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INAUGURAL LECTURE

"POWER AND THE FAILED PUMP: TRAVAILS AND REMEDIES FOR BROKEN HEARTS"

By

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My Lords, Spiritual and Temporal,
Members of my Nuclear and Extended Families,
Distinguished Students of Medicine,
Esteemed invited Guests, Friends and Relatives,
Great students of the University of Ilorin,
Gentlemen of the Print and Electronic Media,
Ladies and Gentlemen.

Preamble

I welcome you all to this great occasion in the name of our Lord Jesus Christ, the author and finisher of our faith. I give God Almighty all glory and honour for life and health he has bestowed upon me to stand before you this day, the 22nd June

2023 to deliver my inaugural lecture entitled: **POWER AND THE FAILED PUMP: TRAVAILS AND REMEDIES FOR BROKEN HEARTS**. Mr. Vice-Chancellor, sir, this is the 236th in the series of inaugural lectures of the better by far University, the 9th from Department of Medicine and 3rd from the Cardiology Unit. This title was carefully chosen to illustrate the problems encountered by individuals who suffer from heart failure and strategies to mitigate against these challenges especially the preventive approach.

Introduction

The heart is a unique organ that is well endowed with capacity to pump blood to all parts of the body in order to supply oxygen and nutrients. It contracts about 100, 800 times per day, about 3 billion beats in a lifetime and in the process, it pumps about 7,500 litres of blood in a day. Its function is determined by a unique hemodynamics that encompasses active relaxation to accommodate venous return followed by contractions to eject its content (Nishimura et al., 2019). It is of note that contractions of the heart are preceded by a well organized electrical activation which allows orderly systolic function such that the upper chambers (atria) are fully contracted before the lower chambers (ventricles). If the heart stops beating, the organism dies within minutes.

Operational Definition of Terms

1. **POWER:** From elementary Physics, power is ability to do work.
2. **PUMP:** A pump is a device which moves fluids by mechanical action from one place to the other. The heart is a muscular pump which can be compared with the municipal water supply system that has both electrical and mechanical parts. If the pump cannot perform its function adequately, it is said to have failed.

3. **BROKEN HEART:** A broken heart can be defined as a serious heart dysfunction that results from overwhelming emotional disorder or from persistent cardiovascular risk factors leading to heart failure.
4. **TRAIVAILS:** Difficulties that are experienced as part of a particular situation
5. **REMEDIES:** Are treatments or medicines that cure or relieve specific conditions.

The Heart, Ancient Mythologies and Emotions

The heart is not only a pump but also regarded as a centre of emotions which generated a lot of controversies in ancient times. Although it remains a matter of debate among scientists on where emotions such as anger, fear and love are controlled, many contemporary scientists agree that these centres are located in the brain but the manifestations are predominantly heartfelt (Molewijk *et al.*, 2011, p.383; Brandt *et al*., 2021, p.1617).

The ancient Egyptians considered the heart to be so important that it was specially protected in the chest at mummification while all other organs are removed. It was considered key to afterlife and reflected the abode of the soul of dead person depending on its weight which is determined by the person's sins as compared with a feather of Maat (Ziskind *et al*., 2004, p.367).

The ancient Greeks considered the heart to be the centre of the soul and the source of heat within the body. It was considered to be associated with our strongest emotions including love. Aristotle expanded the role of the heart even further, granting it supremacy in all human processes. The heart was seen as the centre of vitality and other organs surrounding it such as the lungs and brain simply existed to cool it. Similarly, the ancient Romans linked the heart with love. The goddess of Love, Venus was always blamed for setting the heart on fire with the help of her son Cupid who always acted to inspire love and

passion (Reynolds, 2007; Cook, 2010, p.458). In our local languages, the heart is called “okan” in Yoruba, “zuchiya” in Hausa and “ekogi or nyagban” in Nupe. All these three languages link the heart with love. For example: Yorubas will say “mo feran yin tokan tokan”, Hausas will say “nna sonka da zuchiya na” and Nupes will say “mi de ciicin we dan ekogi ko nyangban mi bo” to express their deepest affections to the loved person.

Cardiac Anatomy and Embryology

The cardiovascular system is one of the first to appear in the embryo as a mesenchyme that forms a group of endocardial cells below the pharynx. These soon fuse to form a single endothelial tube lying longitudinally below the pharynx (Figure 1). Six distinct parts of this tube can be identified namely; sinus venosus, primitive atrium, primitive ventricle, bulbus cordis, truncus arteriosus and aortic roots. The heart in animals ranges from single chambered heart in amphioxus species to three-chambers in frogs and four in birds (Bettex, *et al*, 2014, p.2322). However, the human heart is uniquely endowed and is of top notch in the hierarchy of specialisation with 4 chambers and a lot of intrinsic capacities to carry-out its functions. The structure of the heart is presented in figure 2 showing all four chambers and great vessels.

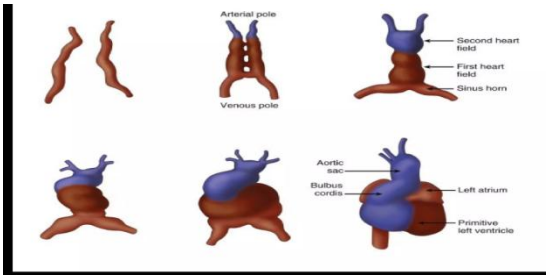


Figure 1: Development of Human Heart **(**Sharma, 2022).

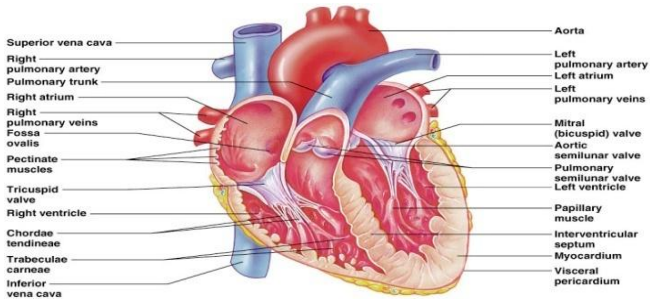


Figure 2: Anatomy of Human Heart (Cooper, 1989).

Cardiac Physiology and Contractility

One of the properties of the cardiac muscle is automaticity which implies that all parts of the heart are capable of generating depolarisation or spontaneous action potential. However, the heart is endowed with a specialised conduction tissue which initiates and transmits this to ensure orderly electrical activation and contraction of the chambers. The pacemaker cell of the heart is the sinoatrial (SA) node which usually displays the highest intrinsic rate of diastolic spontaneous depolarisation during phase 4 of the action potential that progressively brings the membrane potential to a threshold. All other pacemakers are latent and only take over if the SA node is unable to generate action potential or activity (Klabunde 2012).

