Factors affecting kidney function

Kidney Diseases and end stage renal failure are not isolated to affecting just the kidney. All organs are affected by the disruption through Kidney disease and similarly other organs will also affect the kidney and how it functions. The following five diseases show the impact they have on the kidney, its function and pathophysiology.

2. HIV/AIDS

Renal complications in patients with HIV/AIDS can be either as a result of the long-term repetition of, or simultaneous infections in an immune suppressed patient or as a result of the many drugs (nephrotoxins) used to treat the HIV/AIDS virus. The exact role that the HI-Virus plays in the pathology of the kidney is still controversial (James, 2005: 1632-1633).

There are a number of kidney diseases identified by means of biopsies associated with HIV, the most predominant one being HIV-associated Nephropathy. Others are Mesangial Glomerulonephritis where immune deposits are seen, to a lesser degree also minimal change disease, TTP/HUS, Amyloidosis and Lymphoma (Dolin, 2008: 1257).

It was shown that the type of nephropathy was also clearly defined by race, such being that people of Black African origin predominantly showed HIV-associated nephropathy whereas in other racial groups immune complexes played the major role (James, 2005: 1632-1633).

In a study done by Tygerberg hospital in conjunction with Stellenbosch university it has shown that 54% of biopsies done on Black HIV positive patients show HIV nephropathies, in the USA this figure shows that it is the

3rd most common cause of end stage renal failure (http://en. wikipedia. org/wiki/HIV-associated_nephropathy accessed 19/03/2011).

In HIV-associated nephropathy there is sclerosis of the Glomerular apparatus as well as microcystic tubulointerstitial disease which is defined by the enlargement of the tubules with protein deposits in the tubular space as well as oedema in the surrounding tissue, fibrosis and inflammation (Dolin, 2008: 1257).

Where kidney involvement is due to immune complex deposits the entire nephron is involved; this can be as a direct result of infection from the virus or alternatively due to the release of cytokines when first infected with HIV (http://en. wikipedia. org/wiki/HIV-associated_nephropathy accessed 19/03/2011).

Treatment forms include transplantation, which can however, pose problems with regard to medication interactions between antiretroviral drugs and immunosuppressants, furthermore a high rate of rejection as well as a high risk of cardiovascular disease post transplant are a problem (Trullas [in press])

Treatment consists of slowing the process to ESKD and treating the HIV infection with antiretroviral drugs, further treatment with Angiotensin Converting Enzyme (ACE inhibitors) and angiotensin receptor blockers are used to treat hypertension, possibly immunosuppressant drugs or steroids and dialysis if kidney failure progresses to chronic (Greenberg, 2009: 254)

3. Malaria

There are four types of malaria parasites; the one that is generally known to show manifestations in other organs including the kidney is Plasmodium falciparum. There are over 500 million people infected with this parasite worldwide with an annual death rate of between 1-3 million.

There are over 100 countries worldwide in which malaria is prevalent and many of these countries have reported a 0. 57- 60% acute renal failure as a result of malaria. It has also shown that the acute renal failure associated with malaria is more common in adults than children in the tropics “ where transmission of malaria is low or unstable and where symptomatic disease occurs at all ages” (Idonije, 2011: 4-7)

Acute renal failure occurs in a very small percentage of the cases infected, however the mortality rate can be as high as 45%. (Saroj, 2008: 395)

The exact pathophysiology of Malarial Acute Renal Failure is not known but there are many theories as to how the kidney is affected, namely through obstruction and adherence of the vascular space by disease affected and thus altered erythrocytes, this is known as erythrocyte sequestration. Further, immune complexes may be responsible for changes in the glomerular and tubular physiology.

Dehydration due to sweating, vomiting and reduced fluid intake can lead to reduced perfusion of the kidney with ischemia resulting in acute kidney failure.

Pulmonary oedema, acute respiratory distress syndrome and anaemia are all factors that may complicate the malarial acute renal failure.

