UNIVERSITY OF PORT HARCOURT

PREVENTIVE NEPHROLOGY: PANACEA TO AMELIORATING THE GRUESOME BURDEN OF KIDNEY FAILURE IN SUB-SAHARAN AFRICAN COUNTRIES.

An Inaugural lecture

By

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DEDICATION

This 150th University of Port Harcourt Inaugural lecture is dedicated to the sweet memories of my Maternal Grandmother Late Mrs EUGENIA JANE (ADA-AMADI) ALLEN WOKOMA (Nee Amadi) of Owerri.

AND

Her son (My foster father) Late PA SAMUEL ALLEN WOKOMA without whose vision, love, sacrifice, commitment and dedication this day may not have been. Their sweet memories shall continue to abide.

ACKNOWLEDGEMENTS

In the life journey of every man or woman from cradle unto death, there are inevitably numerous persons who contributed to the arduous journey one way or the other, either positively or negatively to the ultimate destination. Be it positive or negative such complex human influences contribute immensely to shaping of ones' character, moral development, orientation, interpersonal conduct and the overall attainments of the individual. These influences include, parents, guardians, relations, teachers, religious leaders, friends, work colleagues, communal and other sundry other persons. A day like this provides the unique opportunity to profoundly acknowledge and appreciate all those whose lives had affected and influenced me in immeasurable ways. They include:

Biologic Parents:
Let me acknowledge with immense gratitude my biologic parents His Royal Highness, Late Kabiyesi Sanni (God made) Ashade, Oba of Ogba, Agege Lagos and my mother late Mrs Vidah Ashade (nee Allen Wokoma) for the conception, safe and uncomplicated birth and subsequent early parental care. Without you there wouldn't have been me. Let me also pay special gratitude to my father for permitting my maternal grandmother to take me with her in those early formative years and for seeing my elder brother through life to eventually ascend the throne he left behind.

My Maternal Grand mother
Late **Mrs Eugenia (Jane) Allen Wokoma** (nee Amadi) a woman of immense attributes, sterling and stoic qualities. First daughter of Chief Amadi of the **Umuoronjo s**ection of the ruling **Njemanze** Royal family of Owerri. She travelled all the way from Owerri in the early fifties to Lagos, just to collect her beloved grandson, leaving my elder brother with my father. The reason for this fateful trip have not been explained to me till date. She doted me so much. I was her "hand bag" every where she went. Before she died, she handed me over to her first son (my mother's immediate junior brother) to foster as his son, which he did till he died in 1995.

Such subservient obedience to a mother is very uncommon days. That singular act of hers charted the course of the rest of my life story. Her sweet memories shall continue to abide forever.

My Maternal Uncle and Foster Father

Late PA SAMUEL ALLEN WOKOMA - a quintessential near perfect gentleman, loving and very caring father who provided support for his siblings, their children, his own children and several other men and women in his father and mother's families. A believer in human development rather material things. In strict obedience to the instructions of his mother he nutured me as his first son (when he had four of his own sons and two daughters) from primary school to University. Similar accolades go to his very loving and darling wife, **Late Mrs Grace (Omaka) S.A. Wokoma.** Another woman of indomitable spirit and strength of character who, like her husband treated me as her son till she died in 2002.

My immediate Family.

Very special appreciation to my beloved wife, **Mrs Francisca Erebi Wokoma (**Nee Ifidi) who have been of immense support and understanding over these 30 years of marriage. Your level headedness and tolerance have helped in no small measure to create the conduce family ambience to enable academic work and professional medical responsibilities over the years. To my children **Engr Igbigisin, Ms Adaba** (Biochemist) and Master **Ibinabo** (Student) many thanks for helping to create conducive family.

Relatives.

With deep sense of gratitude acknowledgement to my brothers, sisters, cousins, nephews, etc for their unflinching support and understanding over the years. Growing up with one another have been a great and wonderful time, full of joy and happiness. There have been no dull moments. Pastor Augustine Wokoma, Barrister Alabo Wokoma, Prince Batubo Wokoma , Engr Karibo Wokoma, Mrs Augusta Obi(nee Wokoma), Mrs Waloloari Mowoe (Nee Wokoma), Bishop Dagogo Wokoma, Mrs Samba Nnamdi (nee Wokoma) , Barrister(Mrs) Ngowari Elewa-Ikpaku (Nee Wokoma),

Ms Amieibi Wokoma, Mrs Inere Smart (nee Wokoma) Ms Batuboba Wokoma, Ms Amieibi Wokoma, Ms Diekiri Wokoma, Mr Reece Uche, Ms Ureh Amadi, Prince Kehinde Ashade, Prince Tunde Ashade, Prince Sulaimon Ashade, etc, their wives, husbands and children too numerous to mention.

Members of Princess Kala-Oruba Wokoma (nee Kariboye-Batubo) Household

Gratitude to the great forebears of the household now represented by the current Head of the family Chief Norman Omuboye Wokoma (Bessy the 1st), Chief (Engr) Ibinabo Wokoma: (Bibi the 1st) Chief Hamilton Wokoma, Elder Sogbeye Benibo and several others.

Same Gratitude is extended to the Chiefs and elders of Late Chief Charles Benibo Wokoma (Kuruye-Alele-1st) of the Wokoma War canoe house in the Horsfall group of houses, represented by our most revered Paramount head, **Chief (Dr) Charles I. T. Wokoma (Kuruye-Alele-4th**) retired foremost Obstetrician and Gynaecologist in Rivers State.

My In-Laws:

Let me very specially appreciate my late Father in-Law, Pa Reuben Ifidi of Opokuma**,** Bayelsa state, for being such a wonderful father in-law and to all his children represented by Mrs Victoria Denenu (nee Ifidi) and Mr Morrison Ifidi.

My teachers, academic and professional mentors

Teachers at all levels remain the indelible guiding compass for their students and must be revered. In accordance with the 2nd clause of the **Physician (Hippocratic) Oath**, **"I will give to all my teachers the respect and gratitude that is their due"** . My gratitude go to all my teachers at every level of my educational attainments from primary school to University and beyond.

Primary school teachers represented by the late Mr AFE Wokoma (a great mentor) and late Mr Bassey (Head master) of blessed memory.

My secondary school teachers, represented by Late Mr Amagboruju (Principal) Late Mr Iche Akarolo (Principal),Chief J J William-West, Dr S.Amachree, Prof. Maculay Lily**,** etc.

To my university teachers and professional mentors represented by Prof Tadros, Prof Atta, Prof O O Akinkugbe (Role model and mentor), Prof K A Harrison, Prof ND Briggs, Prof Lawrie, Prof AF Flemming, Prof Edington, Prof Ed, B Attah, Dr Katchy, Prof Idris Mohamed, Prof Fakunle, Prof Yakubu, etc, all of ABU, Zaria.

Late Chief Dr A A Ibiama (my Oga), Chief Dr O R Long John, Dr C T Wari-Toby, Dr. T. Tuburu, Dr Kue, etc under whom I did my housemanship at the General hospital Port Harcourt. Prof C.O Anah (Father of Internal medicine, and a great mentor), Late Prof T I Francis, Dr Ene, Prof OJ Odia, Prof A Ihekawaba, Prof AC Onwuchekwa, Prof F. Eke, Prof K. Nkangineme, Prof R. Oruamabo, Dr Benny Iko, etc Late Prof Elechi, Prof Adotey (Residency years UPTH). Prof Onadeko, Late Dr Iyun, Late Prof Osuntokun, Prof Kadiri, Prof Wale Akinsola (Ife), Prof Akinkugbe, (Residency years, UCH) etc. **To have been taught, coached and guided by these great teachers, icons, professional and academic giants and role models is indeed an immeasurable privilege**.

Contemporaries and junior colleagues

My gratitude also go to my contemporaries and junior colleagues in department of medicines and the rest of UPTH.

My Co-pioneer Residents in medicine (1984-1990), Dr AG Briggs and Late Prof. Doris Uchenna. We started Residency training in the formative years of the department of medicine UPTH, when there was no structured Residency training program in the hospital, and virtually no sophisticated diagnostic facilities, yet we were able to complete residency training in record time. Others include Dr. M. Akpa, Prof. S. Chineye, Prof. C. Unachuku, Dr. H. I, BellGam, Dr. R. Oko-Jaja, Dr. Emem-Chioma, Dr. D. D. Alasia, Dr. D. Altraide, Dr. I.S.Wokoma, Dr. Eze Nwafor, Dr. Otike-Odibi, Dr. S. Ofori, Dr. Dodoiyi-Manuel, Dr. Iyagba, Dr. C.Alikor, Dr Obaze Dr. Korubo and Dr K. Akhide, all of the department of medicine with whom I have interacted closely and continues to interact in the process of academic and professional activities, teaching ,research and learning from one another.

UPTH management

In my brief sojourn in the administration and management of UPTH, as head of Department of Medicine, head of Renal /haemodialysis and the CMAC(2001-2006) , I have had to be guided and mentored by great medical administrators such as, Chief DR O R LongJohn, Late Chief (Dr) E D O Mangete and Dr U S Etawo respectively.

I shall ever remain grateful to them for the opportunity I was given to serve the hospital and humanity at that critical period in the historical trajectory of UPTH. This include the development of the first Haemodialysis unit, the development of the Permanent site of the hospital, the final movement of the hospital from the temporary site to the present permanent site, as well as the planning and implementation of Federal Government VAMED hospital equipment program, which for the first time saw to the installation of sophisticated HI-tech diagnostic and therapeutic equipment in UPTH. These were the glorious years of UPTH.

General and Nephrology nurses in UPTH who worked with me at different times

I was privileged to have worked and interacted with some of the best in the Nursing profession. These were very professional nurses who treated their patients with **tender loving care** as pioneered by Florence Nightingale (The lady with the lamp) of blessed memory. They include: Late Mrs Beredugo (ADNS Rtd), Late Mrs Iyalla (ADNS- Rtd), Mrs Diri (ADNS Rtd), Mrs E.Weke (ADNS-Rtd), Mrs Nwandu (CNO-Medicine- Rtd), Miss W. William-West (CNO Rtd), Mrs Brown-West(CNO-Rtd), Mrs Aroh (CNO Rtd), Mrs AJ Fiberesima (CNO-Rtd,: Pioneer head nurse -Haemodialysis), Mrs W. Eneyo-CNO, Mrs Chinda-CNO, Mrs Odidi-CNO, and Mrs G.Wariboko-CNO all pioneer Nurses of the haemodialysis unit.

The memories of their hard work and dedication to duty shall remain indelible in my mind.

Hospital administrators in UPTH

I had the privilege of working with these crop of seasoned hospital administrators either as head of department, head of Haemodialysis unit or as CMAC respectively.

They include Ambassador Aworrhabi (DA-rtd), Mrs Odijie (ADA - Admin Rtd.), Mrs B. Amaomu-Jumbo (DA Rtd and friend) ,Late Chief F T Abbey(former DA and friend), Mrs F Osiegbu (ADA-CS&T, Rtd) Mr G Atieme (ADA-Admin, Rtd and mentor), Mrs B Bello-Osagie (ADA-Amin, Rtd), Mrs J.Obianime (ADA-CS & T Rtd and friend), Mr Paul Okpalo (Director of Finance),Chief A. Jama (Chief Conf. Secretary to CMD), Mrs Jackson(Chief confidential Secretary to CMAC), Mr Kalio, Maria, Ebi, Nelson, etc and a host other.

Professional colleagues outside the academia

In the course of professional and academic endeavours , one have had to interact with a host of colleagues outside the academic environment from whom I have learnt a great deal about **the town** based professional practice. The **town and the gown** must always relate for societal progress. They include Dr Peter Odili (former Governor of Rivers State),proprietor of Pamo clinics and Pamo University of Medical Sciences, Dr C. Amanze, Dr Nzenwa, Dr Steve Ekwelibe, Dr & Mrs George, Dr Phil Ukaegbu, etc. Very disciplined and conscientious private medical practitioners.

ORDER OF PROCEEDINGS

2.45P.M. GUESTS ARE SEATED

3.00P.M. ACADEMIC PROCESSION BEGINS

The procession shall enter the Ebitimi Banigo Auditorium, University Park, and the Congregation shall stand as the procession enters the hall in the following order:

ACADEMIC OFFICER
PROFESSORS
DEANS OF FACULTIES/SCHOOLS
DEAN, SCHOOL OF GRADUATE STUDIES
PROVOST, COLLEGE OF HEALTH SCIENCES
LECTURER
REGISTRAR
DEPUTY VICE-CHANCELLOR [ACADEMIC]
DEPUTY VICE-CHANCELLOR [ADMINISTRATION]
VICE CHANCELLOR

After the Vice-Chancellor has ascended the dais, the congregation shall remain standing for the University of Port Harcourt Anthem. The congregation shall thereafter resume their seats.

THE VICE-CHANCELLOR'S OPENING REMARKS.

The Registrar shall rise, cap and invite the Vice-Chancellor to make the opening Remarks.

THE VICE-CHANCELLOR SHALL THEN RISE, CAP AND MAKE HIS OPENING REMARKS AND RESUME HIS SEAT.

THE INAUGURAL LECTURE

The Registrar shall rise, cap, invite the Vice-Chancellor to make his opening remarks and introduce the Lecturer.

The Lecturer shall remain standing during the Introduction. The Lecturer shall step on the rostrum, cap and deliver her Inaugural Lecture. After the lectures, she shall step towards the Vice-Chancellor, cap and deliver a copy of the Inaugural Lecture to the Vice-Chancellor and resume her seat. The Vice-Chancellor shall present the document to the Registrar.

CLOSING

The Registrar shall rise, cap and invite the Vice-Chancellor to make his Closing Remarks.

THE VICE-CHANCELLOR'S CLOSING REMARKS.

The Vice-Chancellor shall then rise, cap and make his Closing Remarks. The Congregation shall rise for the University of Port Harcourt Anthem and remain standing as the Academic [Honour] Procession retreats in the following order:

VICE CHANCELLOR
DEPUTY VICE-CHANCELLOR [ADMINISTRATION]
DEPUTY VICE-CHANCELLOR [ACADEMIC]
REGISTRAR
LECTURER
PROVOST, COLLEGE OF HEALTH SCIENCES
DEAN, SCHOOL OF GRADUATE STUDIES
DEANS OF FACULTIES/SCHOOLS
PROFESSORS
ACADEMIC OFFICER

PROTOCOLS.

- The Vice-Chancellor
- Previous Vice-Chancellors
- Deputy Vice-Chancellors (Admin and Academic)
- Previous Deputy Vice-Chancellors
- Members of the Governing Council
- Principal Officers of the University
- Provost, College of Health Sciences
- Dean, Graduate School
- Deans of Faculties
- Heads of Departments
- Distinguished Professors
- Directors of Institutes and Units
- Visiting Academics and Colleagues
- Esteemed Administrative Staff
- Captains of Industries
- Cherished Friends and Guests
- Unique Students of UNIPORT
- Members of the Press
- Distinguished Ladies and Gentlemen.