Cardiac cycle consists of period of relaxation (diastole) to accommodate venous return and contraction (systole) to eject its content. Deoxygenated blood is returned to the heart from vena cavae through the right atrium and to the lungs for oxygenation. This is subsequently returned to the left side of the heart through the pulmonary veins. This gives credence to the old maxim that all arteries in the body carry oxygenated blood except pulmonary arteries and all veins carry deoxygenated blood except the pulmonary veins. The valves ensure unidirectional flow of blood and prevent backward leak during ventricular contractions.

Power and the Failed Pump

In order to perform its task, the heart needs a great deal of energy to meet up with the workload. Adequate power has to be generated by the heart to pump blood around the body. The heart therefore, has a lot of mitochondria where many high energy phosphate molecules inform of adenosine triphosphate (ATP) are produced and released for the workload. Fatty acids (FA) are recognised as a key source of energy substrates for the heart and 60-90% of its ATP is derived from FA. Other substrates such as ketones and branched chain amino acids are of significance especially in patients with ketoacidosis and heart failure as shown in figure 3 (Lopaschuk & Ussher, 2016).

The action potential in cardiac myocyte leads to the influx of calcium across the plasma membrane which elicits the release of calcium from L-type calcium channel and activates ryanodine (RYR) receptor in sarcoplasmic reticulum. However, in heart failure there is disorganization of T-tubules which leads to impaired energy/power generation and contraction due to reduced, asynchronous and chaotic calcium release. This is the basic mechanism underpinning pump failure in patients with cardiac diseases and it is now a target in the treatment of heart failure (myocardial energetics).

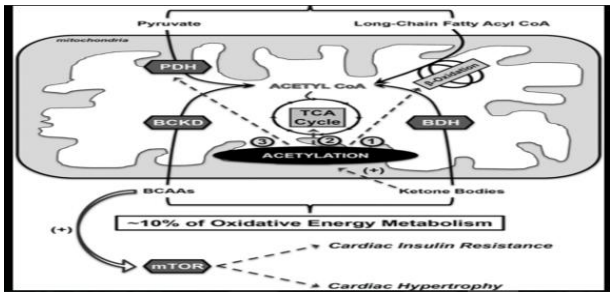


Figure 3: Shows substrates for energy production by the heart (Lopaschuk & Ussher, 2016).

The Silent Enemies of the Heart

The venous return to the heart is the preload while the resistance against which the heart must pump its content is called the after load. Both must be within normal limits for good heart function. Heart diseases are progressive in nature (Cardiovascular continuum) which starts with the presence of a risk factor that is highly associated with heart failure causing alterations in the size and shape of the heart. These risk factors which were first described in the Framingham Heart Study in 1948 can be classified into modifiable and non-modifiable (Mahmood *et al*., 2014, p.999; Fruchart, *et al*., 2004). The former include systemic hypertension, diabetes mellitus, cigarette smoking, elevated cholesterol and obesity can be addressed while latter include age, sex, family history and heredity that cannot be altered. The presence of these risk factors is often without warning symptoms and as such are called silent killers. However, these silent killers have some surrogates that can be used for early detection of their effects on the heart (Bond *et al*., 2019).

The Broken Heart

Conventionally, broken heart is thought to be deep-seated unpleasant feelings that occur as a result of failed promises and relationships which make us not to trust again. This can be between couples, business partners, co-workers and; spiritual leaders and followers. Hope dashed could have serious consequences on our psyche and wellbeing. This has also been confirmed by the holy bible in Proverbs 13: 12: “hope deferred makes the heart sick but a longing fulfilled, is a tree of life”. Our emotions affect the signals sent to the brain in a complex manner and both are interdependent on each other. A form of broken heart due to overwhelming emotional challenge is called “Broken heart syndrome” which was first described in Japan in 1990 especially among women between ages 58-75 years. This is

also called Takotsubo or stress cardiomyopathy (Merchant, *et al.*, 2008). This condition is transient and patients affected often get better with treatment. However, some of them may continue to feel unwell after the heart disease is healed. One should not be surprised why older couples are not able to live long after demise of their partners. Many stories abound in our communities where the second partners are only able to survive for weeks or months before they also pass on.

Furthermore, it is well known that the common final pathway for most cardiac diseases is hypertrophy and dilatation which may eventually lead to heart failure or broken heart (Antropova, *et al*., 2020, p.3797). In this situation, the heart function physically has broken down and it is unable to produce adequate output to meet the need of body tissues despite normal filling pressures. When symptoms of heart failure persist beyond three months or are recurrent, then the patient is said to have chronic heart failure (CHF). This group of patients also suffers from emotional challenges and mood changes which ultimately affect their quality of life and clinical outcomes (Celano, *et al*., 2018, p.175). Patients in this category who are in the majority have a rather poor outlook and their conditions continue to deteriorate which can be likened to what a popular musician; Don Williams described as "some broken hearts never mend or heal" which means irrespective of treatment given, the condition continues to get worse until the final demise of the affected. Literally to a lay man, CHF can be likened to "**starting a journey to say goodbye**". Whatever it is, once the condition is established, it continues to deteriorate with the consequence of either progression to pump failure or sudden cardiac death. That is why every effort must be put in to prevent its occurrence.

Travails of Patients with Broken Hearts

Lack of stamina and limitation of physical activities

Heart failure indicates inability of the heart to perform its basic functions which limits physical activities of the patients. Many of those affected suffer limitations of physical activities and may have to change their means of livelihood due to lack of stamina. Individuals like farmers may have to rest severally before getting to their farms which hitherto did not require such efforts.

Late Diagnosis and Presentation to the Hospital

The early practice of cardiology in Nigeria was with paucity of diagnostic facilities and mainly depended on clinical suspicions. Basic cardiology equipment available then was mainly electrocardiography and chest X-ray. However, echocardiography offered the best objective evidence of cardiac dysfunction which was not available in most centres in Nigeria in early practice. Symptomatic and asymptomatic cardiac dysfunctions have similarities in mortality profile (Kolo & Omotoso, 2010).

Very high mortality associated with chronic heart failure

Heart failure is associated with high intra-hospital and long term mortality. In our series (Ogunmodede, *et al*., 2021, p.221), intra-hospital mortality was 11.6% which is lower than what was reported by Adewole, *et al.*, (1996, p.253) in O.A.U, Ile-Ife where they observed intra-hospital mortality to be 14% in those on Angiotensin Converting Enzyme Inhibitors (ACEI).

