to parenchyma damage leading to AKI.

The third etiology is obstructive uropathy or post-renal AKI. In Review (2007), post renal AKI is caused by an obstruction or blockage in the urinary system, obstruction distal to the kidney that affects urine outflow and the blockage need to affect both kidneys to cause AKI. This causes pressure to rises in the kidney tubules with eventual decrease in GFR. Causes are urinary tract obstruction including calculi (stones), tumors, benign prostatic hyperplasia, strictures, and blood clots. In children structural inborn problems are a common cause of post-renal AKI. Conditions in this case include posterior urethral valves, pelviureteric junction dysfunction, vesicoureteric junction dysfunction and kidney stones. Obstructive uropathy is an etiology to review for neonates who present with signs and symptoms ok AKI with no history of prerenal or intrinsic causes.

2.2.4 PHASES OF ACUTE KIDNEY INJURY

There are 4 phases of AKI. According to Dirkes (2015), first is the onset phase where the kidney injury occurs second is oliguric/anuric phase and in this phase, urine output decreases from renal tubule damage. The third phase is diuretic phase where the kidneys try to heal and urine output increases but tubule scarring and damage occur. Phase 4 is the recovery phase where tubular edema resolves and renal function improves. The four causes can be further discussed in details.

The disease starts with the initial period. As discussed by Workeneh and Batuman (2012) initial period which is the initial insult to the kidney and ends when oliguria develops and lasts for hours to days. Signs of renal impairment are present like elevated levels of creatinine and BUN. During this phase, the cause is sought and treatment initiated and the sooner the renal blood

flow is established the better the chance of recovering renal function with minimal damage to the nephrons. Initial phase is followed by the oliguric phase.

As the disease progresses, oliguric phase sets in. According to Smelter (2010), oliguria period is accompanied by a rise in the serum concentration of substances usually excreted by the functioning kidneys and these include creatinine, urea, uric acid, organic acids and intracellular cations which are potassium and magnesium. The minimum amount of urine required to rid the body of normal metabolic waste products is 400mls per day and in this phase there is a decrease in up to 50%. Uremic symptoms first appear and edema may begin to appear in dependent areas or around the face and orbital area. Life threatening conditions like cardiac arrest from hyperkalemia, metabolic acidosis and decreased nutritional status develop. Non oliguric form of renal failure is characterized by normal urine output of two liters a day or more but decreased renal function with increasing nitrogenous waste retention. Non-oliguric renal failure may occur in burns, traumatic injury, use of halogenated anesthetic agents or after administration of nephrotoxic antibiotic agents to the patient. This phase is therefore associated with fluid and electrolyte imbalance with pronounced signs and symptoms.

The third phase is the diuretic phase. The patient experiences gradually increasing urine output and this indicates that glomerular filtration has started to recover. Serum creatinine, BUN and other laboratory values eventually decreases, urine output may reach normal. However, uremic symptoms may still be present and the need for expert medical and nursing management continues. Patient must be observed closely for dehydration during this phase as if dehydration occurs uremic symptoms are likely to increase (Smelter 2010). This phase is followed by the recovery period.

The recovery period takes 3-12 months and indicates improvement of renal functions. Laboratory values return to the patients' normal level but a permanent 1% to 3% reduction in

GFR is common though not clinically significant Workeneh and Batuman (2012). This is the final stage of AKI.

2.2.5 CLINICAL PRESENTATION IN CHILDREN

Reduction in GFR causes accumulation of waste products in the body and this is manifested in some clinical signs and symptoms. According to Imam (2011), these include; history of vomiting, diarrhea, hemorrhage, sepsis and decrease in oral uptake that results to hypervolemia accompanied by decreased urine output suggests AKI due to pre renal disease.

Tachycardia, dry mucous membrane, sunken eyes, orthostatic blood pressure changes and decreased skin turgor found on physical examination suggests hypervolemia due to pre renal or ATN causing of AKI.

Bloody diarrhea accompanied by oliguria or anuria is consistent with HUS, an intra-renal cause of AKI. A history of pharyngitis or impetigo a few weeks prior to the onset of gross hematuria suggests post- infectious glomerulonephritis.

Nephrotic syndrome, heart failure, and liver failure may result in edema and other signs of specific organ dysfunction.

Oliguria or anuria in a newborn is suggestive of a major congenital malformation such as posterior urethral valves, bilateral renal vein thrombosis or autosomal recessive kidney disease.

Hypotension due to sepsis or intraoperative events as well as administration of nephrotoxic medication to include aminoglycosides, ACEI, or amphotericin B is the common cause of AKI in the hospital.

Proper history taking, physical examination and thorough investigations are thus important to identify the signs and symptoms which will guide in categorization of AKI and guide management.

2.2.6 MEDICAL MANAGEMENT

The kidneys have the ability to recover from insult with proper management of the underlying pathology. In treatment of pre-renal azotemia, renal perfusion is enhanced whereas in post-renal treatment involves relieving the obstruction. Intra-renal azotemia is managed by removing the causative agent. If shock or sepsis is present, they are treated promptly by maintaining fluid balance, avoiding fluid excess or possibly performing dialysis. (Smelter et al., 2010). Aggressive management will involve the use of renal replacement therapies with the aim of enhancing resolution of kidney damage.

2.3 RENAL REPLACEMENT THERAPIES IN AKI

Renal replacement therapy (RRT) is any method of attempting to purify blood in presence of renal dysfunction. RRT replaces non-endocrine kidney function in patients with renal failure and it also occasionally used in management of some form of poisoning. Different techniques are available to include intermittent hemodialysis, continuous hemofiltration and hemodialysis and peritoneal dialysis. Dialysis and filtration can be done intermittently or continuously but continuous is used almost exclusive for AKI. This is so because continuous therapy is sometimes better tolerated than intermittent therapy in unstable patients as solute and water are removed more slowly (Hecnanova, 2018). Hybrid therapies such as sustained low efficiency dialysis (SLED) are also available. With the different modalities, it will therefore be important for the medical team to choose an ideal modality.

The choice of the ideal modality is dependent on several factors. According to Palevsky (2013), the ideal RRT should mimic the physiological mechanisms and the functions of the native organ while ensuring qualitative and quantitative blood purification. It should also be free of complications and have a good clinical tolerance. The aim of using an ideal modality is to restore and maintain hemostasis thus favoring organ recovery.

2.3.1 Hemodiafiltration (HDF)

It is a treatment designed to remove accumulated metabolic wastes from the blood by a combination of diffusive and convective transport through a semi permeable membrane of high-flux type. Fluid is removed by ultrafiltration and the volume of filtered fluid exceeding the desired body weight loss is then replaced by sterile pyrogen free infusion solution (Tattersall and Ward, 2013). HDF thus provides a better elimination of high molecular weight solutes than hemodialysis

2.3.2 Hemofiltration

A technique in which water and solutes are driven by positive hydrostatic pressure across a semipermeable membrane from the blood compartment into the filtrate compartment from where it is drained. With the low flow of water, both the large and the small solutes get dragged through the membrane at a similar rate, that is, solvent drag effect (Kuhlmann, 2017). In hemofiltration, dialysate is thus not used.

2.3.3 Hemodialysis (HD)

Hemodialysis is among the common available dialysis therapies. According to levy, Morgan and Brown (2001), hemodialysis is an extracorporeal method used to remove nitrogenous waste products and correct the electrolyte, water, and acid base abnormalities associated with renal failure. It involves taking blood from a blood vessel and passing it through a synthetic filter known as dialyzer that acts as an artificial kidney. The blood is dialyzed before returning it to the body and the process is controlled by a dialysis machine which pumps the blood around the circuit, adds in an anticoagulant, and regulates the cleaning process, among other things. Fresenius, (2017) further explains that usually, HD is the gold standard type and it takes around three to six hours for one session and this treatment should be carried out three times in a week in a dialysis Centre. According to Ponikvar, (2003), HD employs the principle of diffusion, hemofiltration and convection using the external filter to create an artificial nephron unit.

Intermittent hemodialysis is an effective technique to manage solutes and molecules in blood to close to normal levels.

2.3.4 Continuous renal replacement therapy (CRRT)

CRRT are dialysis treatments that are provided as a continuous 24 hour per day therapy. According to Kellum et al., (2002), CRRT uses the principle of convection, ultrafiltration and diffusion. Convection and ultrafiltration principles are efficient in the clearance of low solute molecules from blood. The middle and the high molecule solutes are removed more effectively by the convective principle.

2.3.4.1 Modes of CCRT dialysis

There are different modes of CCRT and they use different principles. Mowbray, (2009) outlined different modes of CCRT as follows;

Slow Continuous Ultra filtration (SCUF) applies purely the principle of ultrafiltration to remove excess fluid and for this reason, SCUF safely treats fluid overload and the fluid removed is not replaced. The technique involves pumping patient's blood through a filter which separates fluid and molecules according to the size of its pores. In this mode the pores are very small to prevent loss of different solutes. Convection is restricted by the filter pore size and does not therefore occur but since it is not the aim of this therapy, it is not important.

Continuous Venous Hemofiltration (CVVH) uses the principles of ultrafiltration and convection. The size of the pores in the filter is increased allowing molecules to pass into the filtrate. CVVH is therefore useful in removing molecules of all sizes via convection depending on the size of the filter pores. Replacement of the fluid filtered from blood is done with a suitable fluid that has similar chemistry with the blood.

Continuous Venous Hemodialysis (CVVHD) as discussed by Kellum et al., (2002)

applies a totally different principle from the previous modes. CVVHD uses the principle of diffusion which is more effective in removing the small size molecules. A dialysate with similar chemical component as normal blood is pumped counter-current to the blood through a filter, any molecules that are in greater concentration in the blood are drawn across into the dialysate and thus removed from the body while the molecules that are low in the blood are replaced by the normal levels in the dialysate. Replacement of fluid is not done in this mode.

