

# Effects of Chronic Kidney Disease on the Heart

*Submitted by*

*Brenda B. Mwangi Admission*

SMAS

Under the Supervision of Dr. Deepa Muthiah

Assistant Professor

## ABSTRACT

The renal system and the cardiovascular system are interdependent. A problem with one system will ultimately affect the other, this is why when one has a disease in these organs, we generally check the other to rule out a cause and effect. Therefore, when the kidneys are incapacitated, the heart will bear the brunt of the effects. In this review we analyze the problems that arise in the heart due to chronic kidney disease.

## INTRODUCTION

Chronic Kidney Disease (CKD) is a progressive and irreversible loss of kidney function.

This condition affects roughly 10% of the population worldwide and its recently became a leading cause of death due the rise of its risks factors e.g. diabetes (this causes damage to blood vessels in the kidney due to nephropathy leading to the reduce infiltration rate)

hypertension(causes thickening of the blood vessels hence narrowing of the lumen which in turn leads to less blood flow to the kidneys), obesity, family history of kidney diseases and frequent use of painkillers such as ibuprofen.

How do we diagnose CKD

It diagnosed by checking the albumin or protein levels in the blood or checking both of them. Or checking serum creatine in the blood which shows the glomerular filtration rate (GFR) of the kidneys. This is to be done for a period of 90 Days to rule out other kidney problems such as acute kidney injury.

The are 5 stages of CKD

These are measured by the level of GFR in ml/min

- Stage 1: >90ml/min [in this stage there is evidence of kidney damage]
- Stage 2: 60 – 89 ml/min
- Stage 3a: 45 – 59 ml/min
- Stage 3b: 30 – 44 ml/min
- Stage 4: 15 – 29 ml/min
- Stage 5: <15 ml/min [also called end stage renal disease, patient needs renalreplacement therapy]

This disease is asymptomatic in the early stages, as the disease progresses symptoms arise and these include loss of appetite, nausea and vomiting, tiredness and drowsiness, muscle cramps, fluid overload (which includes ascites, peripheral oedema and pleural effusion which leads to difficulty in breathing) and anemia.

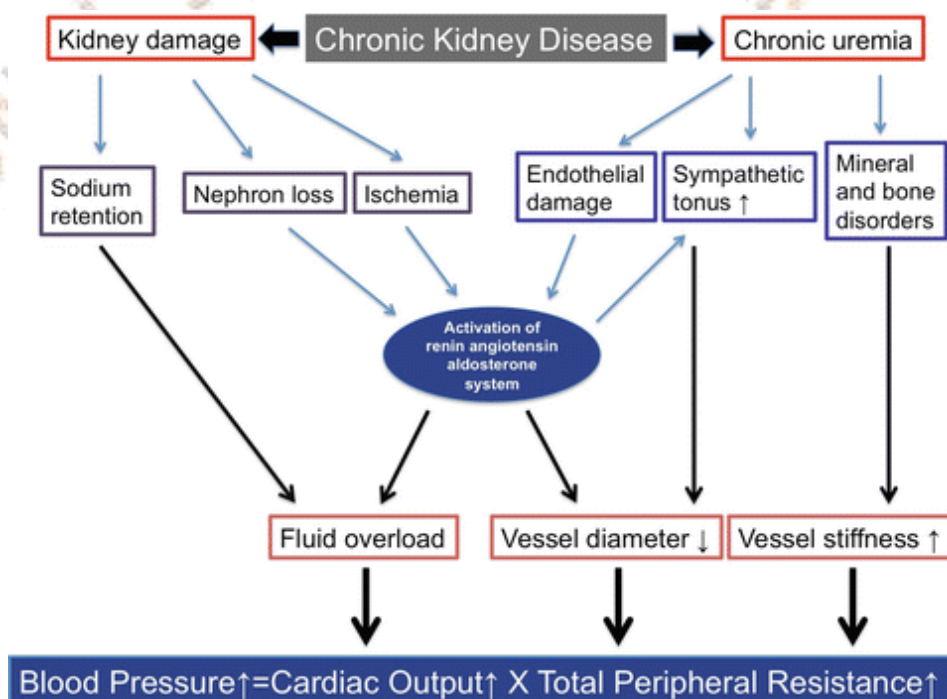
Chronic Kidney Disease causes the following in the cardiovascular system

## 1. HYPERTENSION

Although hypertension is a risk factor for CKD it is also a result of the disease. It causes thickening of blood vessels which lead to narrowing of the lumen of the said vessel this in turn causes the amount of blood that passes through to be lessened.