Peri-partal Cardiomyopathy and broken promise

Pregnancy is a thing of joy to every family and the birth of a young one usually brings fulfillment to those bestowed with this gift by the Almighty. However, some women are so unlucky to suffer heart failure due to no-other cause than pregnancy, peri-partal cardiomyopathy (PPCM). The cause of this type of heart

failure is unknown but myocarditis, vasculo-hormonal abnormalities (16-kDa prolactin and Cathepsin D), genetic susceptibility and selenium deficiency have been implicated. The traditional practices of hot baths and consumption of pap enriched with dried lake salt were not found to be associated with the condition in recent studies. Peri-partal cardiomyopathy is very common in the Northern part of Nigeria and I have also managed a number of young women with this condition here in Ilorin. Any of the pregnancies can be affected and the pathetic aspect of the condition is that the index baby may not survive leaving the woman with no living baby and she would not be able to have another pregnancy. Factors associated with high mortality in this condition include young maternal age of less than 20 years, resting tachycardia, hypoperfusion and ejection fraction less than 25% (Karaye, *et al*., 2023, pp.104-113).

Re-Hospitalisations

The story of heart failure is incomplete without mentioning recurrent exacerbations which often require re-hospitalisation (Diamond & DeVore, 2022, p.199). The cost of such admission is enormous which is entirely borne by the patients in our environment. When such patients recover from these exacerbations, their clinical parameters such as ejection fraction may deteriorate until they develop hypotension or low blood pressure which may lead to cardiogenic shock. At this stage, inotropic supports and left ventricular support are critical to the outcome of the patients.

Burden of Chronic Heart Failure (CHF) and cost of care

Heart failure affects more than 64 million people world-wide and its prevalence increases with age. In addition, the incidence of CHF is increasing because of ageing population and high rate of age-rated cardiac diseases. Whereas, CHF is a disease of old people affecting people in their 7thdecade of life in

high-income countries, it is a disease of the young and middle aged in sub-Saharan Africa, in which those between 3rd and 5th decades of life are affected. This has serious economic implications because it is at these ages that they are very active to earn incomes for themselves and families (Savarese, *et al.*, 2023, p.3272; Ogah *et al*, 2019).

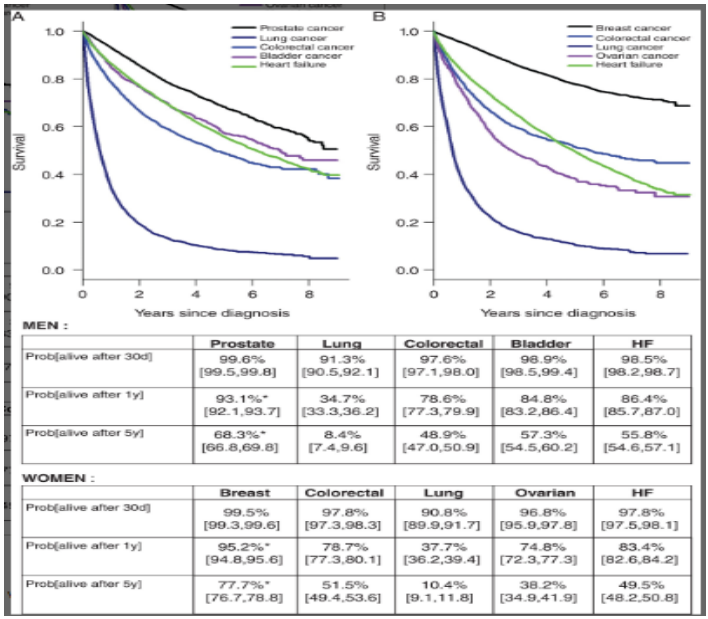
The Sub-Saharan African Survey of Heart Failure (THESUS-HF) was a prospective, multicenter, observational survey of patients with heart failure in 12 teaching hospitals in 9 countries (Damasceno, *et al.*, 2012, p.1386). A total of 1006 patients with acute heart failure were enrolled and mean age was 52.3 years. Heart failure was predominantly due to systemic hypertension (45.4%) and rheumatic heart disease (14.3%) with few cases of ischaemic heart disease (7.7%). In addition, the International Congestive Heart Failure Study (INTER-CHF) was an international, multicenter cohort study, conducted in sixteen countries in Africa, Asia, the Middle East, and South America with six- and twelve-month follow-ups (Dokainish, et al., 2016, p.133). It showed that mortality rate was highest in Africa (34%), intermediate in southeast Asia (15%), and lowest in China (7%), South America (9%), and the Middle East (9%), and the regional differences persisted after multivariable adjustment. In Nigeria, Abuja Heart failure registry enrolled 1515 cohort of patients with heart failure and found that systemic hypertension predominated in the aetiology of CHF.

The cost of managing heart failure globally is enormous due to cost of medications, transportation, recurrent hospitalisations and loss of manpower time. According to the Heart Failure Society of America (HFSA) in a statement released in Journal of Cardiac Failure, the annual cost of caring for heart failure patient in the United States of America is about $30,000 (Heidenreich, *et al*., 2022a). It was estimated that by year 2030, the cost of caring for CHF patients is expected to be at least $70

billion per annum with the total cost of caring for CHF patients approaching $160 billion. This is as a result of ageing population and new treatment options available to these patients. Similarly, estimated the annual cost of care for CHF in Abeokuta, South West, Nigeria in 2014 to be N319,200 naira only (Ogah, *et al* 2014). This huge economic burden of treatment of heart failure is related to hospitalisation and re-hospitalization among them. New policies are therefore, needed to reduce out-of-pocket expenses by CHF patients and multidisciplinary care approach to reduce re-hospitalisation where there is synergy between managing team and family physicians that take care of them in the community.

Outcome of Chronic Heart Failure

The mortality outcome in heart failure is worse than that of many common cancers as seen in Figure 4 (Mamas, *et al*., 2017, pp.1095-1104). In men, CHF has worse 5-year survival rate (55.8%) than prostatic (68.3%) and bladder cancers (57.3%) but better outcome than lung (8.4%) and colorectal cancers (48.9%) while in women, 5 year survival for CHF is worse (49.5%) than that of breast cancer (77.7%), but better than lung (10.4%) and ovarian cancers (38.2%). The five year mortality rate in patients with advanced CHF is about 70% which only continues to deteriorate with a lot of inflammation, elevation of basal metabolic rate and excessive sweating and long standing consequences like weight loss and cardiac cachexia which itself are predictors of mortality (Okoshi, *et al* 2000, p.74).