Continuous Venovenous Hemodiafiltration (CVVHDF) combines ultrafiltration, convection and diffusion to enable the ultimate removal and replacement of solutes and fluids within the blood. The filter used in CVVHDF provides for dialysate to run counter current to blood flow to increase the rate of diffusion. (Mowbray, 2009). CVVHDF is thus able to combine ultrafiltration, convection and diffusion.

2.3.5 INITIATION OF RRT

Presently there is no universal accepted consensus regarding when to initiate RRT in patients with AKI. Guidelines recommend that RRT should be initiated in patients who present with life threatening changes in fluid, electrolyte and acid base balance and hence refractory hyperkalemia, severe metabolic acidosis, volume overload, oliguria, overt uremic symptoms and medication intoxication are all traditionally considered to be classic indications of RRT initiation (Palevsky, 2013). However, there are circumstances in pediatric patient that necessitate initiation of RRT. According to Imam (2011), RRT in children with AKI should be initiated under the following circumstances;

Uremic symptoms indicated by pericarditis, neuropathy or any unexplained decline in mental status.

Azotemia evidenced by BUN greater than 29 to 36 mmols/l (80-100mg/dl)

Severe fluid overload manifested by hypertension, pulmonary edema and heart failure refractory to medications.

Acidosis resistant to medical therapy.

Severe electrolyte abnormalities.

In a child with oliguria or anuria in need of intensive nutritional support.

Among the different modes of RRT, PD has been documented to be of more advantages while used to manage AKI in pediatric patients. Mishra *et al.*, (2012) discussed that depending on the facility and expertise available, different modes of RRT to include PD, intermittent HD and CCRT are all currently used in pediatric patients for management of AKI. However, hemodialysis and CCRT technologies require a vascular access, technical expertise, sophisticated machines and a high financial implication all of which limit their use because of non-availability in most medical facilities in developing countries. Therefore, where these extracorporeal techniques are not available, PD is clearly invaluable in reducing mortality attributed to AKI especially in pediatric population in the developing countries. This is due to its affordability and simplicity and its usefulness has been emphasized in the past and has been recommended that it should be initiated as early as possible to avoid the delay caused by referring critically ill patients to the next level.

2.4 PERITONEAL DIALYSIS

2.4.1 DEFINITION

The definition of PD has been documented by different authors. According to Gokai *et al.*, 2017, PD uses the peritoneal membrane as a filter to clear wastes and excess water from the body and return electrolyte level to normal. A dialysis access usually catheter placed in the peritoneal cavity is initially done for the process of PD known as exchange to take place.

Dougirdas, Blake and Todd (2015) explain that in PD there is the transport of water and solutes across the membrane separating the two fluid containing compartments. One of the compartments is the blood in peritoneal capillaries and in renal failure; this blood contains excess of urea, creatinine, potassium and other waste products. The other compartment is the dialysis solution in the peritoneal cavity and it contains sodium, chloride, and lactate or bicarbonate. This dialysis solution is rendered hyperosmolar by the inclusion of high concentration of glucose.

The peritoneal membrane has different features that are essential for the dialysis process. According to Fischbach and Warady (2009) the peritoneal membrane is a dynamic dialysis membrane and the actual surface area in contact with dialysate is 30-60% of the available anatomic area in the human body. This is measured by computer tomography. The size of the peritoneum in contact with the dialysate is dependent on factors like posture where positive recruitment occurs while on supine position. The peritoneal vascular mesenteric perfusion and the density of the functional pores of the perfused capillaries determine the peritoneal vascular exchange surface area. This is affected by the PD fluid composition, fill volume size and possible inflammatory process. Thus the peritoneal membrane is highly vascularized, has numerous nerve endings, a large surface area and good lymphatic drainage.

There are three steps during PD exchange. The fill phase is when dialysis fluid is introduced in peritoneal cavity, dwell phase is the period the fluid is in peritoneal cavity, extra fluid and waste travel across the peritoneal membrane into the dialysis fluid. The drain phase is when dialysate full of waste products and extra fluid is drained out of the patient's blood and replaced with new fluid or as prescribed (Gokai et al., 2017). Removal of fluid and waste products is therefore dependent on these phases for the transport processes to occur.

In the course of PD dwell, three transport processes. According to Dougirdas, Blake and Todd

(2015), the processes are diffusion, ultrafiltration and absorption. Diffusion involves the transport of uremic solutes and potassium from the peritoneal capillaries down the concentration gradient into the peritoneal dialysis solution while glucose, lactate and to a lesser extent calcium diffuse in the opposite direction. Ultrafiltration is as a result of the osmotic agents (glucose) in the dialysis solution. It is the hyperosmolality of the dialysate that enhances ultrafiltration of water from the blood capillaries into the peritoneal cavity across the peritoneal membrane.

Absorption is another form of transport. Fluid absorption takes place at a relatively constant rate via the lymphatics while small proportion of fluid is absorbed directly into the sub diaphragmatic lymphatics. There is also fluid absorption via the parietal peritoneum into the tissues of the abdominal wall, then taken up by the local lymphatics and the peritoneal capillaries. Absorption of water and solutes from the peritoneal cavity directly or indirectly into the lymphatic system is constant at a rate of 1-2mls/minute.

2.4.2 PERITONEAL ACCESS

Access to the peritoneal cavity involves the insertion of a PD catheter. The different types of PD catheter according to Gallieni et al., (2015) are; straight Tenckhoff catheters coiled Tenckhoff catheter, swan-necked catheters and Toronto western catheters. Different techniques used in insertion. According to Kache, Sale and Makama (2018), catheter insertion techniques may be classified as surgical (dissected) or percutaneous. Percutaneous methods may be further categorized according to whether the procedure is performed by blind or guided techniques.

Surgical Placement is the most common method of catheter placement. According to Peppelenbosch, Bouvy, Sande and Torder (2008), this method involves direct incision of the skin, rectus muscle and parietal peritoneum, followed by insertion of the catheter and stylet.

The procedure typically requires light general anesthesia. The principal advantages are precise placement of the catheter tip, optional fixation and lysis of adhesions and omentectomy. Despite these benefits, surgical placement techniques increase the risk for pericatheter leaks when compared to percutaneous implantation methods.

Blind Trocar Method is the earliest clinically successful percutaneous catheter placement incorporated the use of a large bore trocar developed by Tenckhoff. A trocar is used to penetrate the abdominal cavity during catheter insertion. Blind trocar insertion is a relatively simple technique that is usually performed with local anesthesia. Major advantages of this technique are the option for rapid catheter insertion and the ability to perform the procedure at the patient's bedside. Disadvantages include a large penetration site diameter and a lack of visualization of the peritoneum to guide insertion. As a result, blind techniques are accompanied by an increased risk of bowel perforation especially in obese patients and in those with a history of abdominal surgeries (Gallien et al., 2015). This method has further been simplified with a modified seldinger technique.

Modified Seldinger Technique is a catheter insertion technique similar to the insertion technique of vascular catheters. Modified Seldinger technique is a blind procedure with low risk of perforation as it uses a simple needle for perforation followed by dilatation with a blunt plastic dilator. The benefits and risks of this technique are similar with those of blind trochar method (Kache et al., 2018). The location of the catheter can be improved by using imaging assistance.

Fluoroscopy-Assisted Placement is a method that allows for visualization of the peritoneum during catheter placement in contrast to the Blind and Modified Seldinger techniques. As explained by Kache et al., (2018) this technique incorporates the use of contrast media that is inserted into the peritoneum to allow for identification of peritoneal structures. Fluoroscopy-

guided catheter insertion allows for confirmation of the location of the catheter within the peritoneum. The technique is limited by the poor quality of the generated image, preventing identification of adhesions or omentum that may impede catheter function.

Peritoneoscopic Technique involves the insertion of a peritoneoscope, an instrument that is used to view the peritoneal cavity prior to catheter insertion. The procedure may be performed under local anesthesia and may allow for early identification of imposing structures and impediments to proper catheter function (Gallien et al., 2015). However, there has been an evolution of this technique.

Laparoscopic/mini-laparoscopic technique is a minimally invasive approach. According to Gallien et al., (2015), laparoscopic technique is associated with less pain a quicker return to full activity post procedure especially in obese patients. There is complete visualization of the catheter insertion process and this permits selective proactive interventions in cases of catheter migration, omental entrapment and obstructive adhesions. Diagnosis and treatment of previously unsuspected hernia can be done with laparoscopic technique. Limitations of laparoscopic procedures include a requirement for general anesthesia which may not be appropriate for all patients and the delivery of two puncture wounds to the peritoneum, for the scope and catheter.

Alternative Placement Techniques include Moncrief-Popovich technique, Extended Dialysis Catheters and Self-Locating or Front Loading Catheters. These techniques have been explained by Kache et al., (2018) in Moncrief-Popovich Technique, there is subcutaneous burial of the external segment of the catheter and it prevents colonization of the catheter by skin bacteria. There is however a high incidence of seromas, subcutaneous hematoma and fibrin thrombi with alternative catheter placement technique.

Extended dialysis catheters have been developed to allow placement of the exit site in remote places and preferably in the pre-sternal area. The method is useful in the obese patients, patients with stoma and patients with other sources of potential contamination in the anterior abdominal wall. Advantages of the extended catheter include better wound healing, increased distance from ostomy site, decreased pressure by garments easier exit site care and a lesser chance of exit site infection. There is however a possibility of disconnection inside the disconnection tunnel as the main disadvantage. The main disadvantage is the possibility of disconnection inside the subcutaneous tunnel.

Self-Locating or Front Loading Catheters is use of a PD catheter with a 12-g tungsten cylinder that is embedded in a silicone or a stainless steel weight. This is attached to the distal end of the catheter giving a better catheter survival and less chances of migration as compared to standard catheters.