When the nephron notices this decrease of blood to the glomerular it produces renin which in turn activates the renin angiotensin aldosterone system (RAAS). This system increases the blood pressure so that the kidney may receive more blood. This cycle continues and leads to glomerular sclerosis further damaging the kidneys.

This process increases the blood pressure (BP) in the body to dangerous levels which may lead to a stroke. High blood pressure causes constriction of blood vessels, which damages them. When this happens to the kidneys vessels it impairs their ability to excrete water and sodium. This causes edema because of the buildup of fluids in the body cells.



## 2. ANAEMIA

Anemia is a condition in which the body does not have enough or produces a low count of red blood cells.

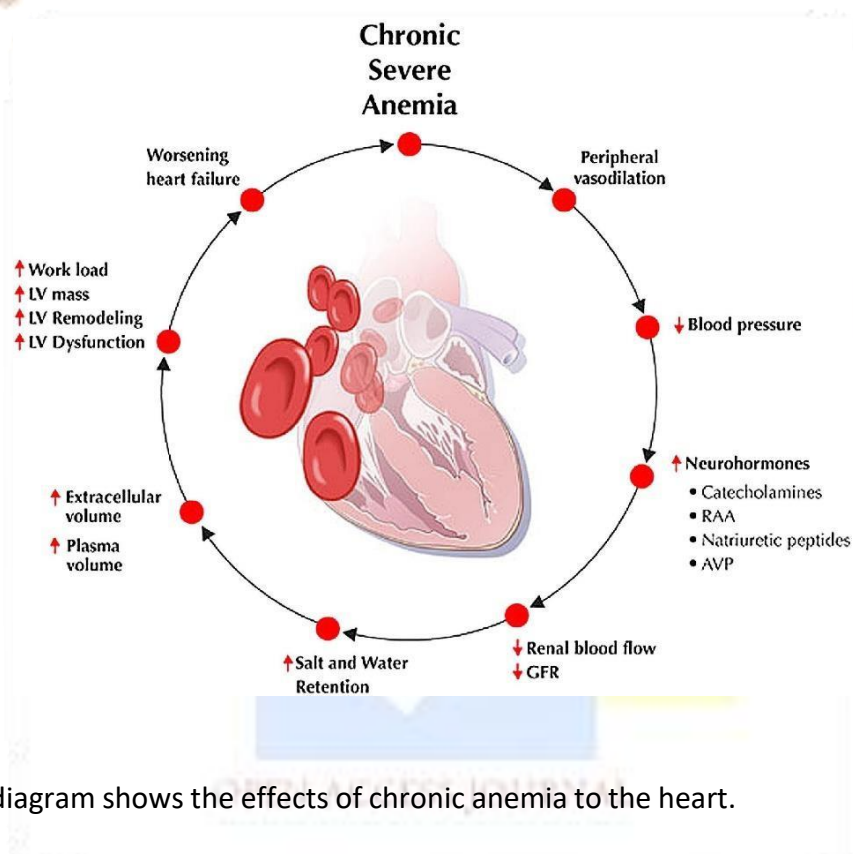
The relationship between the kidneys and anemia is quite important, the kidneys are responsible to produce a hormone known as erythropoietin. This hormone signals the bone marrow to make red blood cells (RBC) also known as erythrocytes. When there is low levels of erythropoietin hormone in the blood then the kidney senses this and produces the appropriate amount of the hormone. Therefore, when the kidney is diseased, the production of erythropoietin is affected since the organ is not performing its function at peak capacity (i.e. cannot accurately detect the amount of erythropoietin hormone in the blood). This leaves with smaller production of the hormone which in turn leads to low production of RBC's. Low RBC count leads to low oxygen supply to the body, because the RBCs are the units that transport oxygen.