LECTURE OUTLINE

LECTURE

SECTION 1

Introduction:

Kidney failure is a global health burden, with Chronic kidney disease (CKD) as its harbinger. **Chronic kidney disease (CKD)** which is the precursor of **End Stage Kidney Disease (ESRD)** or kidney failure, affects over 500million persons globally. About **2.5million** persons globally suffer from kidney failure (ESRD), with **1.8million on dialysis** and over **500,000** persons living with kidney transplant [**1]** There is a steady global rise in the incidence and prevalence of kidney failure and a significant proportion of these are in the sub-Saharan African (SSA) countries. Whereas the global population grows at about is 2-3% per year, the global population growth rate of kidney failure is about 6-7% per year [**2**]. Apart from the enormous burden of human suffering associated with kidney failure, the infrastructural, human resource and huge financial cost of care pose serious challenge to even the developed countries of the world, with all the facilities for optimal care. In resource poor SSA countries , which lack the infrastructure, human resource and financial and social security support for care, kidney failure is a tale of misery characterized by gross sub optimal care and almost 100% case- fatality within the first year of diagnosis. ***For the people in SSA countries Kidney failure is almost synonymous with a death sentence***. A brief examination of the geopolitical economy of the SSA region would be necessary to lay a background for further discourse.

The Sub-Saharan African region

The sub –Saharan Africa region (**Fig. 1; table 1.1**) comprises 50 sovereign African states of about **800million** people of diverse ethno linguistic groups occupying an area of about **24 million square kilometres**. It is bounded by the Sahara desert in the north, the Indian ocean in the east, the Atlantic ocean both in the south and the west [**3**].

The region is geographically sub divided into the West, Central, East and southern African sub-regions. Some of the demographic and socioeconomic characteristics of the region is summarized in table1. The population is dominantly of the **negroid African race or African blacks**, with the exception of few migrant Arab, white and Indian settler populations in parts of the region, hence the region is often described by early writers as the **land of the blacks**.

The climate and vegetation of the region run from the **semi-arid Sahel**, in the immediate sub Saharan parts, through the **Guinea Savannah, sub- tropical and tropical rain forests** characterized by heavy rains during most part of the year, and eventually dovetails into a relatively small **temperate climate** at the tip of the continent in the most southern part of southern Africa. The SSA region is highly populated with an average population of about **800million people** (2007) with a projected population of **1.5billion by 2050** according to the to the united nations projection of 2008.

Over 40% of the population is younger than 15years [**4**]. The SSA region is thus a predominantly young population with a high dependency ratio. Ironically, in spite of the large landmass, the large population, highly fertile land and huge mineral resource the area is characterized by some of the lowest human developmental indices in the world. With the exception of a few countries like South Africa, the area is characterized by high poverty rate, low literacy rate, low gross domestic product (GDP) per capita, high rate of unemployment, and low life expectancy rates [**5**]. Table-2 shows the human development characteristics of some sub-Saharan African countries as compared with developed and emerging countries of the world such as Singapore and Somalia.

The health system and infrastructure for health is weak, characterized by low budgetary provisions for health, inadequate health infrastructure and poor human resource for health which are skewed in favour of urban centers to the detriment of the rural communities where over 70 % of the regions' population resides. Access to health is grossly limited by unavailability, poverty, illiteracy, superstition, religious beliefs, difficult terrains, and lack of social security for health. **There is over dependence on donor funds from overseas donor agencies for provision of health**

services. ***Some special health conditions like Malaria, HIV/AIDS, Tuberculosis and polio control are almost 100% donor driven (6).*** Corruption and misappropriation of funds for health services is common across the region.

The poor socio-economic situation in the region is mostly attributable to poor political leadership, and political instability, characterized by social instability, strife's, intertribal conflicts and civil wars in some cases. The impact of these on the health status of SAA countries has been enormous. Health indices in the region are one of the worst in the world, characterized by high maternal mortality rates (IMR), and infant mortality rates (IMR). High under-five mortality rates (U5MR) and high prevalence of endemic communicable diseases such as malaria, tuberculosis, schistosomiasis, onchoceriasis, etc. [**7, 8, 9**]. The SSA countries have the highest prevalence of HIV/AIDS and the highest mortality rates from HIV/AIDS globally. In 2011, SSA region was home to 69% of the 33 million people living with HIV/AIDS worldwide. The highest new infection rates occur in SSA countries and about 25.5million persons are living with HIV/AIDS in SSA countries, with about 1millon deaths per year [**10**].

While the communicable diseases (CD's) still hold sway in SSA countries there is the paradoxical emergence and increasing incidence and prevalence of **non-communicable diseases (NCD's).**This have been attributed to increasing urbanization (**urban–rural migration**) associated with increasing life expectancy, increased consumption of refined carbohydrate, reduced exercise and increasing sedentary occupations, smoking and the stress of urban living. These urban lifestyle characteristics promote overweight, obesity and increased insulin resistance, the metabolic syndrome, hypertension, diabetes, and other cardiovascular morbidities such coronary artery syndrome, strokes and kidney failure[**11,12**].

WHO estimates that non-communicable diseases (NCD) cause an estimated 35million deaths globally, with over 80 percent occurring in the middle and low income countries such as the SSA countries. WHO projects that NCD deaths will increase by 17% in the next ten years with the greatest increase in the Africa region. For

this reason the WHO have developed a "**2008-2013 action plan"** for the global strategy for prevention and control of non communicable diseases.

The four commonest NCD's targeted for prevention and control are **Cardiovascular diseases**, **Diabetes, chronic respiratory diseases** and **cancers** all of which have potential for prevention and control. The cardiovascular diseases include hypertension and its complications, coronary artery disease, heart failure, strokes and kidney failure. Epidemiologic and clinical studies in several parts of SSA have shown that the incidence and prevalence of cardiovascular disorders and diabetes have been on the increase in recent years in SSA countries [**13, 14**].

One of the non-communicable diseases that is increasingly becoming a serious public health problem globally as well as in the SAA countries is **Kidney failure**. Kidney failure is the end point of chronic kidney disease (CKD) which starts in asymptomatic early grades 1-2, progressing to the serious grades 3-4, and culminating in grade 5 (**End stage Renal Disease-ESRD**), for which renal replacement therapy-RRT: (dialysis & kidney transplantation) is the only option for survival. There is serious global concern for the increasing burden of kidney failure especially in the developing countries. The global prevalence of chronic kidney disease is in the range of **10 to 16%** in most populations [**2, 15 - 17**]. A recent meta-analysis of CKD prevalence studies in the SSA countries [**18**] and about the most comprehensive evaluation of prevalence of chronic kidney disease (CKD) in the SSA region, showed a prevalence range from 2-30 % in most SSA countries, with a mean of **13.9%.** which is higher than 13% in the United states of America and about 11% in most European countries.[15-17]The population burden of CKD in SSA region is about **120 million.** Indeed a higher prevalence of CKD in SSA countries is expected given the persistence of communicable disease risk factors in addition to emerging NCD risk factors in most SSA countries.

Given an average 0.2 % population prevalence of **end stage kidney failure (ESRD)** in most populations[15-17] , it is estimated that about **1.6million** persons in SSA countries would have end stage kidney disease (ESRD), which is higher than

570,000 ESRD cases in the United States in 2012 with a population of about 300million people. Thus the burden of kidney failure in SSA countries is very high.

The public health importance and concern of rising burden of kidney failure in the SSA countries is predicated on the fact that care for the victims of kidney failure in SSA region is extremely challenging and grossly sub optimal. These challenges include deficits in high technology and infrastructures for care, human resource deficit for care, kidney donor deficits, deficits of requisite medicaments for care and of course the enormous financial requirement for care which are not within the reach of over great majority of victims including persons in the high socio-economic brackets within SSA countries.

Distinct from the developed countries' settings, with well entrenched social security systems for ESRD care (Medicare -ESRD, NHS-trust, etc) , most kidney failure victims in SSA countries have virtually no social security mechanisms to enable them access optimal care. This translates to very poor access to care, suboptimal care and worst outcomes. The resultant effect of all these is high case fatality rates of over 80% within the first year of diagnosis. [**19, 20**].

Given the above scenario, the need for SSA countries to explore the **preventive approach** as the primary strategy for the containment of the burden of kidney failure in the sub region cannot be over emphasized. ***Unfortunately there is currently no structured coordinated effort in most SSA countries for any preventive strategy for the containment of CKD/ESRD.***

Developed countries with optimal care for ESRD, such as Europe and North America, are not comfortable with the huge financial burden of care, which is increasing exponentially over the years, and the high demand on the health systems. They have embraced the need for preventive approach to reduce the burden of the disease through risk factor modification for at risk populations, as well as early detection and early intervention strategies. The ***Kidney disease early detection and prevention program (KEEP)*** is a CKD/ESRD preventive program instituted by the United states National Kidney Foundation (NKF) in response to the escalating

costs of ESRD care and the burden of human suffering. **[21**]. Some European countries and Japan have also adopted the KEEP strategy in their countries for the same purpose of containment of CKD/ESRD in their populations.

Reports for the outcomes of KEEP programs in some of these countries show declining trend in the incidence and prevalence of CKD/ESRD **[22**]. The KEEP program as currently designed and implemented is however most suited for the developed country settings. In developing countries such as the SSA countries, there are substantial differences in the epidemiology of CKD compared with developed countries.

These disparities make it imperative for SSA countries to adopt a modified approach in the preventive strategies for prevention and control of CKD/ESRD in their countries. ***This inaugural Lecture proposes a more a holistic, integrated and sustainable CKD/ESRD preventive program which addresses the peculiar needs of SSA region and other developing countries.***

This inaugural lecture shall lay the background to the gruesome burden of kidney failure globally and in the SSA region in the areas of epidemiology, causes, diagnosis, therapeutic strategies and the human and financial and the socioeconomic burden of care for kidney failure. This shall form the basis for the ***imperatives for prevention of kidney failure in SSA countries*** and espouse ***the strategies for the implementation of*** **proposed kidney failure prevention and control program -"the community preventive nephrology program"** that would be most suitable and sustainable for resource poor SSA countries.

Fig.1: Geopolitical map of the SSA region.

Table 1.1: Summary of Characteristics of sub-Saharan African region.

Characteristics	[illegible]
Land mass	[illegible] million square meters.
Geography & Climate	Arid sahel (North) Guinea savannah dominantly youthful population. Tropical rain forest (Middle) Temperate (south)
Population	[illegible]
Ann growth rate	[illegible]
Fertility rate	4/per woman.
Under 15years	[illegible] (dominantly youthful population)
Human development index	Low to Medium (0.47)
Life expectancy	51.8years.
Infant mortality rate.	145/1000 Live births.
Maternal mortality	≥800/1000 live births.
Malaria burden	400m/year (1m deaths/year in children).
HIV burden	[illegible] million (1m deaths/year)
NCD burden	[illegible] million deaths/year
GDP per capita	[illegible]
<2$/day	[illegible]
Health system	Weak. Low health budgets. Heavily Donor driven. Poor and inadequate health infrastructure. High import dependence on drugs/medicaments&equipments. Low and skewed health manpower distribution. Minimal health social security system. Poor health worker remuneration.

Arogundade et al AJKD,2008.

Table 1.2: HUMAN DEVELOPMENT STATISTICS: DEVELOPED COUNTRIES VS SSA COUNTRIES.

Country	Popl. (m)	Edu. Index.	Gdp/ Cap.	Pop.< $1.0(%)	Popl.< $2.0/d	Poverty .Index.	Life Expect.	HDI	SE-Status
USA	320	0.96	43,968	-	-		78.0	0.95	High
UK	63.1	0.93	32,654	-	-		79.2	0.94	High
Russia	142.8	0.93	13,205	<2	<2		65.2	0.8	High
China	1385	0.76	41,612	15.9	36.3		72.7	0.76	High
Japan	127	0.94	31,951				82.4	0.96	High
Malaysia	29.7	0.85	12,536	<2	7.8		73.9	0.82	High
Singapore		0.84	47,426	-	-		79.9	0.82	High
South Africa	52.8	0.84	9087	26.2	42.4		50.1	0.67	Mediu m
Nigeria	173.6	0.64	1852	*	*		46.6	0.49	Low
Ghana	25.9	0.61	1247	64.4	83.9		59.4	0.53	Low
Ethiopia		0.39	700	39	77.5		52.2	0.38	Low
Kenya									
Angola		0.53	4434	31	54.3		67.4	0.48	Low.

*NB: **Popl(m)** –Population in millions: **Popl.**-Population: **Edu indx.**-Educational index.: **Gdp/cap.**- Gross domestic product per capita. : **Pop%<$1**-Percentage population living below $1 per day: **Pop%<$2**)-perentage of population living below $2 per day.: **Pop. Indx.** - Populationa index. **Life Expect.**- Life Expectancy: **HDI**-Human development Index: **SE**-Status- Socio economic status.*

Section 2:
AN OVERVIEW OF THE KIDNEY IN HEALTH AND DISEASE

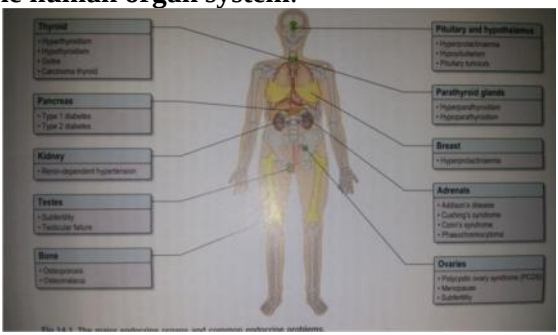
Brief overview of the human physiologic systems.

Although the debate between religious theologians (proponents of God's creation story) and the Darwinian evolutionary theory of the origin of the species, remain unsettled, the balance of evidence tend to tilt more in favour of the Darwinian evolutionists. It is however incontrovertible that the homo sapiens (representing the animal kingdom), remain the most complex, most sophisticated, and most efficient contraption among all living things and among all human inventions. Indeed no machines or organizations invented by man, is as complex, sophisticated and internally consistent as the human being. No computer, irrespective of the processing capacity, created by man is capable of processing information and responding the way

the brain and the human body does it. There is no factory articulated by man that is one percent as efficient as the human body.

The human body like other mammalian organisms is organized into interlinked and interdependent anatomic, physiologic, biochemical and metabolic systems that performs different functions but all geared towards the survival and preservation of the whole. These organ systems are illustrated in fig.2.1.below.

Fig.2.1: The human organ system.



Source: *Anne Ballinger ,Kumar and Clark. Essentials of Clinical Medicine. SAUNDERS 2011.*

They include:

1. **Nervous system** a highly complex weave of over 3billion neuronal cells and fibres that form the **brain**, the **spinal cord** and **the peripheral nerves**. The nervous system serves the functions of maintaining consciousness, complex mental, cognitive and intellectual activities, gross and fine motor movements. The system also sub- serve the special senses of smell, sight ,hearing and balance as well as the three sensory modalities of sensation of pain, touch & temperature, through which the human organism interacts with the external environment.

2. The **Cardiovascular system:** comprising the **heart, and the blood vessels**(arterial system, venous system, the capillary and lymphatic systems) ensure the distribution of blood and oxygen

to all metabolizing tissues in the body as well as the removal of metabolic wastes from their sites of production to sites of elimination.