Safe and efficient access to the peritoneal cavity is an important factor for successful PD.

Enrichment of the physician's interest and experience along with multidisplinary approach is therefore an important factor in PD catheter insertion and may improve patient's survival and decrease the mortality.

2.4.3 PD SOLUTIONS

Peritoneal dialysis solutions are designed to, remove toxins and water, normalize the blood electrolyte profile and provide alkali to help maintain acid-base balance. According to Peng (2016), conventional PD solutions that were used during the very early days had a composition that varied widely from normal saline and 5% dextrose. These solutions contain an osmotic agent-glucose, lactate as a buffer and electrolytes-sodium, chloride, calcium, and magnesium. They have undesirable characteristics that have been shown to result in adverse clinical outcomes like peritoneal membrane injury. For this reason there has been a great interest to

manufacture solutions with more biocompatible features in order to mitigate the side effects. Among the solutions used now are the Dianeal, Nutrineal and Physioneal healthcare solutions.

Dianeal solutions contain dextrose, a monosaccharide, as the primary osmotic agent. The least abundant electrolyte is sodium. It is hyponatremic, so it has a concentration lower than blood to ensure sufficient removal of sodium. This helps in pushing potassium into the intracellular compartment thus reducing the serum potassium. The buffer normally used is lactate which is metabolized to form bicarbonate, the most important buffer in the blood. This enhances the intracellular movement of potassium by generating bicarbonate. Lactate was chosen because solutions containing mixtures of bicarbonate, calcium, and glucose cause the formation of insoluble calcium salts. Dianeal solutions stimulate insulin production via the administration of intra-peritoneal glucose (Vardhan and Hutchison 2014).

Nutrineal/Baxter solutions contain amino acids and are administered once daily for a 4-6 hour dwell. They supply nutrient to dialysis patient and thus compensate for peritoneal protein losses. The buffer solution present is lactate and the osmotic agent is amino acids. They have no glucose degradation products. For the patient on CAPD, bag exchange should be done together with a carbohydrate meal to avoid conversion of protein to glucose (Alam and Krause, 2005). For patient on automated PD, combine Nutrineal with Dianeal.

Physioneal solution contains bicarbonate as a more physiological buffer. According to Nephrol dial transplant group (2005), physioneal is in a double bag, one side containing glucose and calcium and the other side containing sodium bicarbonate which has therefore to be mixed shortly before administration. Bicarbonate buffered solutions have a more physiologic PH (7.0-7.6) as compared to lactate based solutions. Physioneal has low glucose degrading products and they have improved biocompatibility.

Extraneal solution contains glucose polymers (icodextrin) as the primary osmotic agent. The

icodextrin functions as a colloid agent to achieve ultrafiltration during long PD dwells. Extraneal also contains lactate to help normalize acid-base status (Vardhan and Hutchison 2014). These solutions have been shown to be clinically important in improving the patient level outcomes with no identified risks from their use (Peng, 2016). They give a better preservation of residual renal function and residual diuresis which has a benefit towards reducing inflow pain.

2.4.4 TYPES OF PD

There are two types of peritoneal dialysis. Burkhart, Golpher and Sheridan (2018) described two types of PD as follows;

Continuous ambulatory peritoneal dialysis (CAPD)-This type requires dialysate to be instilled manually into the peritoneum via the catheter. It is then allowed to dwell for two to three hours after which it is drained from the peritoneum. The process of instill, dwell and drain is termed as one exchange. The catheter is opened frequently to allow for several exchanges a day and this poses a greater risk of infection with CAPD than with the PD modalities that utilizes a cyclor machine.

Automated peritoneal dialysis (APD) or Continuous cycling peritoneal dialysis (CCPD) requires the patient to be connected to a cyclor machine which controls the exchange of the dialysate over a period of eight to twelve hours. It is the most commonly used type in children and it is easier for the family and child because dialysis can be performed while asleep and during the day, the child and family can go about their normal daily activities.

2.4.5 TECHNIQUES OF PD

Intermittent PD (IPD)

IPD has historically been the most common frequently technique used in the management of

AKI. According to Dourgidas, Blake and Todd (2015), IPD is currently the most common technique of PD in many parts of the world. It takes 48-72 hours of treatment or even longer with rapid instillation and drainage of dialysate, a dwell time of 30 to 60 minutes. IPD involves interruption of dialysis and therefore small solute clearance is limited and this might result to inadequate dialysis especially in hypercatabolic critically ill.

Continuous Equilibrated peritoneal dialysis (CEPD)

Continuous equilibrated PD takes a dwell time of 2 to 6 hours and it can be performed with a cyclor or manually. The volume of dialysate instilled and the frequency of exchanges determined based on the clinical status of the patient determines the clearance of the small solutes. (Dourgidas, Blake and Todd 2015). CEPD offers long dwell time of 2 to 6 hours with up to 2 litres of dialysate in each exchange (Watcharotone et al., 2011). This makes the clearance of middle molecules higher with the long dwells but clearance of the small molecules is inadequate.

Tidal PD

Tidal PD involves an initial large infusion of dialysate followed by a drainage after the dwell phase but about 50 to 70% of the initial volume is replaced with fresh solution restoring the initial Intraperitoneal volume at each cycle. It leaves a constant tidal volume of 1 to 1.5 litres in the peritoneal cavity after the peritoneum is filled with a large 3 litres dialysate volume. TPD results in a higher volume small molecule solute clearance than CEPD. Another advantage is that it reduces the pain experienced with drainage of dialysate from the peritoneal cavity (Dourgidas, Blake and Todd 2015). TPD therefore offers patient comfort since after drain a tidal volume is instilled.

High Volume Peritoneal Dialysis (HVPD)

It is a continuous therapy that utilizes a cycler proposed to increase high small solute clearance. There are frequent of about 18 to 48 in 24 hours, 2 litres per exchange. The total dialysate volume ranges from 36 to 70 litres a day (Watcharotone *et al.*, 2011). It can therefore be of benefit to critically ill patients with very high serum creatinine and BUN levels.

Continuous Flow Peritoneal Dialysis (CFPD)

The in- flow and out flow of dialysis occurs simultaneously through two access routes. With an inflow of 300ml per minute it is possible to achieve a high peritoneal urea clearance (Watcharotone *et al.*, 2011). UF and clearances of urea and creatinine are thus higher with CFPD compared with conventional PD.

With the different techniques available, several factors determine the technique to be used. The choice of the technique to be utilized should be based on the experience of the health care providers, availability of resources, safety and efficiency of the technique, needs of the patient and an informed choice from the patient.

2.4.6 CONSIDERATION OF PD IN CHILDREN

There are some specific considerations in pediatric aspects that are essential to achieve adequate PD treatment. According to Smith (2017), the rapid growth during infancy and puberty must be accompanied by a positive calcium balance and the age dependent changes in body composition. The high total body water content and the high ultrafiltration rate required in anuric infants for adequate nutrition predispose to sodium losses and severe hypotension. Tissue fragility and rapid increase in intra-abdominal fat mass predispose to hernias and dialysate leaks. It is therefore important to take measures that promote growth on pediatric patient undergoing PD.

There are specific tests that should be carried out to ensure effective PD is carried out.

According to Schmitt et al., (2011) peritoneal equilibrium tests should be performed repeatedly to optimize individual dwell time. The Intraperitoneal pressure measurements gives an objective measure of Intraperitoneal filling which allows for an optimized dwell volume and this increases dialysis efficiency without increased risk of hernias, leaks and retrofiltration. However, unavailability of the test should not hinder the commencement of PD.

In situations and settings where these tests cannot be performed there is an alternative protocol used to initiate PD. Schmitt et al., (2011) indicated that PD should be started with 10ml per kg body weight for 5 to 6 days after insertion of the catheter. Dwell volume should be increased subsequently to about 1100ml/m² body surface area within one week in children above one year and 600 to 800 mls in children below one year of age. Jenkins, Arutyunova and Curnow (2017) demonstrated that urgent initiation of PD can be accomplished with relatively low complication rate of modality failure. Universal omentectomy performed at time of catheter placement should reduce catheter obstruction. When leaks of dialysate occur, surgical revision is a treatment option which may allow patient to recommence dialysis quickly, avoiding the risks related to delays in dialysis provision. Programs developing the ability to initiate dialysis urgently may therefore improve the outcome especially when results are limited or when used in the most vulnerable small infants.

2.4.7 ADVANTAGES OF PD

There are several advantages of PD as compared to use of hemodialysis in treatment of AKI. According to Abraham et al., (2009), these include;

In pediatric patients, clinical situations such as hypotension, disturbed coagulation or difficult venous access are encountered frequently and in these cases PD is preferred.

PD requires less specialized expert, fewer equipment and consumables and it's of low cost.

Technically, access in PD can be obtained relatively quickly and safely as compared to HD.

Peritoneal dialysis offers gradual water and solute removal and thus low risk for the development of abrupt hypotension and development of disequilibrium syndrome.

There is reduced risk of renal and cardiac ischemia, fluid and electrolyte imbalance.

Extracorporeal circulation is not required and this reduces the potential pro-inflammatory changes that may occur when blood is exposed to synthetic tubing and membranes.

Manual PD or APD has been successfully used in many AKI patients, especially those at risk of bleeding or with hemodynamic instability, and in infants and children with AKI or circulatory failure. The patient thus achieves: Better volume control, reduction in blood pressure, decreased prevalence of left ventricular heart failure, normalized potassium blood levels and reduction in arrhythmias.

The dietary and fluid restrictions are few; there is decreased incidence of anemia and better control of hypertension.

There is no chance of needle pricks and chances of hepatitis B and C infections are limited.