It is also important to note that the RBC's produced in lieu of a diseased kidney, have a shorter life span than normal RBC's this causes them to expire before their allotted time frame. This causes further deficiency since they die before the body is able to replace them by producing new ones.

Signs and symptoms of anemia include

- Fatigue
- Shortness of breath
- General body malaise
- Palpitations
- Dizziness
- Fainting
- Skin pallor
- Headaches

Anemia causes cardiac stress by tachycardia and increased stroke volume; these are adaptive mechanisms in which the body tries to work harder to compensate for the shortage of oxygen supply to the tissues. If it persists for a long time it leads to left ventricular hypertrophy and cardiac cell death which ultimately contributes to heart failure.



### 3. LEFT VENTRICULAR HYPERTROPHY

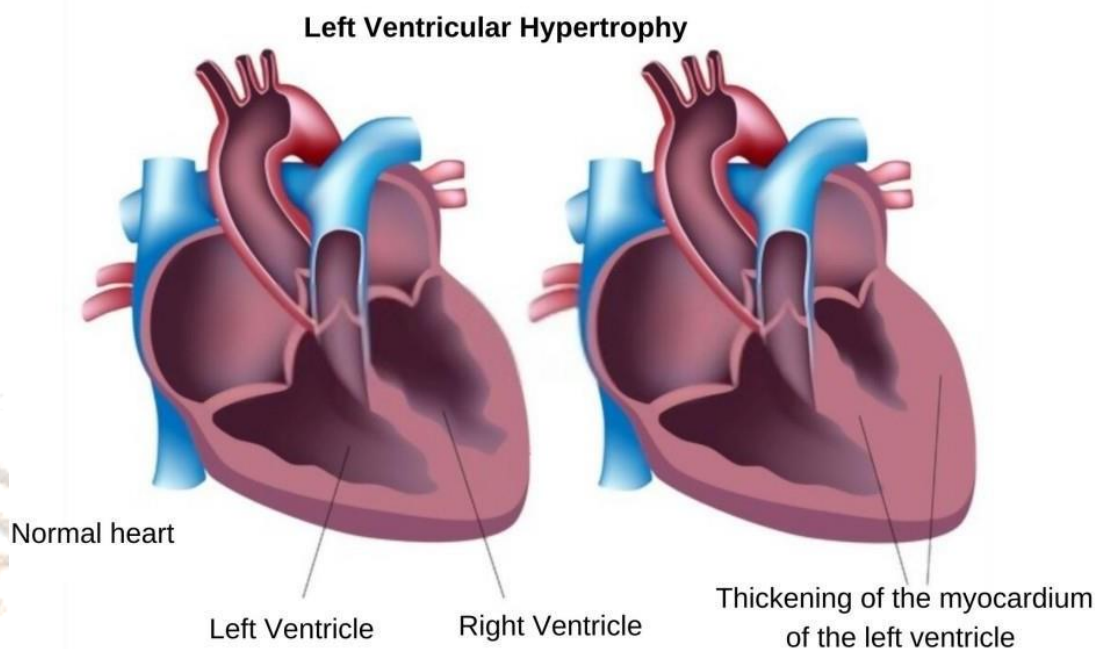
This is the thickening of the wall of the left ventricle walls which is the hearts main pumping chamber (i.e., it pumps blood to the body)

The main causes of LVH are fluid overload, increased afterload and high cardiacoutput due to anemia.

When the kidneys cannot filter well then there will be an increase in fluid in the tissues (oedema). This fluid overload leads to higher volume of blood in the body and blood pressure also increases. In turn it makes the heart to work harder to pump all the blood in the body.

High cardiac output due to anemia is a result of the body sensing that its not receiving adequate oxygen supply therefore the heart will pump harder to try to compensate for the blood that is not there. This process puts a strain on the heart muscles they will increase in size to become stronger so as to work harder than normal.

In CKD there is an increase in deposition of collagen fibers in the vessels and the heart this causes fibrosis which leads to the decrease in the lumen of the blood vessels ultimately leading to HTN. In the veins, a decrease in the lumen size also increases the peripheral resistance which will lead to increase in afterload. An increase in afterload which is the pressure the heart must overcome during systole leads to a decrease in contraction. When this happens the heart will increase the wall muscles to return the contraction power to normal hence hypertrophy.