3. The **Respiratory system**: comprising of the **oropharynx, the bronchi**, **lungs and the airways** ensure the intake of vital oxygen from the air and the elimination of noxious carbon dioxide from the body. Also the prevention of inhalation of particulate matter into the lungs.

4. The **Gastro-Intestinal system:** comprising the **oesophagus, stomach, pancreas, small and the large intestines**, sub serve the functions of ingestion of food and nutrients, digestion of the complex food into their basic nutritional components, assimilation of the needed basic nutrients and the elimination of the unwanted components of food as stool.

5. The **Liver and the biliary (Hepato-billiary) system: which comprise the Liver, Gall bladder and the bile channels** performs the complex role of further processing nutrients, transforming the nutrients and chemicals into safe products and most importantly the detoxification, through complex enzymatic processes, of any potentially toxic or injurious metabolic agent, (drugs or chemicals) and the subsequent elimination of such as bile through the biliary tree.

6. **The endocrine/metabolic system:** comprising a number of endocrine organs and tissues(the hypothalamus/limbic system, the pituitary, thyroid, parathyroid, the supra –renal glands (adrenals), the endocrine pancreas, and other paracrine tissues) sub serve the functions of producing certain peptides –hormones which play the vital role of regulating several metabolic and physiologic processes in the body .Some of such regulatory activities of the endocrine system include regulation of body temperature, regulation of body fluid balance, regulation of blood glucose, blood calcium &phosphate, regulation of the body reproduction system etc. Without these regulatory

mechanisms the entire metabolic synergy in the body will breakdown with consequent threat of life.

7. **The haematopoetic system** of the body comprise a system of blood cells namely **red blood cells, white blood cells, platelets and the, bone marrow system, and lymphatic systems.** While the red cells bear oxygen for release to metabolising tissue, the white blood cells (comprising the neutrophils, the lymphocytes, monocytes and basophils) all of which are involved in the process of innate host defence (**Immune system**) through the processes of direct elimination of threats and indirect elimination via **antibody and cell mediated immunity**. In this way the organism is protected from the threat of internal and external attacks.

8. **The Reproductive system or the genital system which** comprise the reproductive organs (**ovaries, uterus, vagina)** in females, (**testes, vas, prostate and the penis**) in males,) respectively. These are interconnected via the endocrine signaling system, ensure the perpetual survival of the species.

9. The **Musculo-skeletal system** which comprise of the **muscles, bones, ligaments and joints** enable the mammalian locomotion, posture and balance and the ability to engage in physical activities.

10. Finally the **Urinary system** comprising the **kidneys and the urinary system** (calyces, ureters, urinary bladder and the urethra) ensure the continuous elimination of unwanted soluble metabolic products from the body in the form of **urine**. The kidneys in addition, also performs several other functions in the body that ensure the maintenance of the internal milieu of the body.

Learning point

> ***These body physiologic systems are directly or indirectly linked with each other in very intricate ways through vascular, neuronal and hormonal pathways to perform individual and collective functions for the preservation and survival of the whole.***
>
> ***Serious dysfunction in one system or subsystem may have deleterious effect on the other which may affect overall well being or even death of the organism.***

Urinary System

The urinary system comprise the kidneys, the renal pelves, the ureters the urinary bladder and the urethra. It is the major excretory system of the human body and also responsible for the delicate functions of maintaining the internal metabolic balance and the elimination of excess body water and soluble by products of intermediary metabolism.

Embryogenesis (Development) of the Kidney and the urinary system

Following fertilization, the blastocyts stage and the development of the three germ layers (**endoderm, mesoderm**, **and the ectoderm**) of the embryo, the urinary and the genital systems begins to develop in about the **3rd week of gestation**, from in the intermediate **mesoderm,** a collection of cells at the back of the foetal abdominal cavity. During the process, the **pronephros** in the cervical region, the **mesonephros** in the intermediate zone and the **metanephros** in the pelvic region form the primitive kidney. The pronephros and the mesonephros subsequently regress and do not form part of the adult renal system [**23**]. The metanephros eventually evolve to form part of the adult kidneys by transforming to form the nephron and the tubules.

Invagination of the proximal end of the nephron (the ureteric bud) and capillary invasion of same lead to development of the **glomerulus.** The distal portion of the nephron sub didvide severally

to form the calyceal system. The tubule (ureter) empties into the **cloaca**, the later of which becomes saccular to form the urinary bladder which empties into the urethra [**24**].

The renal system become functional during the second half of the pregnancy. With full development within the pelvic region the kidneys ascend to their permanent position in the renal fossae, just below the diaphragm dragging the ureters and renal arteries along with them. These are illustrated in fig.3.

In the process of development and the ascendancy of the renal system, some developmental, structural and functional anomalies may occur affecting the kidneys, the collecting system, the ureters, blood vessels, the urinary bladder, etc constituting congenital anomalies, collectively termed, congenital abnormalities of the kidneys and the urinary tract **(CAKUT**).

Fig 2.2: Embryologic development of the kidney and the urinary system.

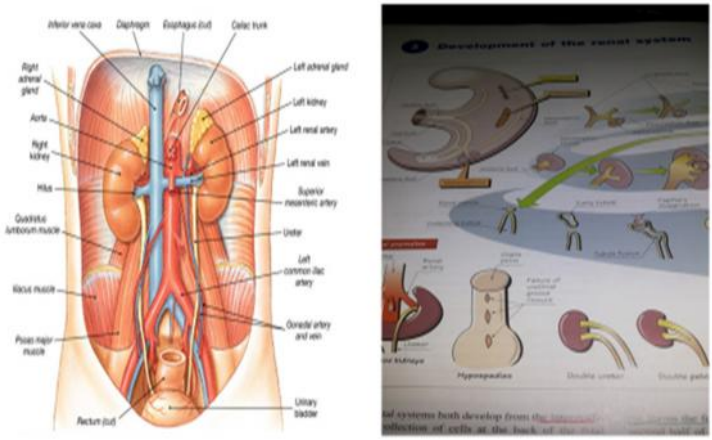


Fig.2.3 : The renal system at a glance.

Source:. Calaghan AO. The Renal system at a glance WILEY-BLACKWELL 3rd ed.2009.)

The kidney in health

Structure.

The kidneys are two bean shaped ox-blood coloured organs located in the posterior part of the abdomen in the lumber region in the retroperitoneal space. The median notch (hilum) of each kidney face medially and connected to the abdominal aorta and the Inferior vena cava on both sides through the renal arteries and veins. (**fig. 2.3**).

Each Kidney weighs about **150 grams**. The bipolar length is about 10-12cm while the width measure about 5-6 cm and a thickness of 2.5-3.5 cm .

The internal anatomy of the kidney is very complex but naked eye view of the saggital section of the kidney will show three contiguous layers the **capsule** (covering), the **cortex** and the **medulla**. Within the cortex and medulla are the compacted functional structures of the kidney comprising the **nephrons, (**the functional unit) the blood vessels, nerve endings, and connective tissues.

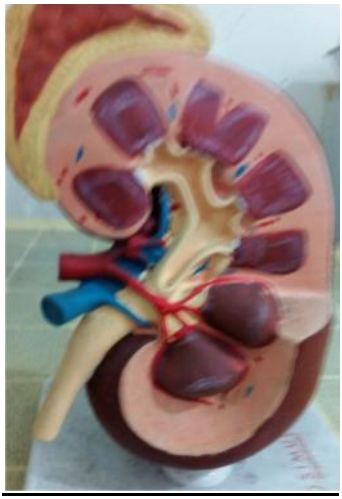
The **Nephron** (fig 2.4) a microscopic structure is the **functional unit** of the kidney. It is about 150um (micron meters) in length and comprise two main parts the Malpigian corpuscule (**Glomerulus)** and the long and tortuous **Tubule.** There about **one million nephrons** in each kidney. The glomerulus serve the function of a **filtration basket**, while the tubules perform the functions of transport and re-absorption of some filtered substances and secretion of other substances into the ultra filtrate which eventually becomes **urine** (water with dissolved unwanted solutes) that is excreted out of the body [**25**]. The glomeruli of two kidneys filters about **180 Liters** of plasma everyday into the tubules, while the tubules reabsorbs over 178 liters of the filtrate back into the blood leaving a balance of about **2Liters/day** which constitute **urine**. That is the extent of efficiency with which the kidneys ensure homeostatic balance in the body.

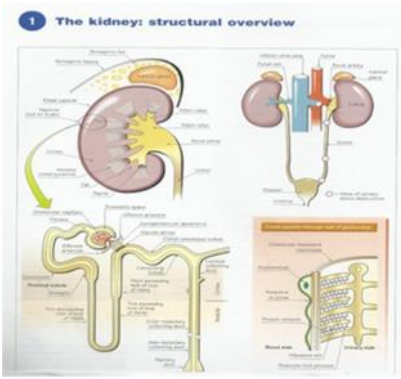
Microscopic anatomy of kidney in health and disease.

The panorama of kidney disorders shown above are the naked eye appearances of the diseased kidneys. Confirmation of the exact nature of most kidney diseases require detailed study of the light microscopic, electron microscopic, immune-histochemistry and immune fluorescence study of sample of diseased kidney obtained

via kidney biopsy. The tissue obtained is processed ,stained with appropriate stains and then examined under both ordinary microscope and electron microscope to obtain detailed microscopic appearance of the damaged kidney tissues. This give a detailed view of the glomeruli, the tubules, vessels and the kidney interstitium.

Fig-2.4: The Kidney: Gross anatomic structure(model).





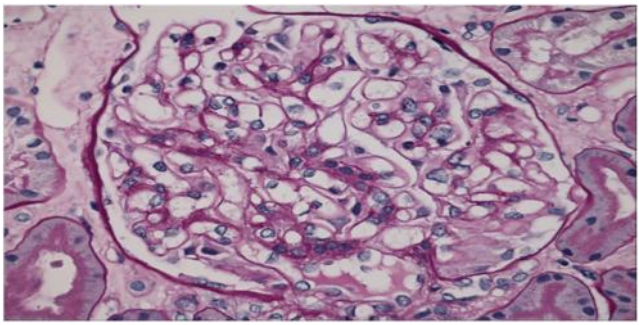
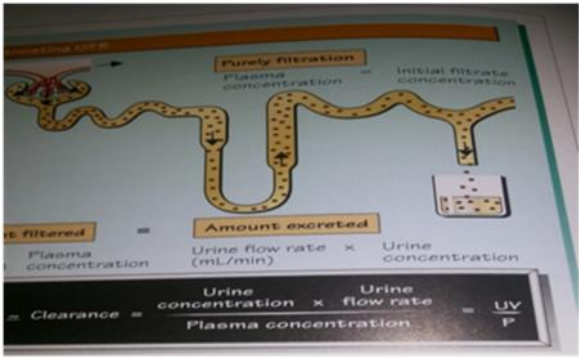


Fig.2.6: Microscopic appearance of the kidney (Glomerulus and the tubules) Light microscopy. PAS X400: (Minimal change disease.)



***(Source: Agnes Fogo et al AJKD* 201x**)

Fig.2.8: The nephron as the functional unit of the kidney.

Kidney in health

Physiologic functions.

The kidneys serve many vital functions in the body that survival is impossible in the absence of at least one healthy functional kidneys. A person can live on one healthy kidney but nature thought it wise to provide a pair. Even so **over 75% of both kidneys** have to be damaged before features of kidney failure would become manifest.

The healthy kidneys subserve the under listed physiologic functions that ensure healthy survival of the mammalian species. The functions of the kidneys fall into three main categories.

1. **Excretory functions.**

This is the most known function of the kidneys by the general public. It is the process of elimination of unwanted products of body metabolism, which if allowed to accumulate in the body would lead serious damage and death of virtually all body cells and tissues.

These include by products of protein catabolism ,enzymatic and hormonal metabolism. ***They are legion but some of them include: urea, creatinine, phosphates, phenol, guadinoacetate, cresol, urate, indoleacetate, B2-microglobulin, xanthine, B2-endorphins, ketoamines, hormones, organic acids, end products of hepatic transformations of drugs and chemicals etc , products of bilirubin metabolism etc.(26)*** These waste products which are water soluble are dissolve in filtered excess water to constitute urine. The glomeruli together filters about 180 liters of **ultra filtrate** from plasma a day and reabsorbs all but 2-3 litres a day which constitute urine. The average daily urine output a day for a healthy person under standard conditions is **1.5-3 litres**. Daily urine output of less than **500mls/day (Oliguria)** and an output of more than **5 litres/day (Polyuria)** are abnormal.

2.Maintenance of the internal physiologic equilibrium of the body.

The kidney through several metabolic, osmotic and haemodynamic sensing mechanisms is able to maintain the body physiologic equilibrium within safe limits to ensure survival. The processes involve: 2.1. The regulation of body water, sodium balance, potassium and blood pressure .Through the efficacy of the Renin – angiotensin-aldosterone system (RAAS) and the Arginine vasopressin (AVP) system, and various tissue osmo -receptor and pressure receptors, the kidney is able to maintain normal homeostasis or balance for water, sodium and, potassium as well as keeping the blood pressure within normal physiologic limits. [**27**]

2.2. **Body Acid-Base balance**.

The process of metabolism of protein results in the generation of organic acids in the body such as sulphuric and phosphoric acids ,which tends to increase body acid load and reduce the body Ph and consequent metabolic acidosis. The Ph of the body is maintained at a very narrow physiologic band of from acidic Ph of 6.8 to an alkaline ph of 7.8 , the range of Ph compatible with life. The mean extracellular fluid (ECF) ph of about **7.4**

The kidneys play a very vital role of removal of excess acid from the body through the renal excretion of excess hydrogen ions (H+) from the tubular cells in the form of ammonium ions, and the reabsorption of filtered bicarbonate (HCO^3) from the proximal tubules.

2.3**. Calcium and phosphate balance (Bone metabolism).**

The kidneys also play the vital role of maintaining a healthy bone in the body and normal plasma levels of ionized calcium and phosphate. This is achieved through the metabolic activity of 1,25, dihydocholecalceferol (Vitamin-D. which is synthesized in the kidneys. Bone is made up of predominantly calcium phosphate and protein bound in a complex called apatite. Both the calcium and phosphate in the bone and circulating calcium ion (Ca2+) and phosphorous Po4- are in a dynamic equilibrium with their counter part in apatite. Active Vitamin D3 (1,25,dihydrooxycholecalciferol) is synthesized by the kidneys through the conversion of 25hydroxycholecalciferol (vitaminD2) in the kidney peri-tubular cells. Vitamin D3 plays a critical role in the regulation of calcium and phosphate in the body to ensure physiologic balance. Deficiency of vit-D due to kidney disease leads to serious bone structural damage (**kidney bone disease**) and cardiovascular morbidities [**28,29**].