Treatment options include the identification of the involvement of the kidney early on which may be difficult especially in home based treatment in the rural environment, renal replacement therapy (haemodialysis or peritoneal dialysis), anti malarial drugs, intravenous fluid replacement (although this may lead to pulmonary oedema and must be closely monitored), diuretics which may reduce the time the patient requires dialysis, possible blood transfusion to help replace fluids as well as assist with the malaria induced anaemia and the avoidance of nephrotoxic drugs (Das, 2008: 83-97).

Mortality of patients increases with: high Creatine levels, oliguria/anuria, anaemia CNS involvement and late referral to a tertiary care center for early commencement of treatment, age plays no role in the mortality of these patients (Kanodia, 2010: 1088-1091).

4. HUS/TTP

There are three reasons for thrombocytopenia namely due to platelet destruction as in Thrombotic Thrombocytopenic Purpura (TTP) and Haemolytic Uremic Syndrome (HUS), failure of platelet production as in malignancies and platelet sequestration (Underwood, 2009: 585)

TTP and HUS are both thrombotic microangiopathies and both are characterised by the deposition of clots in the small vessels of various organs, amongst these being the Kidney. There is a large clinical overlap between the two (Underwood, 2009: 670).

HUS is an acute disorder often following a haemorrhagic or diarrhoeal illness. It is characterised by microangiopathic haemolytic anaemia, which is caused

due to an increase in fibrin in the vessels and this fibrin network damages the erythrocytes causing anaemia. It has been established that HUS is associated with viral and bacterial infections especially in children (McCance, 2010: 1408).

Both HUS and TTP are linked to pregnancy related acute kidney failure but it is a rare occurrence. If they occur then HUS generally occurs postpartum whereas TTP is linked to preeclampsia and occurs pre delivery (Greenberg, 2009: 410).

The toxin released from a bacterium such as E. coli causes inflammation when it attaches to the wall of the intestine and from here enters the vascular system. It finds its way to the kidney where it causes damage both in the glomerular and tubular system through thrombosis, and inflammation and thus kidney failure. This infection may also cause fever, hypertension, cerebral and pulmonary oedema, congestive heart failure and seizures (Lerma, 2009: 289).

TTP on the other hand is caused by blockage of the small vessels through the accumulation of platelets causing vascular lesions in the central nervous system, heart and kidney causing organ failure or malfunction (Underwood: 2009: 671).

There are two types of TTP, one is chronic relapsing TTP which is rare and the other is idiopathic relapsing TTP. This is a lot more severe in its course and can be fatal within 3 months if left untreated (McCance, 2010: 1046).

Treatment for diarrhoeal related HUS is generally supportive, fluid-electrolyte replacement, blood transfusion and dialysis if needed. Recovery rate is high but there is a 3-5% mortality rate during the acute phase (D’Agati, 2005: 498)

Glomerular involvement HUS has a better prognosis than HUS with a high vascular involvement.

Compared to HUS, the TTP has less haemolysis and milder renal impairment but shows more neurological symptoms such as confusion, headache and motor and sensory defects.

Treatment for TTP takes the form of plasma exchange with fresh frozen plasma. Since the implementation of this therapy form the mortality rate has dropped by approximately 25% but with severe renal involvement it still has a poor prognosis. It may re-occur in 25% of the patients who have been successfully treated (D’Agati, 2005: 511).

5. HELLP Syndrome

HELLP Syndrome is an acronym for Haemolysis, Elevated Liver enzymes, and Low Platelets and is generally found in pregnant woman who have developed preeclampsia or eclampsia (Gould, 2006: 120). Symptoms are Microangiopathic haemolytic anaemia, elevated liver enzymes are due to obstruction of the hepatic vessels by fibrin deposits and the low platelets are the result of either increased use of or the destruction of platelets (Counts, 2008: 168).

HELLP Syndrome may only develop during labour and as with preeclampsia the best cure is the delivery of the baby. Severe bleeding is unlikely unless platelet counts are very low (below 50 000/mm3). Severe thrombocytopenia or rupture of a subcapsular liver haematoma can both be life threatening (Ratcliffe, 2008: 493)

Many signs and symptoms such as jaundice, hematuria, GIT bleeds, gum bleeds can be seen in pregnant woman which are related to HELLP but could be mistaken for other diseases such as Hepatitis, ulcers, kidney stones, glomerulonephritis, TTP or HUS so a full blood count is important to differentiate HELLP from other diseases (Queenan, 2007: 275)

HELLP Syndrome is one of the Thrombotic Microangiopathies as is TTP and HUS but as it is a result of preeclampsia it only occurs during pregnancy and then usually only in the third trimester. Preeclampsia is more common than TTP/HUS during pregnancy but with a lower risk of renal failure unless the case is a severe one.