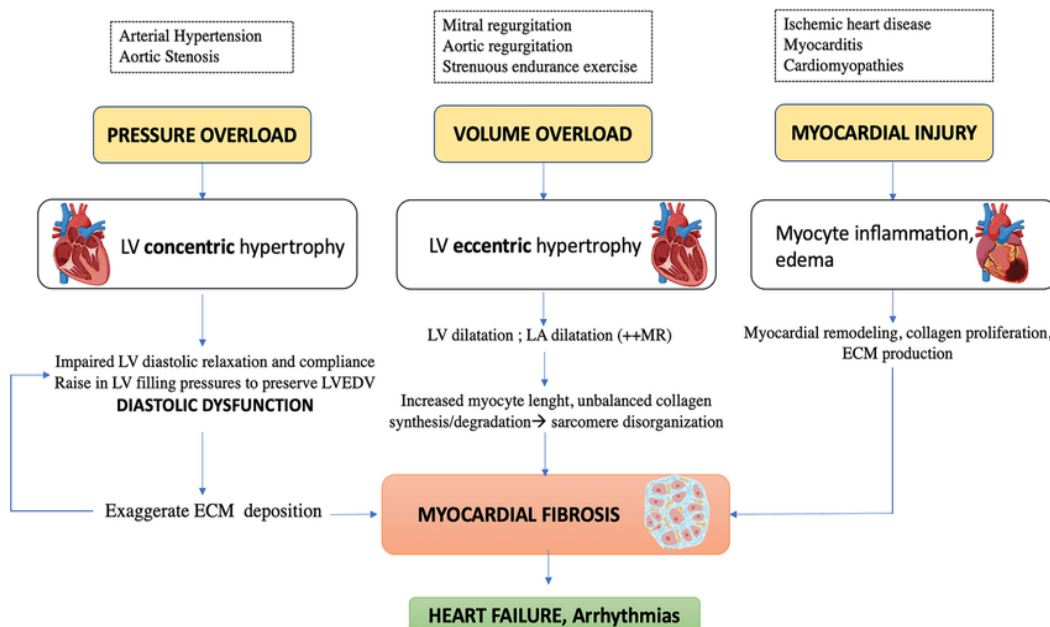
#### 4. MYOCARDIAL FIBROSIS

It is defined as the increase in quantity of collagenous scar tissue on the heart.

In other words, this is when there is scarring of the cardiac muscle which leads to stiffness leading to diminished cardiac function.

When there is a decreased or impaired glomerular filtration rate (GFR) then there will be an excessive deposition of fibrillary collagen which leads to an increased synthesis and deposition of collagen fibers. The accumulation of these on the myocardium changes its structure. This happens mostly due to pressure overload caused by hypertension, it leads to diastolic dysfunction and if it occurs for a long time then it causes ventricular dilatation eventually congestive heart failure.

The following is the pathophysiology of myocardial fibrosis;



## 5. HEART FAILURE

It's also known as congestive heart failure (CHF). This is a condition in which the heart cannot pump enough blood to reach the body's needs. The heart and the kidneys work hand in hand to balance fluids in the body. This means when one organ is compromised then the other will be affected too.

HF is classified into 3

- Systolic HF – decrease in contractility
- Diastolic HF – decrease in filling
- Congestive HF – both

Due to CKD there is hypertension, anemia, myocardial fibrosis, left ventricular hypertrophy and fluid retention. All of these contribute in one way or another to heart failure by increasing preload and afterload which leads to increase in volume and pressure overload.

On account of all the compensatory mechanisms that the heart undergoes as a result of CKD, heart failure occurs as discussed above.

## CONCLUSION

The kidneys and the heart are so closely linked together that they affect each other when one faces a problem. It is quite impossible for there to be a long-term disease of the kidney that does not affect the heart and vice versa. The mortality rate for these two systems is high especially if both systems are compromised. It is advisable to manage the conditions that arise so as not to affect the other system when one is diseased. CKD ultimately will lead to heart failure if not managed properly, therefore it is imperative for patients of CKD to do regular checkups for the heart to curb a problem (if any) arises early.

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