3. Synthetic & endocrine functions of the kidneys.

The kidneys synthesizes and secretes enzymes and hormones critical for normal physiologic functions of the body. These include:

3.1 Renin: An enzyme produced by the granular cells of the juxtaglomerular apparatus (JGA) apparatus. Renin catalyzes the conversion of angiotensin I (from the lungs) to angiotensin II. Ang.II is the most potent vasoconstrictor peptide in the body which contributes substantially in blood pressure control and sodium regulation. In kidney failure the synthesis of Renin is up regulated leading to high blood pressure, sodium and water retention [**30**].

3.2 Erythropoetin (EPO) : A glycosylated 165 amino acid protein, produced in the renal cortical interstitial cells (Pericytes). Play a vital role in the final stages of erythropoiesis in the bone marrow. EPO leads to the maturation of the erythroblasts into mature erythrocytes.[**31**] In renal impairment the production of EPO is seriously impaired leading to anaemia that is responsive only to exogenous recombinant EPO (ruEPO) or erythropoietin stimulating agents(ESA's).

3.3 . 1,25 Dihydroxycholecaliciferol (vitamin D3).

This is the most active form of vitamin D, synthesized in the proximal tubular cells of the kidneys following the conversion of cholecalciferol (from diet) to 25,hydroxycholecalciferol(25HCC) catalyzed by UV- light from sun rays as catalyst. 25HCC is then converted into **1, 25 dihydroxycholecalciferol (vitamin D3**) in the kidneys.1,25 dihydroxycholecalciferol (vitamin D3) plays a vital role in the regulation of body and bone calcium and phosphorus as well as other pleotrophic functions including cardiovascular stability . In kidney impairment, deficiency of Vitamin D3 leads to mineral bone disease (MBD) and other cardiovascular disorders.[28,29].

Functions of the kidneys.

1. **Excretory functions:**
   - ❖ Urine formation and excretion.
   - ❖ Elimination of sundry waste products from the body via the urine.
2. **Maintenance of metabolic equilibrium**.
   - ❖ The regulation of body sodium and water balance.
   - ❖ Regulation of body potassium and Acid-Base balance
   - ❖ Regulation of body Calciumand phosphate balance to ensure healthy bones.
3. **Synthetic and endocrine functions.**
   - ❖ Renin.
   - ❖ Erythropoetin(EPO).
   - ❖ 1,25 Dihydroxycholecaliciferol (vitamin D3).

Summary of functions of the kidney.

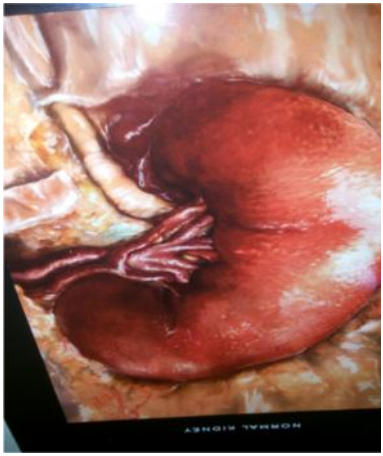
The Kidney in disease.

Diseases of the kidneys and urinary system are legion and can be classified in different ways. One of such classifications is summarized in table 3 below.

Table-2: Summary of causes of kidney diseases.

Causes of kidney disease	Examples
Congenital abnormalities of the kidney and the urinary tract(CACKUT)	Phimosis, epispaedia, posterior urethral valves, Agenesis of the urinary bladder, duplex bladder, Duplex ureters, horse shoe kidneys, Solitary kidney, congenital cystic disorders etc.
Infections of the kidney and urinary pathways.	Lower urinary tract infections, (urethritis, cystitis,). Upper urinary tract infections (pyelitis, pyelonephritis, etc) Infestations of the urinary tracts. (Schistosmiasis, filariasis , etc.)
Glomerular disorders.(primary or secondary)	Acute,Chronic glomerulonephritis The nephrotic syndromes. Glomerulosclerosis.
Systemic vascular kidney diseases with secondary kidney affectation.	Hypertensive kidney diseases,Diabetic kidney disease (diabetic nephropathy), Sickle cellnephropathy. systemic lupus erythematosis (Lupus nephritis),etc.
Toxic nephropathies. /Tubuloinerstitial disorders.	**Chinese herb nephropathy** (Aristolochia)**, Herbal mixtures** and nutritional, supplements **Chemical induced** nephropathies (Clioquinol, Ehylene glycol etc) **Heavy metal nephropathies** (lead, Mercury, cadmium, etc) nephropathy, **Snake bites and arthropod stings** nephropathies Allergic reactions(Acute and chronic interstitial nephritis
Obstruction of the urinary pathways (Obstructive uropathies)	❖ . Calculus disease, ❖ Urethral strictures, fibrosis and adhesions, ❖ Prostatic disease (BPH/CAP) etc. (illustrations

Fig.2.9: Normal (healthy) Kidney.



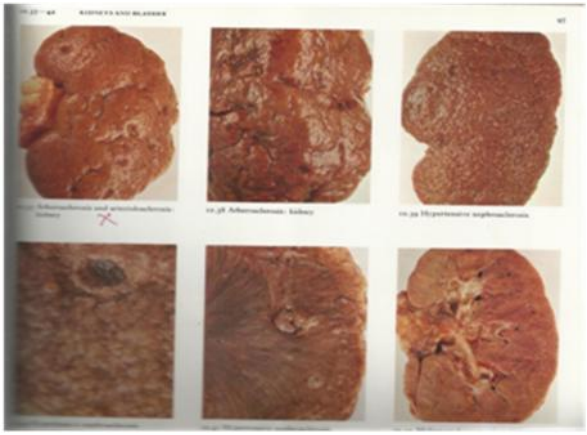


Fig 2.10: Panorama of some kidney disorders.(Gross pathologic appearance)

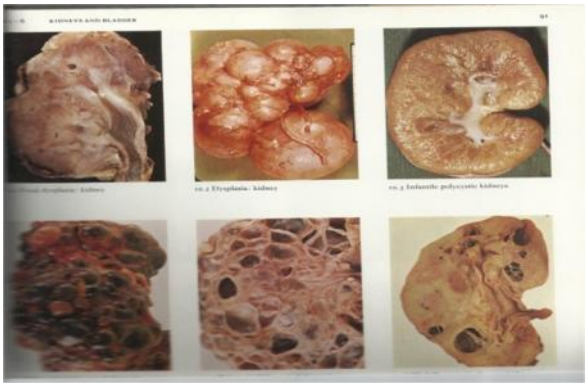


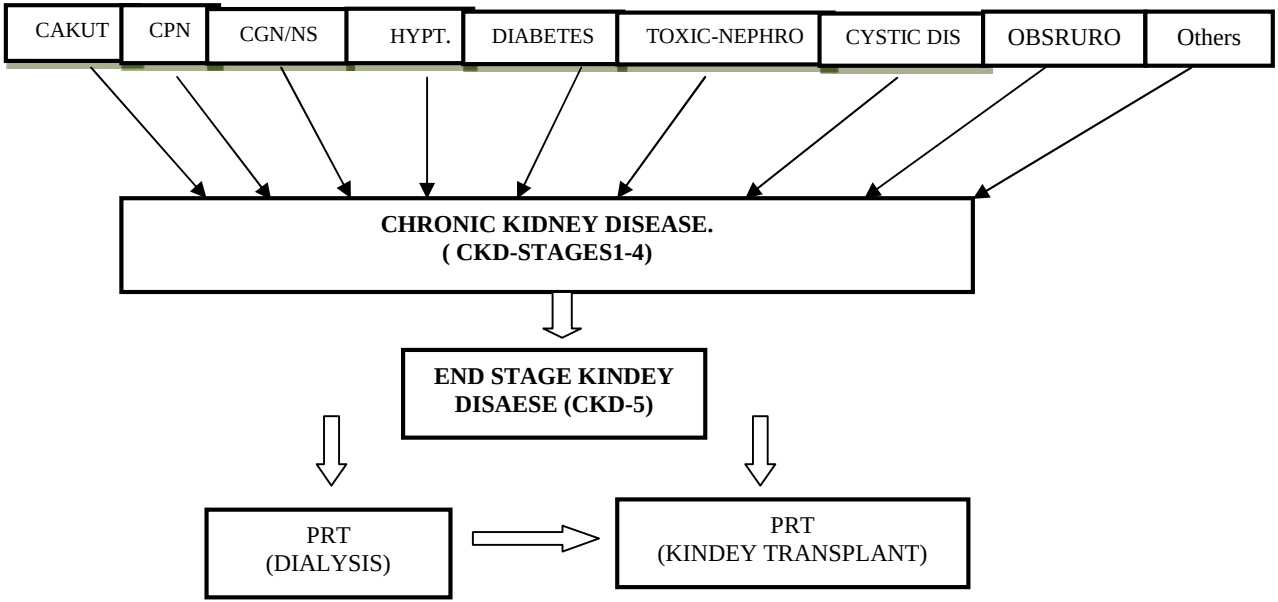
Fig 2.11: Panorama of kidney diseases.

End point of the Kidney diseases.

These numerous kidney diseases listed above (table3) if not prevented, detected early and appropriate intervention applied, would either progress rapidly to:

Acute kidney injury (Acute renal failure) or gradually to **chronic kidney disease (CKD),** which may subsequently lead to **end stage renal disease (ESRD)** or end stage renal failure (ESRD), the stage at which renal replacement therapy (RRT) ie dialysis or kidney transplantation becomes inevitable.

Fig.2.12: The journey to kidney failure.



SECTION 3:

KIDNEY FAILURE: Definitions, Staging classifications.

Kidney failure, used as a generic term can literally be described as the clinical state in which both kidneys are functionally and or structurally deranged to the extent that they are no longer able to adequately perform their normal physiologic functions of preserving the internal physiologic equilibrium of the body**.**

Kidney failure are of two types, Acute kidney failure (now termed acute kidney injury-AKI) and chronic kidney failure (now termed chronic kidney disease-CKD) based on the rapidity of onset, duration, course and potential for reversibility. Both conditions are considered together under the generic term **kidney failure .** Indeed a proportion of survivors of AKI tend to progress to chronic kidney failure over time (**32**). AKI is thus a risk factor for CKD.

Classification and grading of kidney failure

In quantitative terms the International renal community comprising the International society of Nephrology (**ISN)**, National kidney foundation- (**NKF)**, American renal association- (**ARA),** European renal Association, European Dialysis and Transplantation Association- (**ERA-EDTA**) Acute kidney injury network- (**AKIN),** etc have over the years developed universally acceptable definitions, classifications and guidelines for the management of renal impairment and renal failure. These were accomplished through the instrumentality of the **Kidney disease outcome quality initiative (KDOQI) and the kidney disease improving global outcome initiative (KDIGO)** respectively.[**33-35**] The definitions and classifications are given in the panels below.

Definition of Acute kidney injury (formerly Acute renal failure).

An abrupt (within 48hrs) reduction in kidney function characterized by an absolute increase of serum creatinine of≥26.4mmol/l or a percentage increase of ≥50% or a reduction of urine out put>0.5mls/kg/hr for 6hrs.

For the grading and classification of acute kidney injury the **AKIN** (Acute kidney injury network) and the **RIFLE** grading systems were developed.

Table-3.1: Acute kidney injury network (AKIN) staging system for AKI.

AKIN Stage	Serum creatinine(Scr) criteria	Urine output(UO) criteria
1	Scr≥ 26.4umol/l OR: Scr ≥ 1.5-2(150-200%) fold from baseline.	<0.5ml/kg/hr for over 6hrs.
2	Scr >2-3(200-300%)fold from baseline	<0.5ml/kg/hr for over 12 hrs
3	Scr >3(300%) fold from base line OR Scr >354umol/l with an acute rise of ≥ 44umol/l in less than 24 hrs. OR Initiation of RRT.	<0.3 ml/kh/hr for 24 hrs OR: anuria for 12hrs.

CKD -Grade	GFR(ml/min/1.73m2	Description/Action.
1.	>90	Kidney damage with normal or high GFR (Diagnosis and control of risk factors)
2.	60-90	Kidney damage with reduced GFR (Risk factor control and modification.)
3a.	45-59	Moderate kidney damage (Management of complications)
3b.	30-44	Severe decrease in GFR (Management of complications)
4	15-29	Advanced Renal failure (Counselling and preparation for RRT)
5	<15	End stage kidney disease(ESRD) RRT(Dialysis/Kidney Transplantation.)

Bellomo et al. Crit care 2004.

Definition of chronic kidney disease (CKD).

Kidney disease lasting ≥ 3 months with structural or functional abnormalities of the kidneys with or without decline in GFR, with implications for health.
Manifest either as:

- **Markers of kidney damage (Proteinuria, Haematuria, etc) with or without pathological abnormalities.**

OR:

- **GFR ≤60mls/min/1.73m^{2}persisting for 3 months or more with or without kidney damage.**

NKF/KDOQI(2003).

KDOQI-2003/KDIGO-2012.

Table 3.4 below is a colour coded chart of the grading, classification and stratification of patients which combines the degree of proteinuria (kidney damage) and the e-GFR. (**functional impairment**). Green indicate safe domains, patients at low risk, yellow codes connote increasing or intermediate risk while red zone connote patients at high risk of ESRD or already established ESRD with high risk of mortality in the absence of intervention.

SECTION 4

EPIDEMIOLOGY AND GLOBAL BURDEN OF KIDNEY FAILURE. Kidney impairment and kidney failure have globally assumed an increasing magnitude of public health concern in recent times. Kidney failure occurs in all continents, countries, all racial groups ad all socioeconomic groups worldwide. it is estimated that over **500million people** worldwide have some degree of kidney dysfunction.[1]The global distribution of CKD is shown in fig.4.1and in table 4.1 respectively. The world health organisation (WHO) have recently enlisted chronic kidney disease (CKD) among the six common causes of non communicable disease (NCD) deaths worldwide for which long term strategy for their control is being developed for implementation[11].

Renal registry data from North America, west European countries, parts of Asia and Australia, indicate that about **10.7 to 16percent** of their populations have various stages of CKD [15-17]. CKD is akin to the iceberg phenomena, with the bulk of the problem (CKD1-2) submerged in the larger population, while only the severe forms (tip of the iceberg) of the disease (CKD3,4 & 5) are seen in the hospital constituting the bulk of CKD of public health concern. (**fig. 4.2**).

In most populations, the population prevalence of CKD1 constitute 3%, followed respectively by CKD2 (3.0%), CKD3-(5%), CKD4 (0.2%,)and CKD5 (0.2%) respectively.

Most reliable data of epidemiology of CKD are obtained from the United states of America, Canada, North America and in western Europe where **renal registries** have been in existence for years and regularly updated from records of renal centers from their respective jurisdictions. From global map of CKD, it can be seen that kidney failure cut across the six geographic zones of the world with a relatively high population prevalence.

With global population increases, the global burden of kidney disease will continue to increase in the absence of deliberate intervention effort. Where as he annual global population growth rate is 1.1%, the global ESRD growth rate is 6-7% [**36**] respectively.