MEN :

	Prostate	Lung	Colorectal	Bladder	HF
Prob[alive after 30d]	99.6% [99.5,99.8]	91.3% [90.5,92.1]	97.6% [97.1,98.0]	98.9% [98.5,99.4]	98.5% [98.2,98.7]
Prob[alive after 1y]	93.1%* [92.1,93.7]	34.7% [33.3,36.2]	78.6% [77.3,79.9]	84.8% [83.2,86.4]	86.4% [85.7,87.0]
Prob[alive after 5y]	68.3%* [66.8,69.8]	8.4% [7.4,9.6]	48.9% [47.0,50.9]	57.3% [54.5,60.2]	55.8% [54.6,57.1]

WOMEN :

	Breast	Colorectal	Lung	Ovarian	HF
Prob[alive after 30d]	99.5% [99.3,99.6]	97.8% [97.3,98.3]	90.8% [89.9,91.7]	96.8% [95.9,97.8]	97.8% [97.5,98.1]
Prob[alive after 1y]	95.2%* [94.8,95.6]	78.7% [77.3,80.1]	37.7% [36.2,39.4]	74.8% [72.3,77.3]	83.4% [82.6,84.2]
Prob[alive after 5y]	77.7%* [76.7,78.8]	51.5% [49.4,53.6]	10.4% [9.1,11.8]	38.2% [34.9,41.9]	49.5% [48.2,50.8]

Figure 4: Kaplan Meier curve for cancers and heart failure (Mamas, *et al*., 2017)**.**

Modern Management of Heart Failure

Chronic Heart Failure can be classified based on left ventricular ejection fraction (EF) and other echocardiographic indices. There are four categories which include CHF with reduced EF (HFrEF) in which ejection fraction ≤40%, heart failure with improved EF (HFimpEF) in which previous Ef was ≤40% and a follow-up of LVEF > 40%, then we have CHF with mid-range EF (HFmrEF) 41-49% and lastly CHF with normal ejection fraction (HFpEF) ≥50% (Davis, *et al*., 2000; Heidenreich, *et al.*, 2022; Lam, C.S. P., & Solomon, S. D.2021).

The landmark clinical trials on heart failure survival benefits was first performed in 1987 with angiotension converting enzyme inhibitor (ACEI) enalapril in Co-operative

North Scandinavian Enalapril Survival Study (CONSENSUS). Similar results were obtained in Studies of Left Ventricular Dysfunction (SOLVD). Enalapril was found to reduce mortality in CHF by about 16%. Newer molecules that have been found to improve the outcome of CHF patients include angitension receptor blockers (ARBs) which are often used when ACEI are contraindicated especially in patients with cough. Subsequent studies showed that the use of beta-blockers and mineral corticoid-receptor antagonists, when added to ACE inhibitors, resulted in incremental decreases in the risk of death of 30 to 35% and 22 to 30%, respectively. Furthermore, a combination of angiotensin receptor neprilysin inhibitor (ARNI) such as Valsartan-saccubitril combination has been used as a first line treatment in patients with CHF especially those with HFrEF. This has been well documented in PARADIGM study. However, ARNI has not been found useful in patients with HFpEF (those with ejection fraction ≥45%). Similarly, Ivabradine, a Fournier current inhibitor has been found useful in patients with CHF who are in normal rhythm and heart rate greater than 70 beats per minute (Lam, C.S.P., & Butler, J. 2020; CONSENSUS Trial Study Group, 1987; The SOLVD Investigator, 1992; McMurray, *et al.*, 2014; Das, *et al*., 2017).

The search for drugs that improve the outcome of patients with HFrEF and HFpEF had continued until recently when sodium glucose co-transporter2 (SGLT2) inhibitors showed survival benefits in these patients. Randomised controlled clinical trials involving Dapagliflozin, Canagliflozin and Empagliflozin in patients with CHF clearly showed mortality benefits in patients with heart failure (HFrEF and HFpEF) with or without diabetes (Shim, *et al*., 2021; Arnott, et *al*., 2021; Anker, *et al*., 2021).

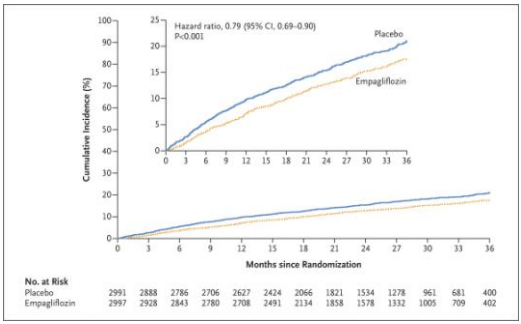


Figure 5: Empagliflozin in heart failure with preserved ejection fraction (Anker, *et al*., 2021).

Device Interventions in Heart Failure Management

Cardiac Resynchronisation Therapy

The main aim of Cardiac Resynchronisation Therapy (CRT) is to restore left ventricular synchrony. Multiple clinical trials have demonstrated the efficacy of CRT to improve cardiovascular mortality, heart failure re-hospitalisation and simulate favourable left ventricular remodeling. Major criteria to consider in assigning patients to CRT include duration of QRS, NYHA functional class and left ventricular ejection fraction. Furthermore, Cardiac Resynchronization Therapy Defibrillator (CRT-D) incorporates additional function to quickly shock an abnormal life-threatening rhythm. Some of our patients have had CRT with significant clinical improvements such as resolution of peripheral oedema and improvement of functional status (Dauw, *et al*., 2019).

Implantable Cardioverter Defibrillator

This is a special electronic device designed to monitor, detect and treat sustained ventricular arrhythmias. It has two basic components namely pulse generator which houses the

battery (can last 6-10 years) and a defibrillator lead. A special variety called cardiac implantable electronic device has capacity to monitor patient's heart rhythm, diagnose arrhythmias and delivers potentially life-saving treatment if high grade ventricular arrhythmias are detected (Manolis, *et al*., 2017, p.759). It is available in some centres in Nigeria but the cost of the device is prohibiting.

Intra-aortic balloon pumping

Left ventricular assisted devices are interventions as a stop-gap to cardiac transplantation which includes intra-aortic ballon pumping and other left ventricular assisted devices.

Cardiac Transplantation

This is the definitive treatment for advanced or end stage heart failure which was first performed in South Africa in 1967. This was followed by another successful heart transplant in Stanford University United States in 1968. This is basically of two types namely: orthotopic where the recipient heart is excised with implantation of donor heart in the recipient's chest and heterotropic in which the recipient's heart is not excised but donor's heart is implanted in the chest of the recipient. Common indications for cardiac transplant include: NYHA class III/IV heart failure refractory to maximal medical treatment, Heart Failure Survival Score (HFSS, Aaronson 1997) showing high risk, Recurrent symptomatic ventricular arrhythmias refractory to medical, ICD, and surgical treatments, Peak VO2 <10 ml/kg/min after reaching anaerobic threshold and Severely limiting ischaemia not amenable to interventional or surgical revascularization. Major challenges with heart transplant include lack of donors, cost of the procedure which makes many patients to be on the long waiting list and rejection after surgery (Bhagra, *et al*., 2019, p.252). Currently, this is not yet available in Nigeria.

My contributions to Science and Knowledge

Heart failure among patients in Ilorin

Mr. Vice-Chancellor sir, my research efforts have been geared towards reducing the high burden and mortality rate of

cardiovascular disease as well as heart failure in Nigeria, although I have research and publications in other fields of Internal Medicine.