Since the PD procedure does not require systemic anticoagulation, excellent candidates for this modality include the following patients: those with a bleeding diathesis, patients in the immediate postoperative period, trauma patients and patients with intra-cerebral hemorrhage

The slow removal of uremic toxins is not associated with the development of the disequilibrium syndrome that is common in HD.

All these advantages taken together are of potential benefit as they permit rapid recovery of renal functions.

2.4.8 LIMITATIONS

Peritoneal dialysis is contraindicated in a number of situations. Ponce, Olivera & Balbi (2017) discussed that PD is contraindicated in patients with recent abdominal surgery, adynamic ileus, intra-abdominal adhesions, peritoneal fibrosis or peritonitis. However, in countries with poor resources with no alternative treatment plan, PD therapy may still be a lifesaving option in these patients albeit at higher risk. These are therefore relative limitations as there are no absolute limitations.

PD is not safe and efficient as extracorporeal dialysis techniques for the treatment of certain emergencies like acute pulmonary edema, life threatening hyperkalemia and drug overdose. This is because the volume and solute removal are slow and at times unpredictable. (Dourgidas, Blake & Todd 2015). In these circumstances, HD is the best choice.

PD is associated with protein losses that may aggravate malnutrition. Protein supplement are therefore recommended for AKI patients on PD.

Peritonitis is a potential problem. Older studies reported a high frequency of peritonitis. However, Pounce (2011) as quoted by Dourgidas, Blake & Todd (2015) established that with better catheter implantation techniques, improved connect ology, and automated methods, the incidence has been reduced and the risk is similar to the incidence of infections with extracorporeal blood purification for AKI.

In patients on mechanical ventilation PD may cause some adverse effects. Abraham et al., (2015) noted that in CCU settings where patients are on ventilation, the use of PD may impair diaphragmatic movement in presence of high volume dialysate.

In all the above mentioned circumstances, PD can still be tried as the initial RRT modality but the prescription must be adjusted to obtain optimal dialysis.

2.4.9 COMPLICATIONS

Complications of PD can be categorized in three different categories. Dourgidas, Blake and Todd (2015) established complications of PD to include;

Mechanical complications – Occurs due to incomplete drainage leading to overfill which is a progressive Intraperitoneal accumulation of dialysate. It leads to abdominal discomfort, distension and may cause respiratory compromise. It is usually caused by catheter related problems that result in poor drainage. Other contributing factors are intra-abdominal adhesions or bowel distension.

Infectious complications-Peritonitis rates at a range of 45 to 41% during acute PD treatment as shown in different studies. This is more common in open drainage system than the closed drainage systems and it occurs more often after 48 hours of initiation of dialysis. Gram positive infections dominate and there are incidences of gram negative infections or fungal related peritonitis in PD.

Medical complications- Hyperglycemia can occur but it varies significantly in patients due to the difference in peritoneal membrane permeability and also the concentration of glucose used. Fast transporters absorb glucose more rapidly but in APD, glucose absorption is reduced as the number of cycles is higher and dwell time are shorter.

Hypernatremia results from the increased losses of water and frequent hypertonic exchanges. Replacement by infusing hypotonic fluid or 5% dextrose prevents the development of hypernatremia.

Hypoalbuminemia is a complication experienced with frequent exchanges that are used in acute PD. This could be due to loss of protein via the dialysate of up to 10-20 grams in a day. If peritonitis is present the loss may even be higher worsening the state of hypoalbuminemia.

2.5 OUTCOMES OF PD IN CHILDREN

A useful classification of recovery from AKI would quantify the extent to which kidney function was lost, indicate when repair is complete and damage is no longer occurring, provide a measure for the current patient's kidney function and reserve and also provide prognostic information. A scheme to align and integrate the KDIGO categories for AKI and provide a simple framework that can be translated for ascertaining transition point for outcome of PD at the end of ninety days would be ideal. This translates that improvement of the kidney function or resolution of the kidney damage would be accessed by an improvement in AKI stage, for example an improvement from stage 3 to 2 or lower (Chawla et al., 2017). This criterion can thus be used to evaluate the outcomes of PD in any facility offering the therapy.

PD is a modality that is now most often used in the developing countries where cost and availability of resources is still a major issue. According to Cullis (2014), it offers a significant cost and an infrastructural benefit over HD because it does not require electricity nor does it use expensive machinery or consumables. A study by Esezobor, Ladapo and Lesi (2014) revealed that there is a 70 percent survival rate and indicated that most children died due to lack of intensive care unit services and thus recommended the setting up of critical care units. A different study by Olowu (2016) on outcomes of acute kidney injury in children and adults in sub-Saharan Africa showed that most adults and children surviving acute kidney injury recovered renal function, although roughly 10% had residual renal dysfunction.

In another different study, half of the patients were treated successfully and were discharged having fully recovered kidney function, 25% were determined to have ESRD whereas 25% others died during hospitalization. In this case, late presentation for dialysis may have contributed to inability to recover (Callegari et al., 2013). The outcome of PD in the pediatric patients therefore ranges from recovery, development of ESRD and even death.

SUMMARY ON LITERATURE REVIEW

Researchers have shown the effectiveness of PD modality in management of AKI in pediatrics as the modality of choice. Studies done in other regions have recorded different percentages of mortality, recovery and progression to ESRD after PD therapy.

GAPS IN LITERATURE REVIEW

From the literature review, no research has been carried out in KNH on the outcomes of PD in pediatrics with AKI, neither has it been done in Kenya. The researcher has therefore established a need to carry out a study at KNH on the outcomes of PD in treatment of AKI in pediatric patients.

CHAPTER THREE: METHODOLOGY

3.1 INTRODUCTION

This chapter outlines the specific procedures and techniques that were used to identify, select, process and analyze data regarding the outcomes in pediatric patients with AKI managed on PD.

3.1 STUDY DESIGN

For the purpose of this study, a retrospective cohort quantitative design was used. Quantitative research employs a formal systemic approach, incorporating numerical data to obtain information about the world (Burns and Groove 2009). This type of cohort study is less time consuming, cost effective and multiple outcomes can be measured for any one exposure.

3.2 VARIABLES

The dependent variables in this study included the outcome, thus restoration of kidney functions, progression to CKD, and death. Independent variables included decision making of the health care worker, early initiation of PD therapy and the efficiency of PD therapy. Confounding variables are: presence of existing comorbidities, long distance to KNH to access PD and availability of finances.

3.3 AREA OF STUDY

The research was carried out at the Kenyatta National Hospital which is about four kilometers from Nairobi city center. KNH receives patients referred from other hospitals in Kenya and outside Kenya for specialized care. It is also a Centre of medical education and research for the University of Nairobi students as well as other medical learning institutions. Facilities for nursing training and other allied courses are also offered at KNH.

The current bed capacity is 1800 and also offers outpatient services in several specialized

clinics as well as emergency and accident cases. The pediatric renal unit (PRU) is a specialized pediatric unit (PSU) situated in second floor with a bed capacity of 6. It has a total of 10 Kenya registered community health nurses who are all trained in nephrology. Other key players are nephrologist, pediatrician, nutritionist, physiotherapists, and counselors. The unit admits pediatrics day one old to twelve years old for peritoneal dialysis in need of inpatient care. Records of patients are therefore available in the records department. KNH was chosen because it is among the two referral hospitals that offer PD, and KNH has the study population needed to carry out the research. It was also feasible for the researcher did not have to spend money on long travels and also time saving. It was therefore the most convenient area for the researcher.

3.4 STUDY POPULATION

The target population for this study constituted of all the pediatrics who were diagnosed with AKI and the modality of RRT chosen was PD.

3.5 SAMPLING AND SAMPLE SIZE

3.5.1 SAMPLE SIZE DETERMINATION

The sample size was obtained using Yamene Taro formula, calculated as follows:

$$n = N \div [1 + N (e)^2]$$

Where; n is the sample size,

N is the population size, an

e is the level of precision.

Therefore, with a population of 137

$$N = 137$$

$$e = 0.05$$

$$n = 137 \div (1+137(0.05)^2)$$

$$=137 \div (1+137(0.0025))$$

$$=137 \div (1+0.3425)$$

$$=137 \div 1.3425$$

$$=102.048$$

Sample size 102 files.

3.5.2 INCLUSION CRITERIA

Files of pediatric patients admitted in KNH with a diagnosis of AKI and the modality of management was PD for the period between 1st January 2017 and 31st December 2017 were eligible for the study. Pediatrics in this study referred to children in the age bracket of 1 day to 12 years old.

3.5.3 EXCLUSION CRITERIA

Pediatric patients with AKI who were managed on different dialysis modality other than PD were not included in the study. The patient files with incomplete information were also excluded from the study.

3.5.4 SAMPLING TECHNIQUE

Census method of sampling was used. A census eliminates sampling error and provides data on all the individuals in the population and it is more attractive for small population of 200 or less(Singh and Masuku, 2014).

The identification of the 137 files was done by the researcher with the assistance of the records personnel and this involved accessing the summary reports of all patients admitted in PRU and

specifically those managed on PD due to AKI from 1st January 2017 to 31st December 2017. In this summary report, the inpatient number of each patient's file was captured and used to retrieve the file.

The shelves holding the patients files were clearly labeled for ease of retrieval, example 001 to 200, indicating that any file with an inpatient number between 1 and 200 is held in that specific shelf. To retrieve the files then, the records personnel identified the specific shelves holding a file with a specific inpatient number and then handed over to the researcher. Once a file was retrieved, it was marked as retrieved on the summary report and coded with a unique participant's identification number using a sticker as there was no provision of inpatient number or names in the data collection tool for confidentiality purposes. For accountability purposes the researcher made a list of the files retrieved with their inpatient numbers and shared it with the records officer in-charge. The researcher also requested for a safe custody within the records department for convenience purposes in data collection.

To collect data, the researcher went through the 137 files retrieved, one at a time to get all the information needed as per the study tool, entered the information in a soft copy of which the password was only known to the researcher. The files with incomplete information were excluded for the study to have a sample size of 102 files.