As at 2015 the global population of ESRD patients treated with one form of renal replacement therapy (RRT) or the other was about 2.45 million people, with **1.68million** people on maintenance dialysis and about **568,000**,living with kidney transplant.[1] Data from the US renal registry (USRDS) 2016[**37**] showed that population prevalence of CKD is **14.8%,**which translate to about **39million people**, while 0.19%of the populations or **571,414**persons are on renal replacement therapy enrolled into the End stage kidney disease program (ESRD-medicare) [15-17]. In Europe the incidence of ESRD is about 350per million persons per population (pmp) and prevalence of 786pmp.There are approximately 360,000RRT patients the EU with 66%on maintenance dialysis and the remainder, about 122,000living with functional graft[15-17].

In sub-Saharan African countries such accurate statistics are not available as most countries lack functional renal registries.
Among SSA countries, only South Africa has a renal registry (the South African renal dialysis and transplant registry), which had 1525 ESRD patients enrolled as at 2008.

Data from most SSA countries are hospital based, admissions prevalence data. These data however show high prevalence of dialysis requiring kidney failures in the region ranging from **3-16** per cent of hospital admissions. [**38-41].**

GLOBAL CKD & ESRD NUMBERS.

Description	**Numbers**
Chronic kidney disease(CKD)	500Million
End stage renal disease(ESRD)	2,545,600
Maintenance Haemodialysis	1,695,000
Peritoneal dialysis	203,000
Living with kidney transplant	568,000

Fesenius 2009

Fig4.1 :Global Map of Chronic kidney disease Showing regional prevalence values.

ISN Global health atlas.

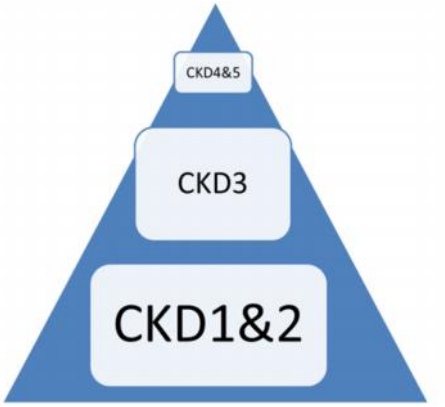


Fig.4.2:Iceberg phenomenon of CKD.

Table 4.1: Global distribution of Chronic kidney disease (CKD), End stage renal disease (ESRD) and renal replacement therapy (RRT).

Characteristic	**US**	**Europe**	**Latin America**	**South Asia**	**North Africa**	**SSA**
CKD prevalence(%))	14.9	6.9	12.0	7-11	NA	13.9
ESRD						
Pop.incidence(pmp)	335	120	207.6	36.9	34.2	3-16%
Pop.prevalence(pmp)	1738	695	660	79.1	40-430	200-300
Peak age group(years)	60-69	63-70.5	NA	NA	NA	25-55
Primary kidney disorder:						
Diabetes(%)	43.8	17.8	50.0	31.8	15.0	16.0
Hypertension	28.1	20.8	NA	13.1	34.2	37.3
CGN	6.5	9.1	NA	45.0	34.0	38.0
ADPKD	2.3	8.3	NA	2.0	NA	3.0
Miscellaneous.	53.82	23.1	NA	36.0	10.3	30.0
Renal replacement therapy(RRT)						
Prev.(pmp)	1811	916.8	568	79.1	385.1	200-300
Dialysis(pmp)	1243	112.7	461	90.0	329,8	45
Kidney transplant.(pmp)	562	325.5	79.7		55.2	240/yr
Sex ratio(M:F)	1.3:1	1.6:1	NA	NA	NA	1.3:1

Key: *US- (United states of America).SSA- (sub-Saharan Africa. Pop prev. (Population prevalence) Pop inc (Population incidience) pmp (per million population) DM (Diabetes mellitus), CGN (Chronic glomerulopathy), RRT (Renalreplacement therapy), Dial (dialysis) Transpl (Transplantation) APDKD (Autosomal polycystic kidney disease).*

In Nigeria, the most populous SSA country with a population of about 170 million people [**42**], 3-16 percent of medical admissions are due to ESRD. These figures tend to corroborate with a recent meta-analysis of publications of chronic kidney disease prevalence

in SSA region by Stanifer et-al[19], who found CKD prevalence of 2-30%with an average prevalence of **13.9%** in the SSA region and **17.6%** prevalence for Nigeria respectively. Assuming a 0.2% population prevalence of ESRD (which is the trend in most communities), Nigeria with a population of 170million people would have an estimated ESRD burden of **340,000**.This would translate to an ESRD population prevalence of **2000pmp**,which is higher than 1,738pmp for USA and more than doubles the 695pmp for Europe respectively. Similarly, SSA countries with a combined population of 800million people at 0.2% ESRD prevalence, would have **1.6milion** burden of ESRD. This magnitude of ESRD in SSA countries is quite enormous .The prevalence and risk factors for CKD based on reports from different parts of SSA are shown in table 4.2

Table 4.2; Distribution if CKD/ESRD prevalence in SSA countries.

Prevalence of CKD and Risk factors	**North Africa (Sudan)**	**West Africa (Nigeria)**	**Central Africa (DRC)**	**East Africa (Kenya)**	**Southern Africa (South Africa)**	**Average for SSA**
CKD prevalence (%)	**8.0**	**17.6**	**19.8**	**4.0**	**14.4**	**13.9**
CKD risk factors:						
Hypertension	8.0	25.0	33.0	NA	24.0	**22.5**
CGN	38.0	27.8	NA	NA	52.1	**39.3**
Diabetes	29.0	34.0	25.0	NA	40.0	**32.0**
mellitus	NA	25	10.0	NA	38.0	**24.3**
HIVAN	NA	3.0	NA	NA	NA	**3.0**
APKD	12.0	5.3	NA	NA	NA	**8.5**
Obstr.Uropathy	13.0	15.0	NA	NA	29.5	**19.2**
Others						

Key: *CKD (Chronic kidney disease) DRC(Democratic republic of congo),CGN(Chronic glomerulopathy) Obtr (Obstructive).*

Demographic characteristics.

ESRD affects virtually every age group globally, with the incidence and prevalence increasing with age. This pattern is consistent in all geographic regions of the world. The median age of occurrence however fall into two patterns according to the socioeconomic environment and the dominant underlying primary renal disease. In

the developed countries of Europe and N. America the peak whereas in the developing countries of Latin America, Africa and Asia the peak age is in the **40-44** year age group espectively.[35-41]This disparity is due to the older demographic structure of developed countries as well as the higher prevalence of common risk factors as hypertension and diabetes among older populations in the developed countries. In the developing countries on the other hand the younger population is due to the predominance of infection related glomerular disorders.

In recent times however the increasing prevalence of NCDs in the developing counties, hypertension and diabetes are beginning to play significant roles in the aetiology of ESRD. Thus in a few decades, the developing countries will acquire the demographic characteristics of the developed countries.

Race.

Though CKD and ESRD occur in all geographical zones, there is some disparity in the incidence and prevalence in different geographic regions. The incidence and prevalence rates however tend to reflect the efficiency of record keeping. Thus countries with efficient renal registries such as US and Europe tend to have higher incidence than countries with no renal registries.

Globally, no racial group have been found to be more susceptible to CKD/ESRD, clinical and epidemiological studies in mixed populations such as the united states, have found CKD to be relatively more common and more aggressive in African Americans followed by Hispanics than among the Caucasian populations. [**44-46**]. This disparity have been attributed to poor access to early detection and intervention, poorer socioeconomic condition amongst blacks, Hispanics, American Indians and Asian immigrants compared to whites. ESRD is **3.5 times** more common in blacks than among whites and **1.9 times** more common in Native Americans than in whites.[37]

Though disparities in environmental and socioeconomic factors are predominantly responsible for this, racial and genetic factors have recently been imputed. The preponderance of CKD/ESRD among African Americans have been attributed to the higher preponderance of ***the APOL1 and MHY49*** genes located on

chromosome 22. African Americans have been found to share the APOL1 and MHY-49 genes. The FSGS, HIVAN and non diabetic forms of ESRD as well as the African trypanosome been found to be also be associated with the APOL1 and MHY49 gene respectively.

Similarly Native Americans with higher genetic predisposition for T2DM, also have a disproportionate higher prevalence of CKD/ESRD than white Americans. Recently a new epidemic of CKD of unknown origin(CKD_U) or tubulointerstitial nephritis ($CKD\text{-}N_T$)-a chronic tubule-interstitial nephritis affecting relatively young agricultural(sugar cane planation) workers in Latin America(Venezuella, Nicaragua and El Salvador).It has been responsible for an epidemic of ESRD in these populations with high mortality rates. Among the putative causes include agric pesticicides, dehydration, heat stroke and genetic factors. The exact causative agent have not been proven. [**48,49**].

GLOBAL LEADING CAUSES OF CKD/ESRD.

Out of the several modifiable causes of CKD/ESRD listed in table 4 above, a few have been identified to be responsible for the bulk of CKD/ESRD world wide. They include Hypertension, Diabetes mellitus, Chronic glomerular disease, Polycystic kidney disease and obstructive uropathies respectively ,for the developed countries. For the developing countries, Chronic glomeruopathies still play a leading role followed by hypertension, diabetes, Toxic nephropathies ,Polycystic kidney disease, obstructive uropathies, and in recent times HIV- related kidney disease, (table4).In recent times the high burden of HIV/AIDS Infection in the SSA countries is increasingly adding to the burden of CKD/ESR by way of HIV-related kidney disease.

With the advent of Anti retroviral therapy (ART), HIV/AIDS have been transformed from a sub-acute fatal disease to chronic disease with longer patient survival, who go on to develop chronic kidney disease. [**50.51**].

Table 4.3: Global leading causes of kidney disease (CKD) and kidney failure

Developed countries	Developing countries.
❖ Hypertension. ❖ Diabetes mellitus. ❖ Chronic glomerular disorders. ❖ Polycystic kidney disease. ❖ Obstructive uropathies.	❖ Chronic glomerular disorders. ❖ Hypertension. ❖ Diabetes mellitus. ❖ Toxic Nephropathies. ❖ HIV-related kidney disease. ❖ Obstructive uropathies. ❖ Polycystic kidney disease.

These include HIV-associated nephropathy (HIVAN),HIV-immune complex disease (HIVICK), Anti-retroviral therapy (ART) induced kidney disease, etc. The prevalence of HIVAN in the SSA countries range from **3-53%** in most series, with attendant rapid progression to ESRD and high mortality rate [**52, 53**]. Thus infection related causes of CKD/ESRD still play significant role in the burden of CKD in SSA countries.

In sub-Saharan African countries toxic nephropathies are important causes of CKD most of which go unnoticed until much later. They include chronic exposures to heavy metals through occupational exposure, abuse of skin lightening soaps and creams, etc. Others include the consumption of a lot of local and imported herbal medications for the treatment of sundry medical conditions. There is also the common place abuse of analgesics of the NSAID group.

CKD/ESRD PATTERN IN PORT HARCOURT.

Tables 4.4 and 4.5, show the demographic characteristics and the underlying kidney disease pattern of haemodialyis (ESRD) patients in our center at the University of Port Harcourt teaching hospital, seen during a **seven year** period. This pattern is similar to those in other parts of Nigeria and other SSA countries but, differs from those in Europe and North American countries as earlier stated.

Table 4.4:Demographic distribution of haemodialysis patients at the University of Port Harcourt teaching hospital during a seven year period.

Age group	Number	Percentage
10-19	40	12.5
20-29*	55	17.2
30-39	44	13.8
40-49	48	14.5
50-59**	60	18.5
60-69	59	18.4
70-79	7	2.6
>80	7	2.6
	320	**100.0**

**Adolescent peak age group. ; **Adult peak age group.*
*Statistics: Mean age **46.2 ± 17.76** (15-79) years Two peak age groups **20-29** & **50-59** (young adult and adult age groups, respectively) Gender ratio M:F 1.6: 1*

***Source:** Alasia DD, Emem-Chioma P**, Wokoma FS.** Int J Nephrol. 2012.*

Table 4.5: Common kidney disease disorders in maintenance dialysis patients UPTH.

Kidney disorders	Number	Percentage
Chronic glomerular disorders	**142**	**46.6**
Hypertensive nephropathy	**95**	**29.5**
Diabetic nephropathy	**56**	**17.5**
ADPKD	**9**	**2.8**
Obstructive uropathy	**8**	**2.5**
Others	**6**	**1.9**
	320	**100.0**

Key: APKD (Autosomal polycystic kidney disease). *Others (Miscellaneous)

Source: Alasia DD, Emem-Chioma P**, Wokoma FS.** Int J Nephrol. 2012.

SECTION 5:

DIAGNOSIS AND CARE OF PATIENTS WITH KIDNEY FAILURE

The diagnosis of kidney failure like any other clinical condition is contingent upon the observation of the clinical process by the attending clinician. This involves comprehensive history taking, (**Clinical interview**), in-depth physical examination and the conduct of relevant general and special investigations relevant to kidney failure. Following the diagnosis, each patient is further stratified according to severity (Grading) of kidney failure in accordance with internationally accepted guidelines.[33,34] The grade of the patient at the time of diagnosis determine the type of therapy or intervention to be offered. The common symptoms and signs in most patients with kidney disease with kidney failure are contingent upon a host of physiologic and metabolic derangement which occur in the body of the patients. Explanations for the basis of some of these manifestations are given in tables 5.1 and 5.2 below respectively.

Table 5.1:Physiologic and metabolic derangements in Kidney failure.

Derangements in Kidney failure	**Explanations**
Body swelling(Oedema).	Extracellular body fluid retention.
Hypertension.	Sodium and water retention, Activation of the sympathetic and RAAS system.
Anaemia.	Failure of kidneys to produce Erythropoeitin, Iron deficiency.
Metabolic acidosis	Excessive bicarbonate loss in the urine. Retention of Hydrogen ion in the body.
Hyperkalaemia	Retention of potassium in the body.
Kidney bone disease (CKD-MBD): (Bone pain, anomalies, and fractures)	Reduced synthesis of Vitamin-D. Retention of phosphorus and SHPT.
Uraemia.	Excess accumulation of nitrogenous wastes in the blood.
Uraemic encephalopathy	Irritation and depression of brain function by uraemic toxins
Cardiovascular disorders. (Vascular calcifications, LVH, heart failure.)	Effect of metabolic derangements on the heart and blood vessels.

Key: RAAS (Renin Angiotensin Aldosterone System; LVH (Left ventricular hypertrophy); SPTH-Secondary hyperparathyroidism.

Table 5.2: Common symptoms and signs of Kidney disease.

Symptoms(Patients complaints	Signs(Doctors' findings on examination.
❖ Fluctuating morning facial swelling. ❖ Swelling in other parts of the body, ❖ Passage of coke-coloured or bloody urine' ❖ .Foamy urine ❖ Nausea, vomiting, hiccups, ❖ Easyfatiguability. ❖ Fast breathing,palpitations. ❖ General bodyand bone pains. ❖ Low urine out put. ❖ Altered sensorium, convulsions, coma	❖ Swollen face, generalized body swelling, ascites etc. ❖ Pallor(Anaemia). ❖ Pallor of the nail plate (Leukonychia) ❖ Discoloration of the nail plates(half and half nails) ❖ Sallor skin. ❖ Uraemic frost. ❖ Uraemic fetor. ❖ High blood pressure. ❖ Cardiovascular disease. ❖ Uraemic encephalopathy.