Quest for Expertise in Echocardiography

In my quest to ensure early objective diagnosis of heart failure in Ilorin using echocardiography which is part of the requirements by many international societies for diagnosis of the condition, I had to travel consecutively with 100 patients to Biket Hospital in Osogbo, Osun State; a distance of about 125 kilometers from Ilorin with my patients to obtain their echocardiographic diagnoses while executing my research for the award of Fellowship of the National Postgraduate Medical College of Nigeria (2002-2004). Biket Hospital is a private hospital with facilities for non-invasive cardiology. Special thanks to God Almighty who granted me journey mercies during the period of travels and my appreciation goes to Dr. Adebisi David Adenle of Biket Hospital for granting me access to his machines and opportunity to have those patients echoed. I also had part of my training under Prof. Michael O. Balogun at Obafemi Awolowo University Teaching Hospital Complex, Ile-Ife, Osun State.

Survival and Mortality among Heart Failure Patients in Ilorin

The first effort in the study of heart failure patients in Ilorin was by Emeritus Prof. Araoye (blessed memory) and Dr. O. Olowoyeye where they devised a point score system to classify hypertensive heart failure which helps in differentiating late stages of hypertensive heart failure from idiopathic dilated cardiomyopathy. This was followed by Isezuo et al who assessed one year survival rate among Nigerians and Gambians with CHF which was found to be 71% (Araoye & Olowoyeye, 1984; Isezuo, *et al*., 2003).

Findings from our study above on heart failure showed that majority were in the advanced stages of the disease (NYHA III-IV=91.2%) which further confirms that our patients with the disease present very late. That is one of the reasons for high death rate among them. After 6 months of follow up, the all cause mortality was 30.8%. Patients who died had higher QTc, low serum sodium, longer duration of symptoms, low left ventricular ejection fraction, elevated urea and creatinine levels. Generally, more than 50% of patients with CHF die suddenly while the remaining suffer from progressive pump failure. A review of mode of death among cases of cardiac failure in Ilorin showed that some of my patients were completely stable but died while just taking a rest or collapsed suddenly outside the hospital environment and died before any help could be given (**Kolo, *et al***., 2008).

Cardiac arrhythmias and sudden unexpected death

The problem of cardiac arrhythmias in heart failure is well described by Michael Phelps who stated that "the trouble with heart disease is that the first symptom is often hard to deal with – sudden death." and Mark Hlatky who said that "the scary thing about heart disease is that you can be fine one minute and dead the next".

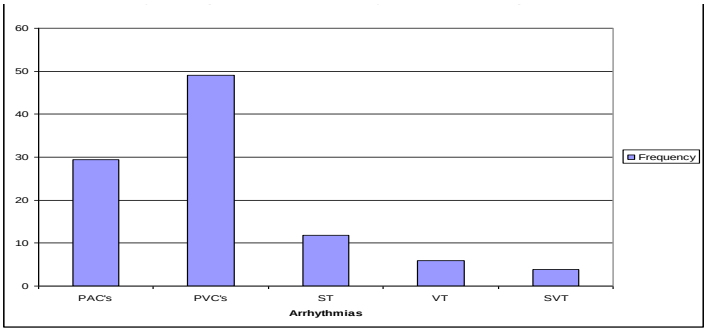


Figure 6: Spectrum of cardiac arrhythmias among heart failure patients in Ilorin (Kolo, *et al*, 2008).

Diseased myocardium serves as a site of development of abnormal cardiac impulse which may degenerate to sustained high grade tachycardia which may lead to sudden collapse and death. Commonest sustained arrhythmias include atria fibrillation, ventricular tachycardia and fibrillation. The spectrum of cardiac arrhythmias is presented in figure 6. One of such patients had sudden collapse with hypotension and loss of consciousness within the hospital. He had immediate check electrocardiogram which showed that the collapse was due to a polymorphic ventricular tachycardia called torsades de pointes (figure 7). He had electrical defibrillation and restoration of cardiac rhythm with his blood pressure getting back to normal; and regained consciousness within few minutes. This case was reported because very few cases survive such cardiac arrests whether within or out of hospital (Kolo, *et al*., 2009c). The case demonstrated that if interventions are instituted immediately after cardiac arrest, there is a good chance of survival even in our environment. Unfortunately, in many of our hospitals and public places defibrillators are not available. This is not acceptable in modern societies and should be taken seriously.

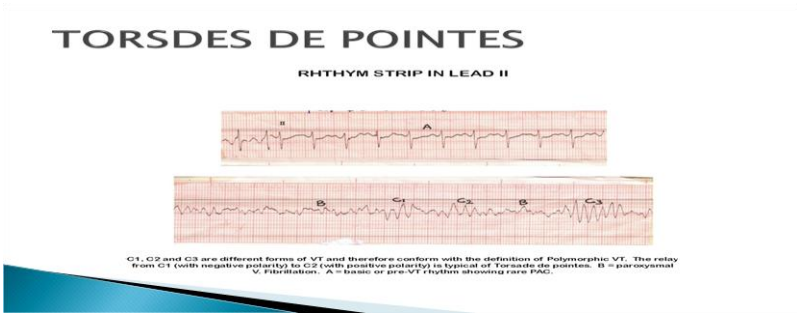


Figure 7: Showing polymorphic ventricular arrhythmia (Kolo, *et al*, 2009c).

Echocardiography and Pattern of Heart Diseases in Ilorin

In any given environment, prevailing cardiovascular diseases determine the causes of heart failure in such place. While coronary heart disease remains the leading cause of death in industrialised nations of the world, systemic hypertension has remained the main driver of cardiovascular complications in sub-Saharan Africa. Following my training in echocardiography at Biket Hospital and Obafemi Awolowo University Teaching Hospital Complex, Ile-Ife, echocardiography service was established at the University of Ilorin Teaching Hospital after the machine (Esaote Mega CVX) was made available by the then CMD, Prof. S. A. Kuranga. Subsequently, the audit of our echocardigraphic services at UITH, Ilorin showed that systemic hypertension was the commonest cardiovascular disease referred for the test (61.4% of patients studied) with 25.5% of them having heart failure. This was followed by congenital heart diseases (7.3%) and rheumatic heart disease (7.0%) (Kolo, *et al*., 2009b).