On completion of the data collection exercise, the researcher reported to the in charge officer in the records department-coding unit who confirmed all the files were present using the initial checklist after which they were placed to the respective shelves.

3.6 RESEARCH INSTRUMENT

Checklists used to collect data constitute three parts. Part 1; Social demographic data, Part 2; Medical history and Part 3; Renal data to include the outcomes levels of serum creatinine, BUN and potassium levels before initiation and of PD and on discontinuation of PD, mortality

in course of treatment, numbers of those who progressed to CKD and the urine output before initiation and on discontinuation of PD.

3.7 VALIDITY AND RELIABILITY

3.7.1 VALIDITY

To measure the extent to which the checklist items replicated the specific areas covered, the content related technique was used. A pretest of the data collection tool at the Kenyatta National Hospital but using the records of a different period rather than the period of study. KNH was chosen because peritoneal dialysis has consistently been offered to the pediatric population.

The pre-test was done with the files for the period 1st January 2016 to 31st December 2016. Ten percent of the study sample size was the number considered for pre-test, which were 10 files.

The researcher was assisted by the records officer to access the summary report for the period 1st January 2016 to 31st December 2016 and the inpatient number were captured in this report. The records officer accessed the files from the shelves using the IP number, handed them over to the researcher who stuck a unique identification number (PPDTP 1 to PPDTP 10) and marked as retrieved on the summary report. The first 10 files retrieved randomly were considered for pre-test. After the exercise, the researcher handed over the files back to the records officer-data coding unit and for accountability purposes, indicated handed back on the initial summary report that was used to guide in retrieving the file for re-filing. No adjustment on the data collection tool was made.

3.7.2 RELIABILITY

It is the measure of consistency in results or data obtained from the use of a particular research instrument after several trials. To estimate the reliability of the instruments, the test re-test technique was used and the data collection tool was reliable.

3.8 DATA MANAGEMENT

3.8.1 DATA COLLECTION

The researcher sought ethical approval from the KNH/UON ethics and review committee and data was collected pertaining to outcomes of PD using the checklist. This was done with the assistance of KNH records department officers. Data was collected retrospectively from the records of children who were managed on from PD due to AKI from 1st January 2017 to 31st December 2017. This was done by filling in all the parts in the checklist.

3.8.2 DATA CLEANING AND ENTRY

The checklist was checked and re-checked for completeness and ensured every parameter was entered in the correctly and appropriately. The data was then entered in Microsoft Excel Spreadsheet for storage in preparation for data analysis.

3.8.3 DATA MANAGEMENT TOOL

Data collected was entered in excel software data management tool as it has the ability to organize and display rafts of data in a structured manner. This data was then exported to SPSS version 21.0 for analysis.

3.8.4 DATA ANALYSIS

The quantitative data generated from the checklist was categorized according to the study objectives. Data collected was coded and analyzed using statistical package for social sciences (SPSS) version 21.0. Social demographic and the medical history were analyzed in percentages. Serum Creatinine, Serum Potassium, and BUN prior to and after dialysis were compared using paired t-test and p-values obtained to determine statistical significance of results. Standard deviation was used to describe the extent of variability.

3.8.5 DATA PRESENTATION

Results were presented in frequency tables and bar graph. Scientific conclusions were drawn from the findings.

3.9 DISSEMINATION PLAN.

The study findings shall be presented as a thesis in partial fulfillment of the requirements for the award of the Master of Science in Critical Care Nursing Degree of The University of Nairobi and thus will be available in the university repository and a hand copy in the library. They will also be published in a medical journal. Presentations in scientific conferences like the nephrology annual symposium and seminars will be done. In addition, the findings will be presented to members of staff working in pediatric renal unit Kenyatta National Hospital and the relevant authorities at KNH in order to inform decisions and policies that will lead to improvement and management of pediatrics with AKI in need of PD.

3.10 ETHICAL CONSIDERATION

The proposal was submitted to the KNH/UON ethical review committee for approval and recommendations. After the approval the researcher sought permission from KNH head of health information department to access records for the data collection exercise. Utmost confidentiality to the information contained in the patients' records was upheld throughout all the stages of research. No names or inpatient (ID) number was indicated on the data collection tool but a unique identification number was used in every file. A sticker with the unique ID was used.

3.11 STUDY LIMITATIONS

The study was retrospective study and therefore the study variables obtained from the files were only limited to the data available and recorded in the files. This was counteracted by excluding the files with incomplete data from the study as outlined in the exclusion criteria.

CHAPTER FOUR: RESULTS

4.1 INTRODUCTION

This chapter represents the analysis of data collected for the retrospective study on the Outcomes of peritoneal dialysis in pediatric patients with acute kidney injury at the Kenyatta National hospital for the period 1st January 2017 to 31st December 2017. The analysis is in accordance to the social demographic data and the final outcome which includes restoration of kidney functions, progression to chronic kidney disease and mortality in course of PD.

4.2 SOCIO-DEMOGRAPHIC CHARACTERISTICS OF THE PARTICIPANTS

100 % (n=102) of the study participant's parents/guardians were of the African race. 45 % (n=44) of the participants were aged 10 days and below. On Occupation, 40.1 % (n=41) of the parent or guardians were small scale business and farming while 8.8 % (n=9) were in large scale business and farming unemployed. This is illustrated in table 1.

Table 1: Socio-Demographic Characteristics of the Participants

	Frequency	Percentage
Characteristics		
Gender		
Male	54	47.1
Female	48	52.9
Age		
1 – 10 days	44.1	45

11 – 20 days	34.3	35
21 – 30 days	7.8	8
Above 30 days	13.7	14

Race

Africans	102	100
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Religion

Christian	92	90.2
Not indicated	10	9.8
Muslims	0	0

Occupation of parent/guardian

Unemployed	14	13.7
Large scale Farming	6	5.9
Small Scale Farming	18	17.6
Large Scale Business	3	2.9
Small Scale Business	23	22.5
Permanent employed	16	15.7
Casual labourers	22	21.6

4.3 PARTICIPANTS MEDICAL HISTORY

92.2% (n=94) of the participants were referrals from other health care facilities while 7.8 % (n=8) were direct admissions. The highest cause of acute kidney disease was Sepsis at 80%. 92.2% of the participant had an existing chronic illness while 7.8% did not have. The minimum number of days taken before medication was one day and the maximum was 14 day giving a range of 13 day. The mean was 2.91, median 2.0 with a Mode of 2 and a Variance of 3.289. This is shown in table 2.

Table 2: Participants Medical History

	Frequency	Percentage
Participant Medical History		
Admission Criteria		
Referral	94	92.2
Direct admission	8	7.8
Cause of Acute Kidney Disease (AKI)		
Diarrhea	22	21.5
Sepsis	80	78.4
Glomerulonephritis	3	2.9
Obstruction in urinary system	6	5.9
Others	14	6.86
Existing Chronic Illness		
No	94	92.2
Yes	8	7.8
Specific Chronic Illness		
HIV/AIDS	1	12.5
Others	7	87.5
Long-term Medication Use		
No	96	94.1
Yes	6	5.9
Specific Medication Used		
Antiretroviral	1	16.7
Others	5	83.3
Number of Days Before PD		
1 Day	17	16.7
2 Days	36	35.3
3 Days	18	17.6
4 Days	17	16.7
5 Days	8	7.8
6 Days and above	6	5.9

4.4 DAYS TAKEN PRIOR TO DIALYSIS AND DAYS TAKEN ON PD.

It took the participants a mean of 2 days to be commenced on PD after a diagnosis of AKI was made. Majority (83.3%) took one to two days for PD to be commenced. As illustrated table 3.

Table 3: Number of Days prior to PD and Number of Days on PD

	Frequency	Percentage	Mean
Number of Days Before PD			
1 Day	50	49.0	1.86
2 Days	35	34.3	
3 Days	13	12.7	
4 Days	1	1.0	
5 Days and above	3	3.0	
Number of Days on PD			
1 Day	17		
2 Days	14		
3 Days	26		
4 Days	18		
5 Days	12		
6 Days	4		
7 Days	5		
8 Days	2		
9 Days	2		
11Days	1		
16Day	1		

4.4 FINAL OUTCOME AFTER PD.

A high percentage of participants had successful restoration of kidney functions as 58.8 % (n=60) while 41.2% (n=42) died in the course of PD. None of the participants in the study progressed to chronic kidney disease. Table 4 illustrates the results.

Table 4: Outcome after Peritoneal Dialysis

	Final Outcome			
	Resolved AKI		Death	
	n	(%)	n	(%)
Gender				
Female	27	(50.0)	27	(50.0)
Male	33	(68.8)	15	(31.3)
Admission Criteria				
Referral	58	(61.7)	36	(38.3)
Direct	2	(25.0)	6	(75.0)
Existing chronic illness				
No	57	(60.6)	37	(39.4)
Yes	3	(37.5)	5	(62.5)
Long term medication use				
No	58	(60.4)	38	(39.6)
Yes	2	(33.3)	4	(66.7)
Creatinine Levels After PD				
Normal	39	(95.1)	2	(4.9)
Abnormal	20	(54.1)	17	(45.9)
Urea levels After PD				
Normal	17	(89.5)	2	(10.5)
Abnormal	42	(71.2)	17	(28.8)
Potassium Levels After PD				
Normal	24	(80.0)	6	(20.0)
Abnormal	35	(71.4)	14	(28.6)
24 Hrs Urine output after PD				
No urine	4	(12.9)	27	(87.1)
Reduced urine output	2	(14.3)	12	(85.7)
Adequate urine output	54	(94.7)	3	(5.3)
Complication during PD				
None	49	(59.8)	33	(40.2)
Catheter blockage	3	(42.9)	4	(57.1)
Catheter leakage	8	(61.5)	5	(38.5)

4.5 SUCCESSFUL RESTORATION OF KIDNEY FUNCTIONS AFTER PD.

The participants who achieved successful restoration of kidney functions after PD are 58.8 % (n=60). 61.7 % (n=58) of the referred patients achieved restoration of kidney functions while only 25 % (n=2) of the directly admitted patients achieved resolved AKI.