Fig-5.1: The impact of CKD on other organ systems in the body.

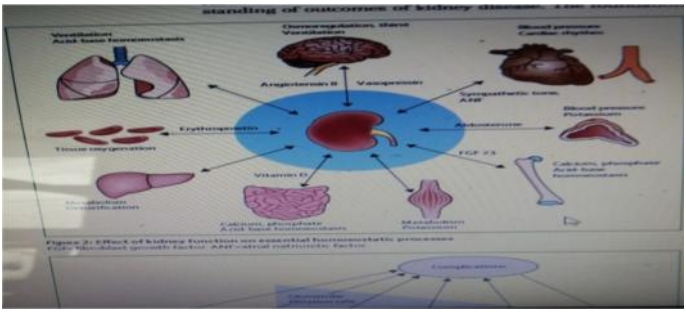


fig-5.2: Typical Kidney failure patient.

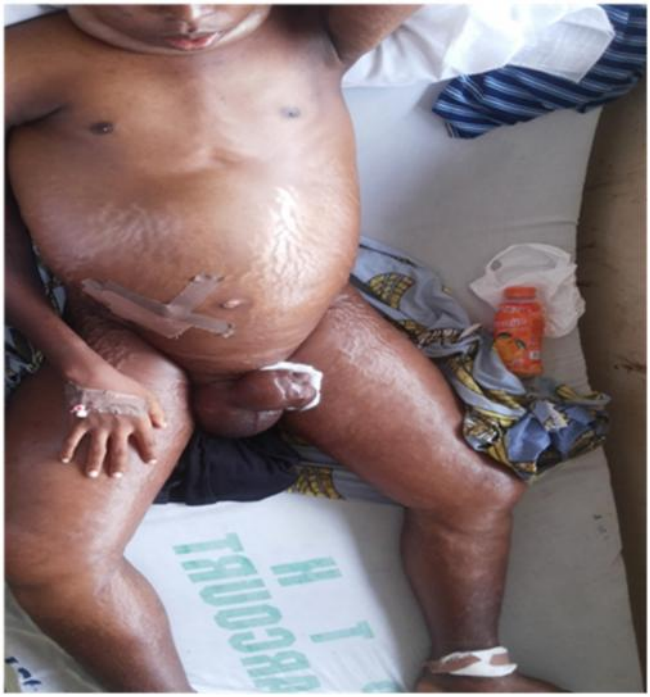


Table 5.3: investigations and typical findings in kidney failure:

Kidney related tests	**Typical findings.**
Urine examination: **Urine analysis.Urine microscopy.** **Urine culture and sensitivity.** **Urine biomarkers.**	Normal to abnormal discoloration (smoky urine, red urine, dark urine, etc. Proteinuria Haematuria, Urinary casts, Crystals,bacteria etc. Crysataluria(calcium oxalate, uric acid,crystals ,etc
Haematologic examination	Anaemia, etc.
Blood chemistry	Varied abnormalities in electrolytes. More than doubling of plasma urea and creatinine levels.,Low bicarbonate levels(metabolic acidosis) High potassium level(Hyperkalaemia).Low calcium levels(Hypocalcaemia) high phosphorous leves(Hyperphosphatamia) Low Albumin levels , high uric acid levels (hyperuraecaemia) low vitamin-D levels , High parathyroid hormone levels(SHPT) Abnormal lipid fractions(Dyslipidaemia)
Measures of kidney filtration. ❖ **Creatinine clearance.** ❖ **Estimated GFR.(e-GFR)using (C&G or MDRD equations.**	Usually low. Less than 60mls/min/1,73m^2. Used to grade kidney failure into 5 clinical stages (CKD-1 to CKD5)
Kidney Imaging studies.	These tests enable the study of the gross morphologic abnormalities of the kidneys.
Kidney biopsy and hisopathology:	These enable the study of the ultra structure of the kidneys at cellular and sub cellular levels and identification of disease causative agents such as immune deposits. They enable the description of specific disease entities such as, hypertensive kidney disease, diabetic kidney disease, HIV-associated kidney disease, etc.

Management of patients with kidney failure.

- Life long counselling of patient and family.
- Dietary counselling and therapy.
- Medication counselling and therapy.
- Counselling for and preparation for Renal replacement therapy(RRT).
- Renal replacement therapy
  - Dialysis
  - Kidney transplantation.
- Other therapies
- Quality of life issues
- Cost of care issues.

The initial management of the patient with CKD depend on the clinical stage of the disease at first encounter. As stated under epidemiology, CKD is a classic example of the **iceberg phenomenon** of some diseases. The percentage of CKD patients who present in the hospital being the tip of the iceberg, is a small fraction of the population disease burden. In CKD only the late stags of the disease (stages-3b to 5) which constitute less than one percent of the population burden of the disease are seen in the clinics and hospitals. The bulk of the disease are submerged within the general population, remain undiagnosed. These hidden population are often discovered during population screening or during medical evaluation for other purposes.

Management of CKD stages 1and2:

When encountered, the care giver counsels the patients along with their immediate family members (the spouse) to educate them on the nature of the condition from a layman's perspective. Counselling also empowers them with the knowledge and skills to enable them to cooperate and collaborate with the care givers.

The content of the counseling include the description of the nature of the illness, the therapeutic processes and the roadmap.

The strong need for behavioral modifications for risk factor control is emphasized. The need for **weight control**, **stricter hypertension and diabetes** and the control of other co-morbid medical conditions must be emphasized. The avoidance of **cigarette smoking** and excessive alcohol consumption is stressed. Attainment of target

Blood pressure (≤130/80mmHg), target HbA1c of <7% and blood cholesterol level of TC≤5.2mmol/l in accordance with Cholesterol Adult treatment Panel-III, for control of lipids must be adhered to. [**54**].

Strict dietary salt intake restriction of less than, **4.g/day (0.6mg/kg body weight/day)** and protein intake restriction to less than **60g/day (0.8g/kg/day)** respectively, must be observed.(see typical kidney failure diets table 6.4).The Renal dietician will assist the patient and family in the details of translating the dietary prescriptions into day to day meals. The need for strict adherence to all prescribed medications and regular clinic attendance for close supervision by the medical staff must be emphasized. During each clinic visits the patients e-GFR is re-calculated to monitor progress.

Table5.4:Typical composition of a kidney failure diet.

Daily dietary allowance.	**Healthy person.**	**Kidney failure patient.**
Calorie(Kcal/kg)	30.0	30-35(50%from CHO's)
Protein(g/kg)*	1-1.5	≤60g/day(0.6-0.8g/kg) High biologic value.
Table salt*	5-6 g/d	≤ 4g/day
Potassium*	Normal	Low
Calcium(mg/day)*	Normal(800-1200 mg)	Normal to low (if low(800-1200mg/day)
Phosphorous(mg/day)*	800-1200	low(less than 600mg/d)
Magnesium(mg/d)	350mg/d	Low(less than 250mg/d)
Vitamin-D(ug/d)	5.0	Normal or high
Iron(mg/d)	10	Normal to 200mg(calculate and replenish store).
Fruits	Liberal	Restrict potassium containing fruits (banana, citrus fruits, etc.)
Vegetables	Liberal	Reduce phosphorus containing vegetables.

***Asterisked are food items with restricted intake in kidney failure. Keen PS. Nut clin prat 2005**.

Disease progression

Several CKD long term monitoring and follow up studies have shown that patients in early stages of CKD 1-2, whose risk factors were well controlled and who abide by the disease modification and control measures outlined above achieve a slower disease progression from CD 1-2 to latter stages of CKD [**55,56**]. There are

several reports of slow progression to dialysis lasting more than ten years. Patients are therefore encouraged to adhere to their control measures. Both observational and controlled studies have shown that apart from racial and genetic factors, factors responsible for rapid disease progression to ESRD include, advancing age, poor hypertension and diabetes control, poor lipid control, poor medication and dietary adherence, and poor clinic visits etc. Others include acute on chronic insults such as dehydration, use of nephrotoxic agents, inter-current infections.

Compared to CKD patients in Europe and North America, CKD patients in SSA countries tend to present late in advance stages of the disease.

Most Patients present for the first time in ESRD with life threatening cardiovascular complications as sever pulmonary oedema, congestive cardiac failure and ureamic encephalopathy [**57-60**] respectively. At this stage urgent dialysis to stabilize the patient becomes inevitable. It is often difficult to determine the CKD onset time as the history of illness is of the illness is short, spanning a few days or weeks. For this reason early mortality is quite high among SSA country CKD patients.

Determinants of CKD progression.

- Advancing age.
- Poor diabetes control (*HbA1C>6.5%).*
- Uncontrolled hypertension (*BP>130/85mmHg*).
- Use of Nephrotoxic drugs, chemicals and herbal medications.
- Inter-current urinary and other infections.
- Comorbid cardiovascular disease.
- Uncontrolled obesity (*BMI >30kg/m^2*).
- Racial &and genetic factors(*Blacks, Hispanics APLO1, MYH49,etc)*

Progression to CKD 3and 4

When CKD progresses to stages 3 and 4, the patient becomes progressively ill with clinical manifestations. The patient begins to feel weak, asthenic, ill and becomes easily tired with poor drive due to anaemia and rising azotemia. Appetite worens and patient may begin to notice a pungent smell to his breath and mouth odour (**Uraemic fetor**) often associated with nausea and vomiting in the morning hours. This may occur spontaneously or while brushing the

mouth. Swelling of the face in the mornings may be observed which wanes as the day progresses. As time goes on the swelling progresses to involve other parts of the body such as the lower limbs (**pedal oedema**) the trunk, and the arms respectively. The oedema fluid may accumulate in potential free spaces in the body such as the peritoneal cavity (**ascites**), pleural space(**Pleural effusion**), pericardial space (**Pericardial effusion**),etc.

The oedema may eventually become generalized and termed **anarsaca**. Headaches, palpitations due to uncontrolled hypertension may occur. Sleep pattern becomes altered associated with bizarre dreams. Without intervention, patient may progressively become somnolent and eventually lapsed into come with or without convulsion.

These processes enumerated above are due accumulation of toxic waste products of protein metabolism which the failed kidneys can longer efficiently eliminate from the body. Others are effects of excess body water, hypertension sympathetic stimulation, anaemia, metabolic acidosis, bone mineral disorders etc.

Physical examination of the patient will show an ill patient with sallow skin, pale oedematous with varying degree of consciousness. Blood pressure is often high with features of cardio-pulmonary instability, there may be sigs of pulmonary oedema, pleural effusion, ascites, pericardial effusion, or pericarditis, heart failure or cardiac arrhythmias etc. Level of consciousness may vary from full consciousness ,drowsiness, delirium and coma. The patient may have asterixix (flapping tremor) which is a sign of uraemic encephalopathy. The relevant laboratory and special investigations would confirm the presence of advanced kidney failure with markedly reduce e-GFR. The multiple clinical problems of the kidney failure patient and the approaches to their management (treatment) summarized in table 5.5. From the table, it can be discerned that the kidney failure patients have multiple clinical problems affecting most of the body systems. This warrants the

concomitant use of several medications. The average **daily pill burden** of the patient is high. Atypical kidney failure patient may be on more than ten different medications concurrently. This

creates problem of poor medication adherence and the medications are equally expensive.

Table 5.5: Therapeutic interventions in CKD patients.

Clinical problems.	Therapeutic interventions.
Oedema	Diuretics (oral or parenteral), dialysis.
Anaemia	Iron replacement and Erythtropoetin stimulating agents(ESA's).
Hypertension	Antihypertensive agents (ACEI/ARB'S) BB, CCB and others
Diabetes	Insulin
Hyperkalaemia	Calcium gluconate, Potassium binders, dialysis.
Metabolic acidosis	Calcium carbonate, Sodium bicarbonate, dialysis
Hyperparathyroidism	Phosphate binders, Calcimimetics, vitamin-D analogues, Parathyroid surgery.
Cardiovascular disorders	Statins, antiplatelet agents, other CVD-drugs, anti –cytokines, Fetuin- A, etc.
Hyperphosphataemia	Phosphate binders (Sevelemer, etc.
Low Vitamin-D	Vitamin-D analogues (calcitriol)
Renal bone disease	Vitamin-D analogues, bisphosphonates, phosphate binders, fetuin-A.

Key: ESA (Erythrooietin stimulating agents) ACEI (Angiotens in converting enzyme inhibitor) ARB (Angiotensin receptor blockers) BB(beta blockers) CCB (Calcium channel blockers).

CKD stage 5: (End stage Renal Failure).

AS the CKD progresses, the patients overall well being deteriorates and there is concomitant drop in the e-GFR. When the e-GFR drops to **15mls/minute/1.73m^2** or less, the patient is deemed to have reached CKD stage-5 (table 5a) which is the **terminal (irreversible**) stage of the CKD-spectrum. At this stage the survival of the patient depends on the patient being placed on **maintenance dialysis** treatment or having a successful **kidney transplant.** The maintenance dialysis treatment and the kidney transplantation constitute **renal replacement therapy** (**RRT**) either of which is quite expensive.

RENAL REPLACEMENT THERAPY.

1. RENAL DIALYSIS.

1a. Peritoneal dialysis(PD):

- **Acute peritoneal dialysis. (APD)**
- **Continuous cyclic peritoneal dialysis (CCPD).**
- **Continuous ambulatory peritoneal dialysis (CAPD)**

1b. Haemodialysis (HD):

- **Acute haemodialysis.**
- **Maintenance haemodialysis.**

1. Kidney(Renal) Transplantation.

- **2a. Diseased donor kidney transplant(DDKT)**
- **2b. Live donor kidney transplant(LDKT)**
- **2c.Xeno transplant(Animal to Man.)**
- **2d. Stem cell therapies.**

Maintenance dialysis

Dialysis is a process of interfacing a patients' blood with a special cleansing fluid (**Dialysate**) in a counter current fashion across a semi-permeable membrane. Dialysis employs the biophysical principles and forces of osmosis, diffusion, convection, reverse osmosis etc. During the process the accumulated bye products of protein catabolism(Urea, creatinine, other bioamines, etc) shift from the patients blood following concentration gradient into the dialysate, while some useful components of the thee dialysate such as bicarbonate, shift from the dialysate into the patient blood to help correct some of the physiologic derangements. This process is allowed to go on for a period of time, during which the patient's blood is progressively cleared of some of the toxic products [**61,62**]. The process of dialysis is an attempt to mimic the healthy kidneys which performs these function on a minute to minute basis very effortlessly.

The dialysis process thus cannot be as efficient as the healthy kidneys which in addition to the cleansing process adds a lot of extra value through its synthetic and regulatory function that help to maintain internal physiologic equilibrium.

Two type of dialysis exist (panel). **Peritoneal dialysis** in which the patient's peritoneum (lining of the contents of the abdomen) serves as the semi-permeable membrane, and **Haemodialysis** in which an artificial membrane (**Dialyzer**) serves as the semi-permeable membrane, with the process facilitated by the **haemodialysis machine**. Of the two dialysis modalities, haemodialysis is the most commonly used, more efficient but also complex and expensive.