Formation of UITH Open Heart Surgery Team

This pioneer effort in establishing the pattern of cardiovascular diseases in Ilorin was followed by formation of open heart surgery team in UITH by the then CMD, Prof. A.W.O Olatiwo which was headed by a Pediatrician of repute, Prof. O.T Adedoyin. Hitherto, our patients with cardiac problems that required open heart surgery had no hope. The team was made up of adult and paediatric cardiologists, cardiothoracic surgeons, anesthesiologists, cardiac nurses and perfusionist as seen in figure 8 (Prof. P. M. Kolo is 3rd from the left) below. As part of preparation for the open heart surgery, I was fortunate to be part of the team that was sent to Philippines Heart Centre in Manila for observational visit. The management also purchased another echo machine (Sonoscape) with transoesophageal probe. In addition, some members of the team had further training at

Apollo Hospital in Chennai India. The collaboration between UITH and our partners from India led to cardiac missions wherein some of our patients with structural heart lesions had open heart surgeries in Ilorin for their conditions. This was headed by Dr. Solomon Nervile (Figure 8: Ilorin Open Heart Surgery Team with foreign members from India). One of the patients who had open heart surgery then is doing very well. She is currently having her National Youth Service (NYSC) programme (Adeoye, *et al*, 2017).

Figure 8: UITH Cardiac Team, CMD (Prof. A.W.O Olatinwo) and our foreign partners.

Remedies for Broken Hearts

There is no effective treatment for advanced stages of heart failure. Therefore, prevention remains the best strategic option. Definitive treatment for the late stages of the condition is cardiac transplantation but donors are not readily available because the heart is not a paired organ and the cost of the procedure is prohibiting. Many of the patients who require this surgery are on the waiting list or queue for a long time.

Effective Psychotherapy and Good Support to Those Undergoing Stress and Alternative Conflict Resolution

Patients with broken heart syndrome need psychosocial support in addition to avoiding stressful situations. Interventions

to reduce stress such as biofeedback, meditation, yoga, physical rehabilitation and exercise can be very helpful to some patients with this syndrome. Self-care strategies include reading self-help books and listening to podcasts. However, the main stay of therapy is the treatment of heart failure using ACEI, ARBs, Beta blockers, ARNI and SGLT2 inhibitors (Sattar, *et al*., 2020).

Control of Heart Failure risk factors

Effective control of Systemic Hypertension

Systemic hypertension remains the main driver of cardiovascular complications. Most of my research efforts have been on early diagnosis, management and complications of this condition.

Through a grant provided by Pharm Access Foundation (funded by the Health Insurance Fund (www.hifund.org) and supported by Kwara State Health Insurance programme, Health Insurance fund and Hygeia Community Health Care, Using a Markov model, the costs and cost-effectiveness of population-level hypertension screening and subsequent antihypertensive treatment for the population at-risk of cardiovascular disease (CVD) within the Kwara State Health Insurance programme was assessed. The results showed that hypertension screening may be cost-effective knowing fully well that cardiovascular disease prevention may not be affordable in many Sub-Saharan Africa settings within current government healthcare expenditures (Rosendaal, *et al*., 2016).

In another study by Kolo, *et al*., (2012d) hypertension-related medical admissions and outcomes in Abubakar Tafawa Balewa University Teaching Hospital, Bauchi, North Eastern Nigeria were assessed. Although, hypertension-related admissions were 23.7% of total admissions, there was an excess of mortality associated with Systemic Hypertension (SH) complications (42.9%). Stroke was the commonest, and it accounted for 44.4% of cases. Stroke had the highest mortality

(39.3%), followed by chronic kidney disease (36.6%); hypertensive emergencies (30.9%) and hypertensive heart failure had the lowest intra-hospital mortality (27.5%). SH-related cases were common among medical admissions in Bauchi Nigeria and were associated with high mortality. Community interventions that promote early diagnosis and reduction of cardiovascular risk profiles are urgently needed to reduce SH related deaths.

Similarly, for the first time among Black Africans living in Africa, we established the efficacy of Newer versus Older Antihypertensive Agents in African Hypertensive Patients (NOAAH) trial, which was a multi-national study involving six African countries; sponsored by University of Kinshasa and directed by Study Coordination Center, Catholic University of Leuven, Belgium. The study found that the combination of newer drugs (Amlopidipine/Valsartan) was more effective in reducing systolic blood pressure than combination of older drugs (Bisoprolol/hydrochlorothiazide) and therefore controlled hypertension better in native black African patients (M'Buyamba-Kabangu, *et al*., 2013, p.729; Osakwe, *et al*., 2013, pp.174-180).

Hypertension complications study which was sponsored through the University of Ilorin Senate research grant of 2010 assessed relationship between retinopathy and renal complications among hypertensive patients. We found a strong correlation between these two conditions and concluded that the presence of a complication of systemic hypertension requires extensive screening for other complications of the disease (Omotoso, *et al*., 2016).

Offspring of Hypertensive Parents

Systemic hypertension remains the commonest cause of heart disease in Sub-Saharan Africa and studies have shown that the normotensive offspring of hypertensive parents have changes in the heart that may predict future hypertension and

cardiovascular complications. I have studied the offspring of parents with systemic hypertension and the result of the study was presented at the World Congress of Cardiology in UAE in 2012. The abstract was also selected for the world press conference on hypertension during the meeting where colleagues from USA, India, Taiwan and Iran were involved in the briefing about this disease. The study showed that offspring of hypertension parents have increased left ventricular wall thickness, mass and subtle alterations in left ventricular diastolic function. The study clearly showed that normotensive offspring of hypertensive parents have changes in their left ventricles which may be surrogates for future hypertension and cardiovascular events. Therefore, this group of individuals requires early lifestyle interventions to promote normal body weight, stop cigarette smoking, increase exercises, moderation of alcohol intake and appropriate diet (Kolo, *et al*., 2012a; Kolo, 2012e).

Diabetes Mellitus

Diabetes mellitus is one of the major cardiovascular risk factors. The presence of this condition amplifies the risk of early morbidity and premature death. Many of the patients with type 2 diabetes develop cardiovascular events such as stroke, heart failure, kidney failure, and peripheral vascular disease and eye complications especially if their blood glucose is poorly controlled. We assessed left ventricular function of 150 normotensive type 2 diabetic patients with 150 age and sex-matched controls using echocardiography. The results showed that patients had higher left ventricular mass compared with controls and 72% had diastolic dysfunction as against 6% in the controls. Diabetes mellitus is also a major risk factor for coronary artery disease. We recommended low cost care as means of achieving quality outcomes in type 2 diabetes mellitus (Aigbe, *et al*., 2012, pp.84-90; Okoro, *et al*., 2009).

Furthermore, we have also assessed mobile phone ownership among our diabetic patients. One hundred and thirty eligible diabetic patients were studied and 68.5% had Mobile Phones with active lines. The results indicate that over two thirds of those with diabetes attending the clinic had active Mobile Phone lines and this could be used as an adjunct to or replace street address as a contact particularly between patients and their professional care givers (Okoro, *et al*., 2010, pp.183-186).