4.5.1 Blood biochemistry results before and after PD.

A paired t-test was run on a sample of 102 participants to determine whether there was a statistically significant mean difference between the blood biochemistry levels prior to initiation of PD and on discontinuation of PD.

The Mean for Serum Creatinine prior to PD was 602.0 which is greater than the mean on PD discontinuation (243.49). The standard deviation prior to PD is 243.49 and 160.92 on discontinuation of PD. The results are statistically significant with a p-value of 0.001 which is less than 0.005.

The mean serum urea levels before initiation of PD was 51.49 which is greater than the mean serum urea on discontinuation of PD which is 14.58. The standard deviation prior to dialysis is greater than on discontinuation of PD (14.56 > 12.53). The P-value is 0.024 which is less than 0.05. This shows that the results are statistically significant.

There was a mean difference between the potassium levels before initiation of PD and at discontinuation of PD. The mean potassium levels before initiation of PD was lower at 6.85 and SD 6.83 as opposed to the potassium levels at the outcome mean of 3.08 and SD of 1.45. The results are statistically significant (p=0.036), margin error 0.005. The results of biochemistry results are illustrated in table 5.

Table 5: Biochemistry result prior to and on discontinuation of PD.

	Outcome				Mean	Median	SD	P value
	Normal		Abnormal					
	N	(%)	N	(%)				
Creatinine levels	0		78	(100)	602.90	602.0	243.49	0.001
Before PD	41	(52.6)	37		146.95	92.00	160.92	
After PD			(47.4)					
Urea levels	0		78	(100)	51.49	49.80	14.58	0.024
Before PD								
After PD	19	24.4)	59	(75.6)	14.13	9.80	12.53	
Potassium levels	10		68		6.85	5.95	6.83	0.036
Before PD	(12.8)		(87.2)		3.98	3.60	1.45	
After PD	30		48					
		(38.5)	(61.5)					

4.4.4 Urine output before and after PD

All the participants had inadequate urine output prior to commencement of PD and after PD therapy 71.8% had adequate 24 hours urine output as shown in figure 1.

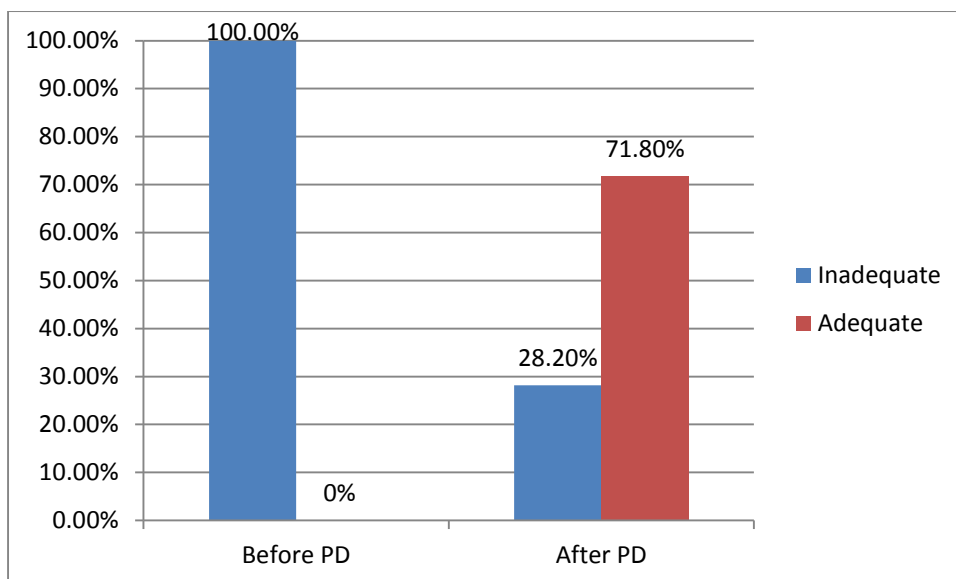


Figure 1: 24 hours urine output

4.6 MORTALITY AMONG PEDIATRICS WITH AKI

The overall mortality of the participants in the course of PD was 41.2 % (n=42). Majority (87.5%) of the direct admitted participants died while only 38.3% of the referred participants died. There was no statistical significance (p=0.126) between the existence of chronic illnesses and the final outcome.

Table 6: Chronic illnesses and the final outcome

	OUTCOME		P value
	Resolved AKI	Deaths	
Existing chronic illnesses			
No	60.6%	39.4%	0.126
Yes	37.5%	66%	
Long term use of medications			
No	60.4%	39.6%	0.226
Yes	33.3%	66.7%	

4.6.1 Biochemistry results.

A paired t-test was run on a sample of 19 participants to determine whether there was a mean difference between the creatinine levels before initiation of PD and at the time of death. The mean creatinine levels before initiation of PD was higher at 640.6 with an SD of 602 as opposed to the creatinine levels at the outcome 379.8 and SD of 92. Though the results were not statistically significant ($p=0.241$), there was a mean drop of 260.8.

The mean serum urea level prior to PD was 54.8 and an SD of 18.7 which is higher than the results at time of death, mean 33.5 and SD 13.5. There was a mean drop of 21.1. The results were however not statistically significant ($p=0.218$) with a confidence limit of 0.005. This is illustrated in table 6.

Table 7: Biochemistry results analysis prior to PD and at time of death

Biochemistry results			
Serum Creatinine	Mean	Standard Deviation	P value
Before	640.6	602.0	0.241
After	379.8	92.0	
Serum Urea	Mean	SD	P value
Before	54.6	13.5	0.218
After	33.5	18.7	
Serum Potassium	Mean	SD	P value
Before	6.4	1.7	0.305
After	4.9	1.8	

CHAPTER FIVE: DISCUSSION, CONCLUSION AND RECOMMENDATIONS.

5.1.1 Introduction

For normal functioning of the kidneys and micturition, the glomerular filtrate ascends down the renal tubules and its composition altered by the process of tubular reabsorption (removal of water and solutes) and tubular secretion (secretion of solutes into the tubular fluid) to form urine that enters the renal pelvis (Barret, Barman, Boitano and Brooks, 2012). The alteration therefore of the normal kidney processes result in kidney disease like AKI which requires proper management for the restoration of normal kidney functions. Among the available modalities of RRT is PD which the modality of choice in pediatrics with AKI. This chapter discusses the results of the study on outcomes in pediatric patients managed on due to AKI at the KNH giving a conclusion of the study and recommendations.

5.1.2 Successful restoration of kidney functions after PD

This study revealed that there was successful restoration of kidney functions in the majority of the participants. This correlates with the results of a study carried out by Mishra et al., (2012) where the participants were children of up to 12 years and most of them were referrals from other health facilities. The study recorded a higher percentage of restoration of kidney functions and a lower percentage of the mortality rate.

Resolution of AKI is measured by a reduction in the biochemistry results. According to Chewla et al., (2017), resolution of kidney disease would be assessed by an improvement in the AKI stage from stage 3 or 2 to a lower stage. In this study, there was an improvement in the biochemistry results as the mean values for serum creatinine, serum urea and serum potassium prior to PD was greater than the mean on discontinuation of dialysis. Gokai et al., (2017) reported that PD uses the peritoneal membrane as a filter to clear wastes from the body and

return electrolyte levels to normal. There was therefore a significant clearance of wastes from the body resulting to resolution of AKI.

It was noted that not all the biochemistry results of participants in this study reduced to a normalized level but there was a reduction in the mean levels on discontinuation of PD especially for those participants who died. This reduction affirms the role of PD in reduction of biochemistry results. The death of the participants could probably have occurred due to other contributing factors.

The 24 hours urine output increased significantly from no or inadequate urine output to adequate output on discontinuation of PD. Studies suggest that increase in urine output is the most reliable early indicator of recovery (Cerdeira et al., 2015). This implies the efficiency of PD as it is expected for urine output to improve with improved renal functions.

Majority of participants with resolved AKI were referrals from other health facilities. A survey by Olowu et al., (2016) showed unavailability of renal replacement therapy in the 66 health facilities that were under study. KNH is a national referral hospital and thus majority of patients are referred for specialized care that is not available in the health facilities.

The results of this study reveals that after diagnosis of AKI was made, it took the participants a mean of 2 days to be commenced on PD. Nascimeto, (2012) stated that early dialysis maybe more beneficial as it can achieve spontaneous clinical recovery thus lower mortality and higher renal function restoration among patients. According to Aguiba, Quinta, Prieto & Leal, there is not yet a consensus of when to initiate renal replacement therapy, but it seems that early initiation confers a better prognosis and could have an impact on life expectancy and early renal recovery. This suggests that if immediate PD was commenced, rather than the two days delay there would be a higher percentage of successful restoration of kidney functions with minimal mortality rate.

All participants in this study were on continuous ambulatory PD (CAPD) which is the only type of PD available at KNH. It took the participants a range 1 day to 16 days on PD therapy and the mean number of days was 3 days with a mode of 3 days. According to Cullis et al., (2014) treatment pattern need to be developed in accordance with the individual patient needs taking into account the available resources and hospital environment to achieve the best practice available and the best patient outcome possible. The period on PD is thus in response to individualized reduction of biochemistry levels which are monitored on daily basis.

It was however noted that a few of the participants developed PD catheter complications. According to Peppelenbosch et al., (2008), enrichment of the physician's interest and experience of PD catheter insertion may improve patient's survival and decrease the mortality. This could be attributed to the fact that the medical team has the necessary skills in initiation and performance of PD and availability of Tenckhoff catheters which are associated with low complications. These factors results to a very low percentage of participants experiencing the complications.