Maintenance haemodialysis.

The standard recommended haemodialysis treatment for ESRD known as **maintenance haemodialysis** is a minimum of **10 to 12 hours** of dialysis exposures per week, delivered on a thrice-weekly, four- hour sessions. Fig 5.3 shows some patients on haemodialysis treatment at UPTH. This protocol continues for as long as the patient remains alive or graduates to a successful kidney transplant. ESRD patients on optimal regular maintenance dialysis and other medical therapies achieve long term survival and good quality of life that enable them return to work and live a near normal life. Data from the USRDS, DOPPS and other major dialysis registries show 10-year survival of over 70% in maintenance dialysis patients.[34.37] Similarly most maintenance dialysis patients worldwide have shown fairly high health related quality of life (HrQol) indices close those of healthy populations. [**63, 64**]. Lifelong maintenance dialysis is however expensive and not readily within the reach of average patient in the absence of social support schemes.

KIDNEY TRANSPLANTATION

Kidney transplantation is a complex medical and surgical process in which suitable, viable and compatible kidney obtained from either a **diseased** (Caderveric, breathing brain dead) **donor** or from a **living donor** is transplanted into the ESRD patient. A successful kidney transplant approximate to a **"cure"** for the ESRD.A successful and functional kidney transplantation will stop further need n for maintenance dialysis and correct some of the physiologic derangement associated with ESRD such as anemia, metabolic acidosis and amelioration of renal bone disease. (CKD-MBD).It is however not a complete cure as patient may still have the co-morbid risk factors such as hypertension, diabetes, HIV/AIDS, etc may

persist. which would require continued treatment..Also the patient would continue to be on life- long immunosuppressive therapy to preserve the graft kidney. Successful kidney transplant though expensive it is cost effective on the long run with very good quality of life expectations and good long term patient survival that is far better than maintenance dialysis. The protocol for kidney transplant is complex requiring ethical considerations(to prevent transplant tourism and kidney sales etc),screening of potential donor to exclude the transmission of serious infectious and cancers, blood group and genetic compatibility matching of donor and recipient., etc. The details of the processes involve in kidney transplantation are beyond the scope of this discourse. discourse. Fig. 5.4 is an illustration of kidney transplant.

Combined Kidney and pancreas transplantation

In some patients Diabetic patients who develop diabetes induced ESRD, a double barrel approach to "cure" of both the kidney failure and the diabetes is achieved by dual transplantation of the kidney and pancreatic tissue/pancreatic islet cells. (fIg.5.5) .When successful, the patient become cured of the diabetes, while the kidney transplant cures the kidney failure. This procedure is however most suitable foe Type 1 diabetes who are insulin deficient. It is also feasible with diseased donor transplants only.

ALTERNATIVES TO KIDNEY TRANSPLANT

(Xeno-transplantation and stem-cell transplant.)

Due to increasing scarcity of organ donors worldwide, research are on to find suitable alternatives to human Kidney transplant. These include research into the use of other mammalian kidneys for transplant into human (**Xenotransplantation).**To date kidneys only kidneys from pigs have been found to bear some genetic and immunological closiness to humans. There have not been any reported successful porcine xenografting due to a number of ethical considerations involved.

The other method is the process of developing kidney tissues from toti-potential stemcells sourced from fetal umbilical tissue, embryos and other cells or tissues in the body. Such cell are programmed in tissue cultures to transform into renal cells in-vitro

which are then injected into the patient kidneys to grow into functional renal tissue. This technical process is still early developmental stages.

Fig.5.4 Patients undergoing haemodialysis at UPTH.

Fig. 5.4 Sketch of kidney transplantation.

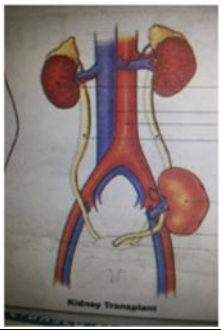
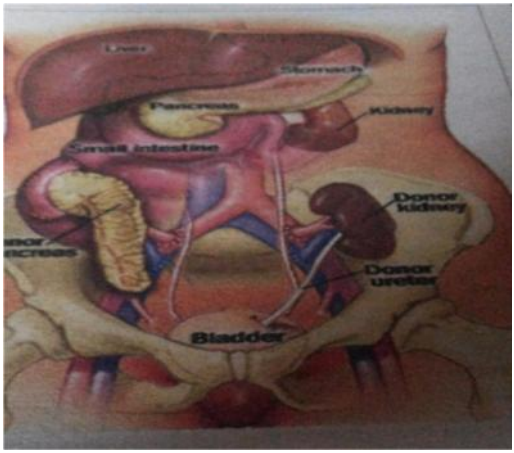


Fig.5.5: Sketch of kidney and pancreas transplantation



SECTION 6:

COSTS OF CARE OF CKD/ESRD

The burden of care for patients with CKD/ESRD is complex, comprising intangible and tangible costs to the victim, the family, care givers and the health care givers, the health system and society at large. The physical burden of suffering of the patient has been outlined above which include the numerous symptoms and manifestations of the disease, poor health, and related poor quality of life. The latter is characterized by inability to engage in gainful employment, near total dependence on family members, poor libido, ED, with attendant frustration on patient and spouse, often leading to strain and divorce. Both functional and organic depression as well as bipolar disorders have been well documented in CKD/ESRD populations, [**65.66**].

Social costs of CKD care.

The need for frequent clinic visits (Dialysis visit, etc) hospitalizations and re-hospitalization put a lot of demand on care givers and overstretches medical resource of a country. ESRD patients have a higher hospitalization rates compared to matched control populations[37]. Because of the intangible nature of these costs, it has been difficult to accurately quantify their economic costs to society. Experts in health economics have tried to estimate them in quantitative terms and in terms of their opportunity costs.

The panel below show the sub headings of the financial costs of care for CKD/ESRD patients

Family	Society
❖ Physical and psychological burden of suffering. ❖ Loss of income due to illness. ❖ Total dependence on family. ❖ Erectile dysfunction. ❖ Marital & family stress. ❖ Abandonment. ❖ Functional Organic depression.	❖ Heavy demand on public health resource. ❖ Occupational stress among professional care givers. ❖ Loss of productivity to society
	❖

- Costs of routine drugs and medicaments.
- Costs of maintenance dialysis.
- Costs of Erythropoietin stimulating agents(ESA's).
- Costs of Kidney transplantation.
- Costs of post transplant immunosuppressive drugs and other drugs.
- Costs of frequent hospitalizations.

The United states renal Registry data system(USRDS) provides perhaps the most reliable and comprehensive up to date source of information on the financial costs of CKD/ESRD care. Annual data reports (ADRs of CKD/ESRD) data from all renal dialysis and kidney transplantation centers across the states of USA are collated, analyzed and published annually as ADR. The ADRs which have been published since 1989,provides detailed statistics of all CKD/ESRD patients registered under the **MEDICARE CKD/ESRD program** in the USA.[17] ADR data covers the incidence and prevalence rates of CKD/ESRD as well as their absolute numbers. Detailed demographic and epidemiologic characteristics of the patients are captured. Others include the distribution of the primary risk factors and the primary renal disorders causing CKD/ESRD, such as hypertension, diabetes, cardiovascular disorders, obesity etc. The distribution of the modalities of CKD/ESRD care as well as the individual and aggregate annual costs of care. The outcome of care, patient survival and mortality rates are all diligently captured.

The United States End Stage Renal Disease (ERSD) program.

In 1972, President Nixon signed into law an "ACT" of the US government for the establishment and commencement of the End Stage Renal disease (ESRD) program as a government subsidized, re- imbursement program for the care of patients with ESRD [**67**]. The ESRD care was then integrated into the existing **Medicare program** for the medical care of elderly citizens 65 years and above. It became known as the **Medicare End stage renal disease program**.

The ESRD ACT was passed by the US congress following the demonstration by USRenal disease experts that lives of ESRD patients can be prolonged substantially on maintenance dialysis and kidney transplantation as well as the fact that, only very few Americans could afford the costs of care form out of pocket sources. *The program is an insurance based physician reimbursement system driven by government and provides for all the components of RRT care as enlisted above.* The program provides coverage to all patients with kidney failure if they are insured under social security or are spouses or dependents of persons

so insured. About 93% of all patients with ESRD in the United states are enrolled in the program. Over the years since the inception, the program have undergone several reforms, but the essential objective of ensuring that all ESRD patients registered under the program receive optimal ESRD care, without out of pocket payments at the point of need. Patients in the early stages of CKD 1-3 are enlisted in the General Medicare program designed for persons 65years and above.

The USRDS report of 2010 to 2015show the annual expenditure profile for CKD and ESRD patients enrolled in the Medicare ESRD program. In 2015 a total **28,593,800** persons 65 years and above were enrolled in the Medicare program out of which **1,234,405** patients (**9%)** were CKD 1-5 cases. The total Medicare expenditure for all Medicare enrollees in 2015, was **$475.3billion,** while the Medicare-CKD care expenditure was **$64.6billion** and the Medicare ESRD was **$33,9billion** respectively.

Note that while ESRD patients constitute just 9% of Medicare population, they account for 17% of total Medicare costs, indicating the high costs of ESRD costs. These are summarized in the panel below.

Summary of US Annual Medicare and ESRD costs of care (2015)

Subject head/year.	**US-dollars (bn)**	**Naira equivalent. (tn)**
All Medicare	**475.3**	**N144.96tn.**
Medicare CKD(1-4)	**64.6bn**	**N19.7tn.**
Medicare ESRD	**33.9bn**	**N10.34tn.**

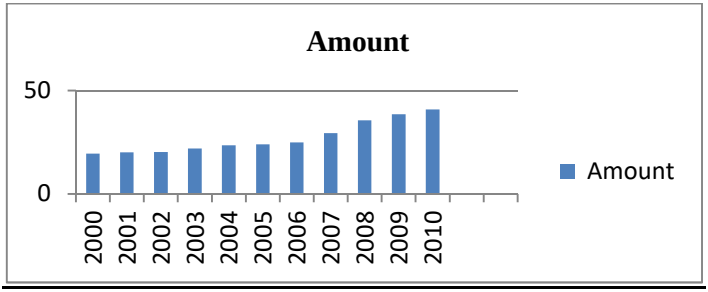
At the current prevailing official exchange rate of $1:N305.0

From the summary table above, the US-Medicare CKD costs for US adults (>65years) for 2015was would be about **23 times** the total Nigerian Federal budget of N6.2 trillion in 2015. Similarly, the US-Medicare CKD costs in 2015 would be **3 times** the Nigeria Federal budget for the year. Finally the US-Medicare ESRD cost for 2015 would be **1.7 times** the Nigeria budget for same year.

This means that the entire Nigerian annual budget for 2015 would be insufficient to care for same number of patients with ESRD in Nigeria.

In the US and other western countries, the financial costs of care continues to increase annually due to the ageing population and increasing prevalence of CKD/ESRD [**68, 69**]. Canada with less than 0.1%of the population with ESRD spent over $1.3 billion in 2000 for ESRD care. Figs. 6.1 and 6.2 show the steady rise in annual costs of care for the Medicare and ESRD populations in the USA between 2001 and 2010.

Fig. 6.2 : Trends in annual costs of care for ESRD in the USA 2000-2010 in Billions of US-dollars.



Source: Adapted form United states Renal Data Statistics (USRDS) Annual data report 2009 &2 010.

Resource and costs of care for CKD/ESRD IN Sub-Saharan Africa: Nigeria as a surrogate country.

Most renal centers in the SSA region operate fee for service regimes whereby patients pay from their pockets for medications, dialysis and kidney transplantation. In both public and private institutions. In public institutions, Government provides the physical infrastructure and pays for staff wages only. Few countries provide free renal care services, including kidney transplantation. South Africa ,Sudan and some North Africa (Arab) countries are few examples.

In most SSA countries, kidney care services and transplantation are neither structured nor regulated as it is with developed countries of USA, Canada and Europe.

Renal care service is characterized by inadequate human resource of all cadres. There are few haemodialysis units, machine, as well as other requirement for dialysis care. Few patients have access to permanent vascular access.

Renal transplant services are also rudimentary performing mainly live donor (LD) transplants. Facilities for brain dead donor transplants virtually do not exist as there are very few functional ICU's sustenance of brain dead patients. [**70**].

Virtually all medical consumables, drugs and equipment for renal care are imported at high exchange rates. Thus equipment and consumables very expensive which translates to high costs of care. Nigeria with a population of over 170million people have just about 160 nephrologists (1:1milliom).Nigeria National health insurance scheme (NHIS) does not provide coverage for kidney care services. Table 6.1 below illustrates the state of resources for kidney in some SSA countries as at 2007.Between 2007 and date there have been some marginal improvements in some countries such as Nigeria, and S. Africa, but the situation remains a far cry compared to Europe and N. America.

Table-6.1: Resource for Renal replacement therapy (RRT) in some sub-Saharan African countries as at 2005. (USA for comparison)

Country	Nephrologists	Haemodialysis machines	PD-Facilities	Kidney transplant /year
USA	**Over 15,000**	**Over 10,000**	**5,689**	**17,209**
Kenya	**17**	**500**	**20**	**10**
Nigeria	**100**	**200**	**1**	**100**
Rwanda	**2**	**12**	**18**	**17**
Sudan	**60**	**500**	**400**	**74**
Uganda	**3**	**25**	**5**	**0**
Zambia	**12**	**2**	**25**	**5**
Zimbabwe	**0**	**100**	**5**	**0**
South Africa	**160**	**6125**	**1547**	**240**

Costs of ESRD care in SSA countries (Nigeria as surrogate country)

In Nigeria as in most other SSA countries accurate data for the costs of care for CKD/ESRD patients are not readily available as out of pocket payment system dominates. Medical fee regimes differ from jurisdiction to jurisdiction even within the same country and hospital charges vary widely.

Estimates from our center and some others in Nigeria [**71,72**] show that, the average per person per year (PPY) cost of renal care services are as follows:

- Non dialysis CKD-ND drug treatment based on prevailing costs of drugs, is about **N706,240 ($4,414.0)** per person per year**.**
- Maintenance haemodialysis with Erythropoietin stimulating agents (ESA) therapy it is about **N2,652,000.0 ($16,575.0)** per person per year.
- Cost of kidney transplant and immune suppressive therapy for one year is about **8million naira($50,000.0)**per person.

The estimated gross total costs of treating one kidney failure patient in Nigeria is about N11,358,204.0($70,988.8) a year.
This is not very different from the $70,216.0 figure for USA.

(Note: The prevailing exchange rates as at the time of study was N160 to 1US-d-dollar.)

A study in our center, UPTH to evaluate the income status and sources of funding for maintenance haemodialysis patients, showed as follows:

- 68% of the patients earned less than one million ($6250.0) naira per annum.
- Only 10% of the patients earned above 3million naira($18,750.0) per annum.
- In over 50% of the patients, their annual income was less than half the cost of maintenance haemodialysis a year.
- 65 % of the patients sourced funds from direct family sources(out of pocket).
- None of the patients had any health insurance nor government aided social security support.