Body Image Preferences, Obesity and Heart Diseases

Obesity is accumulation of excess body fat which is defined by World Health Organisation (WHO) using body mass index ≥30kg/m2. However, this does not reflect the distribution of fat in the body leading to its limitation in this regards. Other methods of assessment of distribution of fat in the body include waist circumference, waist-hip ratio and abdominal ultrasound to assess the visceral adipose tissue (VAT) especially nonalcoholic fatty liver. According to WHO, 2016, more than 1.9 billion adults were overweight (39% of the population) and over 650 million (13% of population) were obese. Many factors including genetic, lifestyle and excessive food consumption with poor physical activity could modulate the expression of obesity in an individual. It is linked with metabolic abnormalities resulting in constellation of conditions which include insulin resistance, endothelial dysfunction, impaired glucose tolerance, dyslipidaemia and systemic hypertension. Obesity is an independent risk factor for cardiovascular death (WHO Fact Sheet, 2016).

In many African societies, excess body weight is considered as a sign of good health, economic prosperity and good living. Therefore, many individuals who are obese would not be motivated to lose weight. In some communities women are sent to fattening houses as a prelude to their weddings. In a study of some Yoruba communities Ilorin by Okoro, *et al*., (2014, pp.77-88) the residents were asked to choose from a list of graduated images for men and women to match their present weight and the one they would like to be. They were also required to choose the best image that they liked in a man or woman (figure 9). The result showed that the preferred body figure in this study was much larger than those reported for Americans of African descent. Sixty four percent of the participants preferred a body figure for themselves that was in the range with visible fat (image 5 and above). The study raises the possibility that a perception of body image and attractiveness exists in this cohort that may discourage weight reduction behavior.

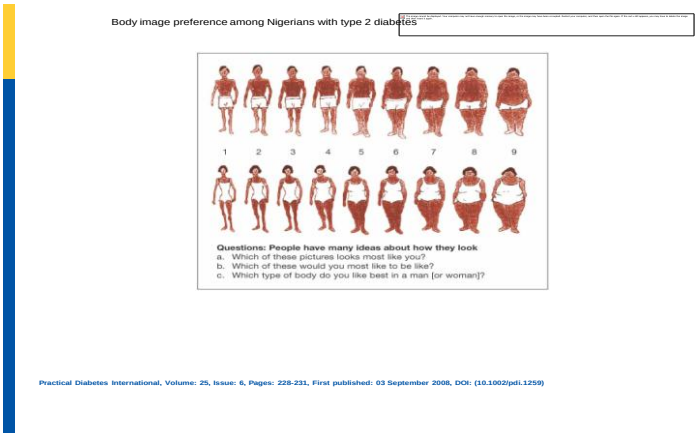


Figure 9: Body image preferences among Yoruba in Ilorin (Okoro, *et al*., 2014, pp.77-88).

Rheumatic Valvular Heart Disease

Rheumatic heart disease is non-suppurative complication of rheumatic fever which results from immune cross reactivity of antibodies against beta haemolytic streptococci with some specific tissues in the body such as the skin, synovial joints, central nervous system and the heart. In a study by Kolo *et al*, (2009a, pp.18-23) on rheumatic valvular lesions as seen at echocardiography, 7.0% of patients assessed over three years had various types of lesions affecting heart valves. The commonest the most frequent being regurgitation. Some of the patients had surgical interventions within and outside the country for the valvular heart disease.

Congenital Heart Disease

Congenital heart diseases (CHD) are structural heart diseases that are present at birth which means the baby is born with the condition. In a review of echocardiography done at Ilorin over a three year period, CHD accounted for 7.3% of cases seen. The commonest lesion diagnosed at echocardiography was ventricular septal defect (hole in the heart) which accounted for 27.6% followed by atrial septal defects in 21.1%, patent ductus arteriosus (13.1%) and tetralogy of fallot (11.8%). It should be noted that majority of patients with CHD now live up to adult life because of availability of corrective surgery at affordable prices. On the contrary, most patients in our environment are diagnosed late because of lack of facility for open heart surgery. There is also lack of financial wherewithal by most patients to undergo surgery which is really expensive for most patients. In advanced stages, they may come to the hospital with symptoms of heart failure and severe pulmonary hypertension which are contraindications for surgical intervention due to high mortality associated with the condition (Kolo, *et al*., 2012b, pp.230-234).

Coronary Artery Disease

Coronary Artery Disease (CAD) is an obstructive coronary lesion which results from atherosclerosis of epicardial coronary artery leading to myocardial infarction and it is one of the main causes of CHF. In early 1960s and 1970s, CAD was thought not to be a disease of black Africans because of its rarity. However, with gradual changes in diet of native Africans to the pattern of Caucasians and sedentary lifestyles we have witnessed a gradual worsening of metabolic risk factors and rise in cases of CAD. Opadijo *et al*., (1998, pp.49-50) saw only ten cases of MI at the University of Ilorin Teaching Hospital (UITH) between 1984 and 1994, an average of a case per year. However, Kolo *et al*., (2013, pp.5-8) reviewed MI cases among medical admissions in the same hospital where we saw 14 cases over a three year period (between 2006 and 2009). The incidence had therefore increased from 0.075% to 0.21%. Risk factors identified in the patients included systemic hypertension, obesity, dyslipidaemia, cigarette smoking and diabetes mellitus. Similar trends were reported by colleagues from other parts of Nigeria. It is worthy of note that among the 14 patients managed for this condition at UITH, only one of them had opportunity for coronary angiography and open heart surgery (CABG) which is the definitive treatment. He had coronary angiography which showed severe disease and coronary artery bypass graft surgery was done at a hospital in New Castle, United Kingdom. This study revealed that although the incidence of coronary artery disease was increasing, the facilities for diagnosis and treatment are lagging far behind. Therefore, community intervention through health education on dietary choices and the need for regular exercises are important. In response to above findings from the hospital-based study, I and my colleagues conducted another study in Ilorin on the awareness of heart attack

symptoms and signs. We also enquired from the participants what they would do if they suspected somebody to be having a heart attack. The result of this study was presented at the World Congress of Cardiology and I won Early Career Investigation Award given by World Heart Federation in 2014 in Melbourne, Australia. The presentation generated a lot of interesting discussions especially on the fact that although many developed countries have been able to reduce percutaneous coronary intervention (PCI) door-to-balloon time to less than 90 minutes after acute myocardial infarction but most regions have not been able to reduce event-hospital presentation time which negatively affects the outcome of this condition. This is because time is of the essence for good clinical outcome (Kolo, *et al*., 2015, pp.95-100).