Catheter blockage and catheter leakage were the recorded complications. According to Palvesky (2014), there is needed to rest the catheter for at least 24 hours and then restart PD. During this period the patient is off PD, urea and creatinine accumulate in blood and if severe azotemia occurs, there is the risk of death. In this study, 5 participants out of the 13 who developed catheter leakage died. Participants with catheter blockage were 7 and 4 of them died. A study by Esobozor et al (2014) showed that catheter blockage was the major complications due to blockage of outflow during drain phase. This renders PD ineffective if the catheter is not unblocked successfully or frequent episodes of catheter blockage.

5.1.3 Progression to chronic kidney disease

AKI is defined as occurring over 7 days and CKD starts when the kidney disease persists for more than 90 days (Osterman and Joannidis, 2016). According to Khwaja, (2012) AKI has some adverse outcomes both in short term and long term and chronic kidney disease are increasingly recognized as common sequel of AKI. However, the results in this study has no evidence of any of the participants progressing to CKD as a higher percentage had a successful restoration of kidney functions and the rest died in the early days of PD therapy.

5.1.4 Mortality among pediatrics patients managed on PD.

40.2% of the participants died in the course of PD. This agrees with a number of studies carried out in the developing countries on the outcomes of PD in pediatric patients. Among them is a study in Ghana that reported 25% deaths (Callegari et al., 2013) while a different study by Ademola et al., (2012) reported 70% survival rate. This affirms the effectiveness of PD in treating AKI in pediatrics although there is need to lower the mortality rates further.

Among the deaths, most of them died within the first 24 hours of dialysis and this could probably be attributed to other factors like severity of the disease. A study by Nascimento, (2012) showed that severity of the disease caused high risk of death regardless of the timing of the dialysis initiation. Directly admitted pediatrics recorded a high mortality rate compared to the referred patients probably due to late presentation in the hospital with severe AKI. A study by Esezobor et al., (2014) revealed that most children died due to lack of intensive care unit services. Management in intensive care unit may not have been readily available for these participants.

Not all participants in this study achieved successful restoration of kidney functions. Data in infants and children have shown that PD can provide adequate clearance, ultrafiltration and correction of metabolic abnormalities (Vesuedevan *et al.*, 2017). The analysis of biochemistry

results revealed that mean serum creatinine and serum urea was high before commencement of PD and reduced by the time of death though the results were statistically not significant. However, it is worthy to note that the lower means recorded in the biochemistry results is an indicator that PD is effective in reduction of serum creatinine, urea and potassium levels and mortality could have been caused by other factors.

5.2 CONCLUSION

In conclusion, this research revealed that majority of the pediatric patients with AKI had successful restoration of kidney function after PD therapy. There is no evidence of progression to chronic kidney disease but rather all the participants whose AKI failed to resolved died. The study also revealed that for those who died, there was some reduction in biochemistry results. This therefore accepts the hypothesis that PD is an effective modality in reducing serum creatinine and blood urea levels.

Majority of the participants were referrals from other health facilities in the country and had to travel for long distances to KNH to access PD which is not available in most of the government hospitals that offer cost effective services. Among the minority who died, the study showed that the direct admissions recorded a very high mortality percentage and this could probably be associated with the severity of the disease. Majority also died in the first day of dialysis and this could also be associated with the severity of the disease and the period taken from onset of illness to commencement of PD.

5.3 RECOMMENDATIONS

Peritoneal dialysis remains a relatively effective therapy which is simple and easy to use especially in children and infants with AKI and therefore this modality of RRT should be brought closer to the patients to facilitate early initiation of PD in management of AKI. This

will enhance successful restoration of kidney functions in AKI, prevent progression to chronic kidney disease and also reduce the mortality rate.

The trained medical staff in nephrology should advocate for PD services with a dedicated team in the county hospitals and this requires the policy makers to set a policy that will support this move. A consultant nephrologist should also be deployed in these hospitals and more staffs trained in nephrology. Efforts should be made to avail the PD solutions and PD catheter since this modality of RRT does not require any sophisticated equipments.

The results of the study show the mortality rate to be high among the direct admissions. It would therefore be necessary to carry out a prospective study on the causes of deaths among pediatric patients on PD due to AKI to identify the causes that can act as a guide to policy development in measures to lower mortality rates.

Areas of further research:

Random control study on the outcomes of PD among pediatric patients with AKI.

Prospective study on the outcomes in pediatric patients on dialysis on PD due to AKI.

Causes of mortality among pediatrics with AKI undergoing PD.

Factors hindering immediate commencement of PD for pediatric patients with AKI necessitating RRT.

A study on outcomes in Pediatric patients with AKI managed on PD in other facilities offering PD.

How to combat sepsis as a major cause of AKI in pediatrics.

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APPENDICES

APPEDIX 1; TIMELINE

DURATION IN MONTHS; YEAR	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
2017/2018												
ACTIVITIES												
PROBLEM IDENTIFICATION AND CONCEPT WRITING												
PROPOSAL WRITING												
SEEKING CONSENT												
PRE-TEST												
DATA COLLECTION												
DATA CLEANSING AND ENTRY												
DATA ANALYSIS												
REPORT WRITING, PRESENTATION												
DISSEMINATION												

APPENDIX 2; BUDGET

NO	ITEM	COST
1	Internet	10,000
2	Stationary	5,000
3	Access to record fee	2,000
4	Transport	10,000
5	Printing and binding	10,000
6	Statistician fee	15,000
7	ERC fee	2,000
8	Researchers allowance	10,000
9	Publication	25,000
10	Contingency	11,000
	Total	130,000

JUSTIFICATION OF THE BUDET

Internet- to facilitate the researcher access information needed for the study and work conveniently.

Travelling allowance-This is to cater for travelling to KNH to collect data and to Thika for pilot study.

Stationary-One ream of full scaps, pencils biro pens, erasers, 2 hand book, hand board will be purchased

Printing and binning- two copies of the proposal and two copies of the research document will be printed and binded. The checklist will also be printed in 102 copies.

ERC fee-This amount will be paid to KNH/UON ERC for consideration for approval

Data access fee- Amount paid to KNH to be allowed to access the files as required by KNH policy.

Researcher's allowance- to cater for meals during the study period

Contingency allowance- will cater for any other unforeseen expense.

- 3) Cause of Acute kidney injury-Diarrhea-0, Sepsis-1, Glomerulonephritis-2, Malaria-3, Diabetes-4, HIV-5, Obstruction in urinary system-6, others-7
- 4) Number of days before seeking medical attention; 0 to 7days-0, 7 to 14 days-1, 14 to 21 days-2, 21 days and above-3.
- 5) Presence of chronic illnesses; No-0, Yes-1.
- 6) Specific chronic illness present- Cancer-0, Diabetes-1, HIV/AIDS-2
- 7) Long term use of medications; No-0, Yes-1
- 8) Specific medications used on long term; Antiretrovirals-0, Anti-tuberculosis drugs-1, Aminoglycosides-2,
- 9) Anticancer drugs-3, Antihypertensives-4.

Part 3; renal data

- 1) Date diagnosed with AKI- insert exact date.
- 2) Date of commencement on PD-insert exact date.
- 3) Technique of PD applied- continuous PD-0, Automated PD-1.
- 4) Numbers of days on PD- insert exact days.
- 5) Blood biochemistry levels and urine output - insert exact values.
- 6) Albumin replacement done- No-0, Yes-1.
- 7) Complications of PD encountered- None-0, Catheter blockage-1, Catheter leakage-2, Peritonitis-3.
- 8) Final outcome- Resolution of AKI-0, Progression to CKD-1, Death 2

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PROT 1	Age in months
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PROT 1	Occupation of parent/guardian
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PROT 1	Date of admission
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PROT 1	Admission criteria
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PROT 1	Cause of AKI
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PROT 1	Existing chronic illness
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PROT 1	Long term medication use
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PROT 1	No. of days before medical attention
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PROT 1	Date diagnosed with AKI
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PROT 1	Date of commenced of PD
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PROT 1	Technique of PD
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PROT 1	Date PD discontinued
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PROT 1	No of days PD done
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PROT 1	Serum creatinine levels before PD
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PROT 1	Serum creatinine levels after PD
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PROT 1	Serum urea levels before PD
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PROT 1	Serum urea levels after PD
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PROT 1	Serum potassium levels before PD
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PROT 1	24 hours urine output before PD
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PROT 1	24 hours urine output after PD
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PROT 1	Albumin replacement done
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PROT 1	Complications during PD
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A CHECK LIST FOR DATA COLLECTION – PAGE 2
 TITLE OF THE STUDY A RETROSPECTIVE STUDY ON OUTCOMES ON PEDIATRIC PATIENTS ON PERITONEAL DIALYSIS DUE TO ACUTE KIDNEY INJURY AT THE
 KENYATTA NATIONAL HOSPITAL

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	Race
	Religion
	Occupation of parent/guardian
	Date of admission
	Admission criteria
	Cause of AKI
	Existing chronic illness
	Specific chronic illness
	Long term medication use
	Specific medications used
	No. of days before medical attention
	Date diagnosed with AKI
	Date of commenced of PD
	Technique of PD
	Date PD discontinued
	No of days PD done
	Serum creatinine levels before PD
	Serum creatinine levels after PD
	Serum urea levels before PD
	Serum urea levels after PD
	Serum potassium levels before PD
	24 hours urine output before PD
	24 hours urine output after PD
	Albumin replacement done
	Complications during PD
	Final outcome