HELLP syndrome shows mild disseminated intravascular coagulation (DIC) which is characterised by uncontrolled coagulation, increase in bleeding time and liver enzymes (Greenberg, 2009: 410)

It can be potentially fatal to the expectant mother, decrease perfusion of placenta thus threatening the foetus (Counts, 2008: 168) with a mortality rate of up to 24% for the mother and 7. 7 – 60% to the unborn due to intrauterine asphyxia, placenta detachment or extreme prematurity (Feehally, 2007: 350).

In some instances symptoms do not improve after birth but generally the best therapy is the delivery of the baby. Corticosteroids may be used to help hasten the recovery and reduce the need for blood products (Feehally, 2007: 350). Treatment is generally symptomatic; the stasis of any bleeding, blood products if a significant amount of blood was lost or is still likely to be lost without intervention, and the same applies for FFP. A cryoprecipitate may be given if the fibrinogen levels are low (for example Factor VIII from frozen blood) and fibrinolysis inhibitors may be considered in some patients (McPhee, 2009: 474-475).

6. Rhabdomyolysis

Rhabdomyolysis is due to damage of muscle cells as a result of a variety of factors and can become a life-threatening problem (McCance, 2010: 1575). As a result of the damage of muscle cells, its contents (myoglobin, enzymes, potassium and phosphorus) leak into the blood stream. The kidneys secrete myoglobin as myoglobinuria in the urine (Lerma, 2009: 109).

Muscle cell damage can be due to a variety of reasons and amongst others are: Trauma, extreme exercise, seizures, compromised blood flow, electrolyte disturbances (such as hypokalemia, hypophosphatemia), drugs, temperature (hyperthermia, burns), inflammation and infections. Clinically this disease can vary from mild, with slightly elevated serum levels of myoglobin and creatine kinase (CK) to severe with the necessity for renal replacement therapy. Incidence of acute kidney failure due to rhabdomyolysis is as high as 5-15% (Greenberg, 2009: 298-299).

Renal insuffiency is due to the excessive amounts of myoglobin being filtered by the kidney resulting in tubular injury and is generally also associated with hypovolaemia (McPhee, 2009: 742). Large amounts of myoglobin may clog the nephrons with these being overwhelmed and may produce casts which will also cause obstruction in the tubules. Hypovolaemia is due to not only a decrease in fluid intake but also due to large amounts of fluid accumulating in the damaged muscle tissue (Counts, 2008: 162-163).

Decreased renal blood flow, hypovolaemia and acid urine all are signs that acute tubular necrosis is likely (Lerma, 2009: 109).

Treatment consists of hydration with high volumes of preferably IV fluids to increase the intravascular fluid volume, thus increase the perfusion of the kidneys and forcing diuresis, reducing the risk of cast formations in the tubules and increasing the GFR.

In severe cases of rhabdomyolis the use of mannitol and bicarbonate to improve urine pH as well as high fluid volumes of up to 12l/24hours have proven beneficial, Dialysis may need to be commenced if urinary output remains low and with urea and hyperkalemia not responding to conservative treatment (Greenberg, 2009: 302). Fluid administration must be carefully monitored, as there is a risk of pulmonary oedema in the face of acute kidney failure. The mannitol will assist in myoglobin clearance and urine flow and thus assist with the reduction of the nephrotoxicity of the myoglobin. CK levels will drop over a period of a few days provided there is no further injury to the muscle. Hypocalcemia is generally not treated in these instances, as the calcium tends to accumulate in the injured tissue (Lerma, 2009: 112).

7. Conclusion

Many external factors and diseases with origins elsewhere in the body, easily affect the kidney in its function. The above five diseases showcase just a small percentage of the many diseases and dysfunctions which affect the kidney in a multitude of ways and gives us an insight of just how important an organ it is.