Contributions to Manpower Development in Nigeria and Globally

1. I have participated in the training of Medical Students at the University of Ilorin between 2005 and to date. Similarly, I had also participated in the training of Medical Students at Bowen University as a visiting lecturer in Cardiology between 2017-2020
2. I have co-supervised the training of 11 Fellows in Core Cardiology: Nine of them are currently working in Nigeria (Drs. J. Alfa, I. F Aigbe, J. A. Ogunmodede, M. Gbadamosi, H. A. Bello, B. F. Dele-Ojo, I. Yusuf, Dr. Salawu) and three are working in United Kingdom (Dr. O.R. Awodun, Dr. W. Yusuf and Dr. O.A. Adeyemi).
3. I have co-supervised Senior Registrars in other sub-specialties like Anaesthesia (Dr. Adedapo A. M.) and Family Medicine (Dr. O. Semilore).
4. I am currently co-supervising seven Senior Registrars in Cardiology (Drs. O. G. Adeoye, R. Adefila, T. Farayola, M. Jimoh, J. Lawal, S. Ahmadu, S. Orugun) and one in Neurology (Dr. Sanyaolu)

5. I have served as an External Examiner to the Final MB;BS Examination of Ladoke Akintola University of Technology, Ogbomoso 2010, Igbinedion University, Okada Edo State 2011, Usmanu Danfodio University, Sokoto 2019, Afe Babalola University, Ado-Ekiti, 2021.
6. I am an Assessor to a number of universities in Nigeria for promotion or appointment to the professorial cadre.

Community Service

My Vice-Chancellor, sir, some of my major community services include:

University of Ilorin Assignments

1. Senate Representative, Board of University of Ilorin Press (2023 to date)
2. Chairman, Computer Based Test Center (2020 to date)
3. Head of Department of Medicine (2019-2022)
4. Coordinator, Medical Education Resources Unit (2014 to 2016)
5. Departmental Examination Coordinator (2006-2009)

University of Ilorin Teaching Hospital

1. Member, Standard Operating Procedures (SOP) Committee (2021-2022)
2. Head of Department of Medicine UITH, Ilorin (2019-2022)
3. Member, Ethics and Research Committee, UITH (2020-2022)
4. Residency Coordinator Department of Medicine (2016-2019)
5. Member, University of Ilorin Teaching Hospital Open Heart Surgery (2014-date)
6. Member, service watch, University of Ilorin Teaching Hospital, 2010-2014
7. Chief Resident of the Department of Medicine (2003-2004)

National Assignments

1. Associate Editor, Nigerian Postgraduate Medical Journal (2022-date)

2. Member, Publication Crew of the Newsletter of the Faculty of Internal Medicine, National Postgraduate Medical College of Nigeria (2019-date)
3. Assistant Secretary, Nigerian Hypertension Society (2017-date)
4. Member, Faculty Board of Internal Medicine, National Postgraduate Medical College of Nigeria (2015-2019)
5. Examiner Part 1 and Part 2, Fellowship Examination of the National Postgraduate Medical College of Nigeria (2010-Date)
6. Member on various Accreditation Teams to many training institutions in Nigeria on behalf of National Postgraduate Medical College of Nigeria (2012-date)

Other Community Services

1. Chieftaincy title by Etsu Tsaragi as Galadima Magani of Tsaragi (2022-date)
2. Representative of the Chapel on the Board of Governors of UMCATC, Ilorin (2018-date)
3. Member, UMCA University Implementation Committee (2018-date)
4. Secretary, Soko Wun Sun Cooperative Society (2000-date).

Conclusion

Heart failure has continued to be associated with very high morbidity and mortality; and recurrent re-hospitalisation rate with high cost of treatment. Interventions targeted at worsening cardiovascular risk factors should be intensified among Nigerians and Physicians delays in starting antihypertensive medications in patients with mild disease should be discouraged.

Recommendations

1. Systemic hypertension, obesity, diabetes mellitus and other non-communicable diseases should be declared a

public health emergencies with all efforts directed at community education on diet and lifestyle choices to prevent these conditions.

2. Pre-hypertension and mild elevation in blood pressure should not be ignored but treated properly after individuals' risks are fully assessed. Physicians inertial in treating hypertension should be discouraged for early medical intervention.
3. Medication adherence and persistence by patients with hypertension and other cardiovascular diseases should be encouraged. Patients should not abandon their medications for non-orthodox drugs such as Tiansi, bitter cola, snail water and GNLD drugs.
4. Offspring of hypertensive parents should be considered as a special group that needs early assessment, hypertension screening and monitoring for future cardiovascular events. They should be discouraged from cigarette smoking and ethanol abuse.
5. There is the need for government at all levels to join hands together and establish heart institutes in the 6 geopolitical zones of the country like in Philippines, India etc which will make open heart surgery available in Nigeria and take care of patients with structural heart diseases.
6. There is the need for the establishment of cardiac catheterization laboratory in major teachings hospitals in Nigeria to address cardiac diseases that are amenable through interventional procedures.
7. Manpower training and re-training to provide expertise in the field of cardiovascular medicine and cardiothoracic surgery is essential for regular open surgery.

8. Provision of defibrillators in public places to address cases of patients with cardiac arrests outside the hospital is essential.
9. Regular training of all hospital staff or other institutions to be able to offer first aid to patients with cardiac arrest
10. Government should provide legislative support to those who wish to donate their organs including the heart, if they are involved in conditions causing brain death.
11. Psychosocial supports should be encouraged among families especially in those who have had recent losses, such as loss of close relatives, business and domestic violence.

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I will like to thank and appreciate my teachers deeply for their roles in my life. I am indeed lucky to be mentored by Late Emeritus Prof. Mathew Akinyemi Araoye (the Oracle of Medicine himself) and Prof. A. B. O. Omotoso (Doctors must be all ears and eyes). Prof. A. B. O. Omotoso and his wife have not only been mentors to my family but my destiny helpers. They had the herculean task of convincing me to stay back in Ilorin after my Residency Programme. Thank you sir for reading this manuscript and offering very useful suggestions at every stage. I will also like to thank my teacher, Prof. O. G. Opadijo who did not only give his office to me but I inherited all his patients in Ilorin. Thank you for your help and support all the times. I also place on record the role Prof. I. A. Katibi played in my training as a Cardiologist. I want to specially appreciate my teachers, Sir (Dr.) Ademola Aderibigbe and Prof. E. O. Okoro for their special interest in me and my family. May the good Lord bless you immensely. My other teachers and trainers in Medicine include: Prof. Y. M. Fakunle, Prof. B. J. Bojuwoye, Prof. P. O. Oluboyo, Prof. A. Chijioke, Prof. A. K. Salami, Prof. M. O. Balogun (O.A.U Ile-Ife), Prof. A. Akintomide (O.A.U Ile-Ife) and Prof. R. A. Adebayo (O.A.U Ile-Ife) are well appreciated. Special thank you goes to a very good friend of Cardiology Unit: Prof. W. B. R. Johnson. I will also like to appreciate the following medical elders for their advice and support; Prof. S. B. Agaja, Prof. Ayodele Soladoye, Prof. A. B. Okesina, Prof. A. P. Aboyeji, Prof. T. M. Akande, Prof. A. A. Fawole, Prof. O. R Balogun, Prof. Ayodele Ojuawo, Prof. O. A.

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