A CHECK LIST FOR DATA COLLECTION – PAGE 3
 TITLE OF THE STUDY A RETROSPECTIVE STUDY ON OUTCOMES ON PEDIATRIC PATIENTS ON PERITONEAL DIALYSIS DUE TO ACUTE KIDNEY INJURY AT
 KENYATTA NATIONAL HOSPITAL

PROT 43	Unique ID number
PROT 44	
PROT 45	
PROT 46	
PROT 47	
PROT 48	
PROT 49	
PROT 50	
PROT 51	
PROT 52	
PROT 53	
PROT 54	
PROT 55	
PROT 56	
PROT 57	
PROT 58	
PROT 59	
PROT 60	
PROT 61	
PROT 62	
PROT 63	
	Date of data collection
	Gender
	Age in months
	Race
	Religion
	Occupation of parent/guardian
	Date of admission
	Admission criteria
	Cause of AKI
	Existing chronic illness
	Specific chronic illness
	Long term medication use
	Specific medications used
	No. of days before medical attention
	Date diagnosed with AKI
	Date of commenced of PD
	Technique of PD
	Date PD discontinued
	No of days PD done
	Serum creatinine levels before PD
	Serum creatinine levels after PD
	Serum urea levels before PD
	Serum urea levels after PD
	Serum potassium levels before PD
	24 hours urine output before PD
	24 hours urine output after PD
	Albumin replacement done
	Complications during PD
	Final outcome



PROT 64	Unique ID number
PROT 65	
PROT 66	
PROT 67	
PROT 68	
PROT 69	
PROT 70	
PROT 71	
PROT 72	
PROT 73	
PROT 74	
PROT 75	
PROT 76	
PROT 77	
PROT 78	
PROT 79	
PROT 80	
PROT 81	
PROT 82	
PROT 83	
PROT 84	
	Date of data collection
	Gender
	Age in months
	Race
	Religion
	Occupation of parent/guardian
	Date of admission
	Admission criteria
	Cause of AKI
	Existing chronic illness
	Specific chronic illness
	Long term medication use
	Specific medications used
	No. of days before medical attention
	Date diagnosed with AKI
	Date of commenced of PD
	Technique of PD
	Date PD discontinued
	No of days PD done
	Serum creatinine levels before PD
	Serum creatinine levels after PD
	Serum urea levels before PD
	Serum urea levels after PD
	Serum potassium levels before PD
	24 hours urine output before PD
	24 hours urine output after PD
	Albumin replacement done
	Complications during PD
	Final outcome



A CHECK LIST FOR DATA COLLECTION – PAGE 5
 TITLE OF THE STUDY A RETROSPECTIVE STUDY ON OUTCOMES ON PEDIATRIC PATIENTS ON PERITONEAL DIALYSIS DUE TO ACUTE KIDNEY INJURY
 KENYATTA NATIONAL HOSPITAL

PROT 85	Unique ID number
PROT 86	
PROT 87	
PROT 88	
PROT 89	
PROT 90	
PROT 91	
PROT 92	
PROT 93	
PROT 94	
PROT 95	
PROT 96	
PROT 97	
PROT 98	
PROT 99	
PROT 100	
PROT 101	
PROT 102	
PROT 103	
PROT 104	
PROT 105	
	Date of data collection
	Gender
	Age in months
	Race
	Religion
	Occupation of parent/guardian
	Date of admission
	Admission criteria
	Cause of AKI
	Existing chronic illness
	Specific chronic illness
	Long term medication use
	Specific medications used
	No. of days before medical attention
	Date diagnosed with AKI
	Date of commenced of PD
	Technique of PD
	Date PD discontinued
	No of days PD done
	Serum creatinine levels before PD
	Serum creatinine levels after PD
	Serum urea levels before PD
	Serum urea levels after PD
	Serum potassium levels before PD
	24 hours urine output before PD
	24 hours urine output after PD
	Albumin replacement done
	Complications during PD
	Final outcome



A CHECK LIST FOR DATA COLLECTION – PAGE 6
 TITLE OF THE STUDY A RETROSPECTIVE STUDY ON OUTCOMES ON PEDIATRIC PATIENTS ON PERITONEAL DIALYSIS DUE TO ACUTE KIDNEY INJURY AT
 KENYATTA NATIONAL HOSPITAL

PROT 106	Unique ID number
PROT 107	
PROT 108	
PROT 109	
PROT 110	
PROT 111	
PROT 112	
PROT 113	
PROT 114	
PROT 115	
PROT 116	
PROT 117	
PROT 118	
PROT 119	
PROT 120	
PROT 121	
PROT 122	
PROT 123	
PROT 124	
PROT 125	

	Date of data collection
	Gender
	Age in months
	Race
	Religion
	Occupation of parent/guardian
	Date of admission
	Admission criteria
	Cause of AKI
	Existing chronic illness
	Specific chronic illness
	Long term medication use
	Specific medications used
	No. of days before medical attention
	Date diagnosed with AKI
	Date of commenced of PD
	Technique of PD
	Date PD discontinued
	No of days PD done
	Serum creatinine levels before PD
	Serum creatinine levels after PD
	Serum urea levels before PD
	Serum urea levels after PD
	Serum potassium levels before PD
	24 hours urine output before PD
	24 hours urine output after PD
	Albumin replacement done
	Complications during PD
	Final outcome



A CHECK LIST FOR DATA COLLECTION – PAGE 7
 TITLE OF THE STUDY A RETROSPECTIVE STUDY ON OUTCOMES ON PEDIATRIC PATIENTS ON PERITONEAL DIALYSIS DUE TO ACUTE KIDNEY INJURY
 KENYATTA NATIONAL HOSPITAL

PROT 126	Unique ID number
	Date of data collection
	Gender
	Age in months
	Race
	Religion
	Occupation of parent/guardian
	Date of admission
	Admission criteria
	Cause of AKI
	Existing chronic illness
	Specific chronic illness
	Long term medication use
	Specific medications used
	No. of days before medical attention
	Date diagnosed with AKI
	Date of commenced of PD
	Technique of PD
	Date PD discontinued
	No of days PD done
	Serum creatinine levels before PD
	Serum creatinine levels after PD
	Serum urea levels before PD
	Serum urea levels after PD
	Serum potassium levels before PD
	24 hours urine output before PD
	24 hours urine output after PD
	Albumin replacement done
	Complications during PD
	Final outcome





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KNH-UoN ERC

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Facebook: <https://www.facebook.com/uonknh.erc>
Twitter: @UONKNH_ERC https://twitter.com/UONKNH_ERC



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Tel: 726300-9
Fax: 725272
Telegrams: MEDSUP, Nairobi

Ref: KNH-ERC/A/240

June 13, 2018

Hellen N. Mwai
Reg. No. H56/87102/2016
School of Nursing Sciences
College of Health Sciences
University of Nairobi



Dear Hellen,

RESEARCH PROPOSAL – A RETROSPECTIVE STUDY ON THE OUTCOMES IN PEDIATRIC PATIENTS ON PERITONEAL DIALYSIS DUE TO ACUTE KIDNEY INJURY AT THE KENYATTA NATIONAL HOSPITAL (P163/03/2018)

This is to inform you that the KNH- UoN Ethics & Research Committee (KNH- UoN ERC) has reviewed and **approved** your above research proposal. The approval period is from 13th June 2018 – 12th June 2019.

This approval is subject to compliance with the following requirements:

- a) Only approved documents (informed consents, study instruments, advertising materials etc) will be used.
- b) All changes (amendments, deviations, violations etc) are submitted for review and approval by KNH-UoN ERC before implementation.
- c) Death and life threatening problems and serious adverse events (SAEs) or unexpected adverse events whether related or unrelated to the study must be reported to the KNH-UoN ERC within 72 hours of notification.
- d) Any changes, anticipated or otherwise that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH- UoN ERC within 72 hours.
- e) Clearance for export of biological specimens must be obtained from KNH- UoN ERC for each batch of shipment.
- f) Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. (*Attach a comprehensive progress report to support the renewal*).
- g) Submission of an *executive summary* report within 90 days upon completion of the study. This information will form part of the data base that will be consulted in future when processing related research studies so as to minimize chances of study duplication and/ or plagiarism.

Protect to discover



KENYATTA NATIONAL HOSPITAL
P.O. Box 20723-00202 Nairobi

Tel.: 2726300/2726450/2726565
Research & Programs: Ext. 44705
Fax: 2725272
Email: knhresearch@gmail.com

Study Registration Certificate

1. Name of the Principal Investigator/Researcher
..... HELLEN N. NIWAI
2. Email address: hellenaiwai@gmail.com Tel No. 0726 870 280
3. Contact person (if different from PI) JEREMAH WERI
4. Email address: jeremah.weri@gmail.com Tel No. 0720 427 538
5. Study Title
A RETROSPECTIVE STUDY ON OUTCOMES IN PEDIATRIC PATIENTS
ON PERITONEAL DIALYSIS DUE TO ACUTE KIDNEY INJURY AT
THE KENYATTA NATIONAL HOSPITAL
6. Department where the study will be conducted HEALTH INFORMATION
- (Please attach copy of Abstract)
7. Endorsed by Research Coordinator of the Department where the study will be conducted.
Name: MUSINA P.W Signature [Signature] Date 21/6/18
8. Endorsed by KNH Head of Department where study will be conducted.
Name: Dr. M. D. Mwendya Signature [Signature] Date 21/6/18
9. KNH UoN Ethics Research Committee approved study number P163/03/2018
- (Please attach copy of ERC approval)
10. I Hellen N. Niwai commit to submit a report of my study findings to the Department where the study will be conducted and to the Department of Research and Programs.
Signature [Signature] Date 21/06/2018
11. Study Registration number (Dept/Number/Year) Health Information 125 2018
- (To be completed by Research and Programs Department)
12. Research and Program Stamp

All studies conducted at Kenyatta National Hospital **must** be registered with the Department of Research and Programs and investigators **must commit** to share results with the hospital.