Wokoma et al.TJN, 2010.

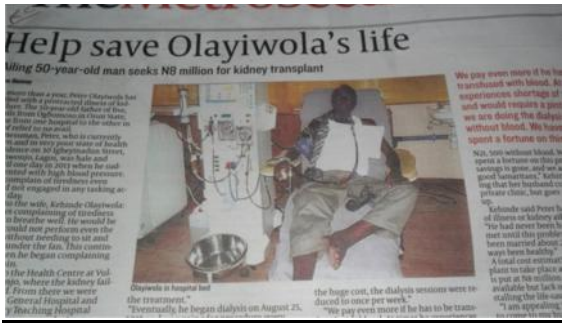
In Nigeria as in most other SSA countries the financial burden of care as shown above, for CKD and ESRD is quite huge and out of reach for the average citizen. Nigeria with an annual minimum wage

of **N216,000.0 ($1350.0),** high poverty index with over 65 percent of the population earning less than $2.0/ day (5), only extremely wealthy few Nigerians, can afford to sustain maintenance haemodialysis for a year or obtain renal transplant from out of pocket payments. The resultant effects of this adverse economic situation of ESRD patients in Nigeria and SSA countries is responsible for the frequent public media adverts of victims of ESRD soliciting for funds from fellow Nigerians to support their treatment as depicted in some Nigerian newspaper cut-outs below. (fig 6.3 and 6.4).

Fig. 6.5 depicts the testimony of a patients who had exhausted family resources on maintenance dialysis. Those who are unable to raise the critically required amount of money for kidney transplant would eventually die and they die in their numbers (Over 80%) within the first year of diagnosis of ESRD. Socioeconomic consequences of high cost of care:

Clinical and socioeconomic implications of kidney failure in SSA.

Fig.6.3: Nigerian ESRD patient soliciting for financial support form the public.


Help save Olayiwola's life

ulling 50-year-old man seeks N8 million for kidney transplant

Fig. 6.4: Nigerian ESRD patient soliciting for financial support form the public.

omade, promising young graduate, needs N8.5m for kidney transplant

WITH a university degree and a professional qualification to boost future career, 26-year-old ade Yewande Balogun is a ly young lady who has looking forward to bright pects in life. Suddenly, her ms are being shattered, as ecently took ill and was di- ed with renal failure. der to save Yomade's life, ends formed a commit- raise funds for her to kidney transplant. of the letter written ned by the head of the made Committee, Mr Adeniyi, made avail- *The Guardian*, reads: ade Yewande Balogun, graduate of Obafemi wo University ogy & Anthropology) rticulation No and chartered in

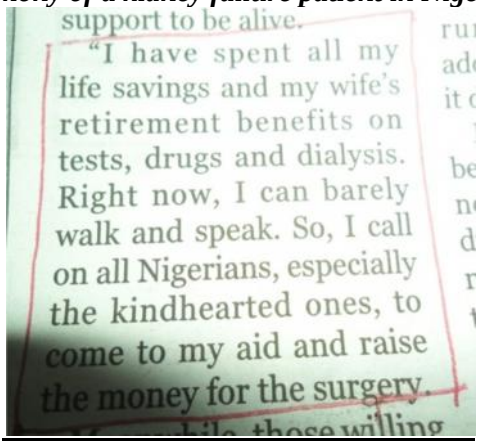
Yomade before and now

dent/no 35398 who lives at no 2, Olorunfunmi Street, Pedro, Gbagada, Lagos."

"Yomade has chronic kidney going dialysis at Gbagada General Hospital, under the supervision of Dr Busari with hospital no 210770."

"She lost her father in a motor accident on March 30, years ago). Her nephro advised that a kidney plant should be done as possible."

Fig.6.5: Testimony of a kidney failure patient in Nigeria.



support to be alive.

"I have spent all my life savings and my wife's retirement benefits on tests, drugs and dialysis. Right now, I can barely walk and speak. So, I call on all Nigerians, especially the kindhearted ones, to come to my aid and raise the money for the surgery.

The lack of adequate human and infrastructural resource for kidney failure care, the high cost of treatment as highlighted above, the prevailing high poverty rate, the lack of social health support system and other factors characterize the outcomes of kidney failure care in the SSA region compared to their counterparts in developed countries. Table 6.2 below shows the haemodialysis performance and outcomes statistics across Nigeria(a surrogate SSA

country)compared with those of developed countries of Europe and N. America. It clearly shows the wide disparity on dialysis exposure, efficiency and effectiveness of dialysis as well as the short and long term survival outcomes.

Table 6.2: Haemodialsis treatment out comes: SSA vs Developed countries.

Haemodialysis outcomes	Nigeria	Europe & N. America.
Period of study.	**3 years**	**3 years**
Average duration on dialysis.	**<6 months**	**>3 years**
AV. Dialysis sessions/wk.	**0.8**	**3**
URR> 65%.	**18%**	**>85%**
Kt/v=1.2	**18.2%**	**88.3%**
SURVIVAL		
90-day survival.	**< 28%**	**>93%**
1-year survival.	**6.9%**	**81.1%**
In hospital mortality rate .	**40%**	**28%**
Loss to follow up.	**62.5%**	**< 1%**
Transplant rate .	**< 1%**	**>12.5%**

URR (urea reduction rate), Spkt/v(Single pool solute clearance).

*Source: **Wokoma** TJN and Okafor.TJN;2008: DOPPS data;2005.*

From the fore going it is evident that ESRD care in SSA countriesis characterized by the features listed in the panel below.

Characteristics of ESRD CARE in SSA countries:

- ❖ Very poor access to routine medications and poor medication access.
- ❖ Very poor Access to dialysis with gross dialysis inadequacy.
- ❖ Poor access to EPO with persistent anaemia.
- ❖ High cardio-metabolic morbidity.
- ❖ Late presentation.
- ❖ Frequent hospitalizations.
- ❖ Low HrQoL Indices.
- ❖ High 90-day mortality rates of over 85percent.
- ❖ High 1-year mortality rates of over 70 percent.

HrQoL: Health related quality of life.

SECTION 7:

FUNDAMENTAL QUESTION:

Can Nigeria and other SSA countries afford ESRD care for her citizens now and in the foreseeable future as is the case with developed countries?

Given the antecedent epidemiologic, socioeconomic, sordid clinical outcomes of the kidney failure scenario in SSA countries as presented above, the pertinent question that readily come to mind is "Can Nigeria and other SSA countries be able to support ESRD care for her populations just as the developed countries have done? Using Nigeria as a surrogate SSA country with a population of **170million people** and an ESRD population prevalence of about 0.2% (global standard), the number of ESRD cases in Nigeria per year would be about **340,000 cases**. At an annual ESRD expenditure rate of about N11.4 million per person per year (section6), Nigeria would need **N3.87trillion naira ($23.57billion)** per year to provide treatment for all the ESRD patients. This amount is about **53%** of the Nigerian National budget of **6.02** trillion naira for 2016 and about **four times** the Nigerian health budget for the same year respectively [**73**]. ***Clearly Nigeria cannot afford to spend 53% of the National budget on just one disease condition in the face of several other disease conditions such as HIV/AIDS, Tuberculosis, poliomyelitis, cerebrospinal meningitis(CSM), Diabetes, Hypertension, etc, as well as other developmental needs of the country in other sectors. Doing that would amount to a National economic suicide. Similarly no other SSA country (perhaps with exception of Sudan and South Africa) can afford to do so. The implication therefore is that, even where SSA countries have the political will, no SSA country has the resources to meaningfully support and contain ESRD care.***

The Imperatives for structured Preventive nephrology care and strategies for actualisation in SSA countries.

> ***"ESRD care alone has the potential to liquidate the economies of SSA countries. The need therefore for SSA countries to explore preventive measures cannot be over emphasized."***

As shown in the first segment of this discourse, kidney failure in SSA countries have far reaching socio-economic burden on the individual victim, family members, the health system and society at large. The resources for care of ESRD are huge and not within the reach of the individual patients nor within the easy reach of SSA country governments. It therefore becomes imperative on Governments of SSA countries to adopt a preventive approach to reduce the scourge of the problem. ***It is said that Prevention is not only better than cure but also cheaper.*** History of some global health disorders , epidemics and pandemics such as plague (the black death), cholera, (1829 &1851), Tuberculosis, Leprosy, poliomyelitis etc, which ravaged Europe during the early industrial revolution , were controlled mainly through public health measures. These include improvement of sanitation, personal hygiene, improved housing to prevent overcrowding, better nourishment, vector control and elimination and vaccinations. [**74-76**]. Today most of those diseases are virtually non existent in the developed countries of Europe and North America, except sporadic cases imported into those countries by immigrants and tourists from other endemic regions of the world.

The imperatives therefore for the need to adopt the prevention as the primary driver for the containment of CKD/ESRD in the SAA counties cannot be over stated. Unfortunately, preventive nephrology have not been given the desired attention by Governments and nephrologists in the SSA countries. ***Contemporary Nephrology practice in the SSA countries have been modeled along the developed country pattern of emphasis on dialysis and kidney transplantation with little emphasis on preventive nephrology.*** Unfortunately SSA countries as demonstrated above

lack the requisite resources to sustain dialysis and transplantation services.Indeed even the developed countries, with enormous resource for ESRD care, are increasingly adopting preventive measures to reduce the burden of ESRD in their populations.

Imperatives for structured preventive nephrology practice in SSA countries.

- **CKD/ESRD is a component of the Global Non communicable disease(NCD) responsible for over 35million deaths/year in the world. Sixty percent of such deaths occur in SSA countries annually. ESRD is the 19th leading cause of death globally.**
- **The human, technological, infrastructural and the logistics requirement for optimal management and care of kidney failure patients in SSA countries are in gross short supply and almost 100 per cent import dependent.**
- **The financial burden of care for kidney failure patients is prohibitive and not within reach of majority of victims. SSA Governments are incapable of providing support for ESRD care.**
- **The inability to access optimal ESRD care lead to unacceptably high morbidity and mortality from ESRD in SSA countries**

KIDNEY FAILURE CARE OPTIONS FOR SSA COUNTRIES

What then are the options available to SSA countries for dealing with the scourge of kidney failure? The options are limited and would include:

- **Maintain the status quo hoping that one day the economic situation will improve to attain the status of developed countries to enable Medicare ESRD program for the SSA populace.**
- **Utilize 53%of National budget and four times the annual health budget for the care of kidney failure, at the expense of other health and developmental needs of the country.**
- **Develop a structured and sustainable Prevention focused Kidney care system that would enable reduction in the burden of kidney disease and kidney failure in SSA countries.**

Of the three options, it is obvious that the last option is more rational, implementable at a reasonable cost and sustainable. A structured preventive nephrology program, which forms the **bed rock** of renal care by way of promoting kidney health, risk factor prevention , early risk factor detection and modulation and early intervention. This would reduce the incident cases of CKD, and subsequent ERSD. It will also ensure early detection and early intervention thereby retarding the rate of progression of CKD.

The **Kidney Early Detection and Early Intervention Program (KEEP)**[21,22] is increasingly being implemented in a number of developed countries, with reports of the retardation of progression of CKD to ESRD in different jurisdictions. Variants of KEEP are implemented in various jurisdictions. Thus we have the US-KEEP, Japanese KEEP, Australian KEY (Kidney disease early detection and you project), Guatamala FUNDAINER project, the Dutch PREVEND program, Indian SEEK, etc[**77-79**] respectively.

These KEEP programs as designed and implemented in the developed countries, may however not be most suited for SSA countries. The KEEP and similar programs deal more with the early detection of modifiable CKD risk factors such diabetes, hypertension, dyslipidaemia, etc, and the early detection of markers of established CKD. These include micro-albuminuria, urine albumin-creatinine ratio (ACR), elevated serum creatinine and e-GFR <60mls/min/1,73m^2 respectively. These enable early intervention and retardation of disease progression.
These KEEP and similar programs are however essentially secondary or tertiary kidney failure preventive strategies. The US-KEEP model is thus bereft of primary prevention or renal health promotion, so it is not holistic and would not serve the SSA countries very well.

SECTION 8:

Proposed Preventive Nephrology Program (PNP) for SSA countries.

I define **Preventive nephrology** as the science and art of deploying simple scientific processes, technologies and social interventions in the prevention of the occurrence,(primary prevention).the retardation of progression(secondary prevention) and amelioration of severity kidney disease(intervention).It entails the promotion of kidney health, early detection and control of risk factors of kidney disease, the early detection of kidney injury and early intervention to retard the progression of kidney disease. The process is holistic and integrative using existing health resources, especially at the community and primary health care levels.

- It encompasses continuous advocacy at the community level for kidney health promotion.
- Routine screening of all antenatal patients at booking and thereafter, for kidney disease and the routine examination of all new born babies for congenital abnormalities of the urinary system.
- Routine vaccination and immunization of at risk persons against infection- related causes of kidney disease.(e g vaccination against HBV and HCV, etc).
- Environmental and public health methods to control communicable diseases linked with kidney diseases.(eg Malaria, schistosomiasis, streptococcal infections,etc).
- Environmental and public health methods to control exposures to nephrotoxic drugs, chemicals and herbal nephrotoxins.
- Compulsory screening of target populations for asymptomatic kidney diseases through Pre-school, pre-employments, pre-military recruitment medical examinations.
- Continuous screening of all PHC patients at first encounter for kidney disease with linkage with center based nephrology units.
- In the hospital setting it entails clinical vigilance among care givers for the prevention of hospital acquired kidney failure.

Strategies for Preventive Nephrology in SSA Countries.

Epidemiologically, kidney failure fall in to two groups, based on the dominant place of acquisition of the risks of kidney impairment or failure. They are:

- **Hospital acquired kidney failure.**
- **Community acquired kidney failure.**

1. Hospital acquired kidney failure.

Hospital acquired kidney failure occur in patients hospitalized for conditions other than kidney failure. Kidney failure occur because the patients have certain underlying morbid conditions that predispose them to kidney failure (usually acute kidney injury). The kidney failure develop on account of effects of medical interventions or physiologic derangements consequent upon the primary illness.

Patients at risk of hospital acquired kidney failure include:

- **ICU based critical care patients with compromised hemodynamic and metabolic states.**
  - **Post myocardial infarction,**
  - **major cardiac and other surgeries,**
  - **CCF, etc.**
- **Toxaemic patients with severe sepsis.**
- **Patients with severe burns or heavy fluid losses.**
- **Patients with severe obstetric and surgical haemorrhages.**
- **Patients who suffer iatrogenic injuries to the urinary system.**
- **Others.**

Hospital acquired kidney failure is often associated with high morbidity and high case fatality of over 50% in most series and a proportion of those who survive the hospitalization, may continue to have progressive CKD and subsequent ESRD [**80, 81**].

For this reason, doctors attending to hospitalized patients should be conscious of hospital acquired kidney failure and always take all necessary precautions to prevent the condition

2. Community acquired kidney failure.

On the other hand, community acquired kidney failure constitute subjects presenting to the hospital for the first time with either acute or chronic kidney disease.

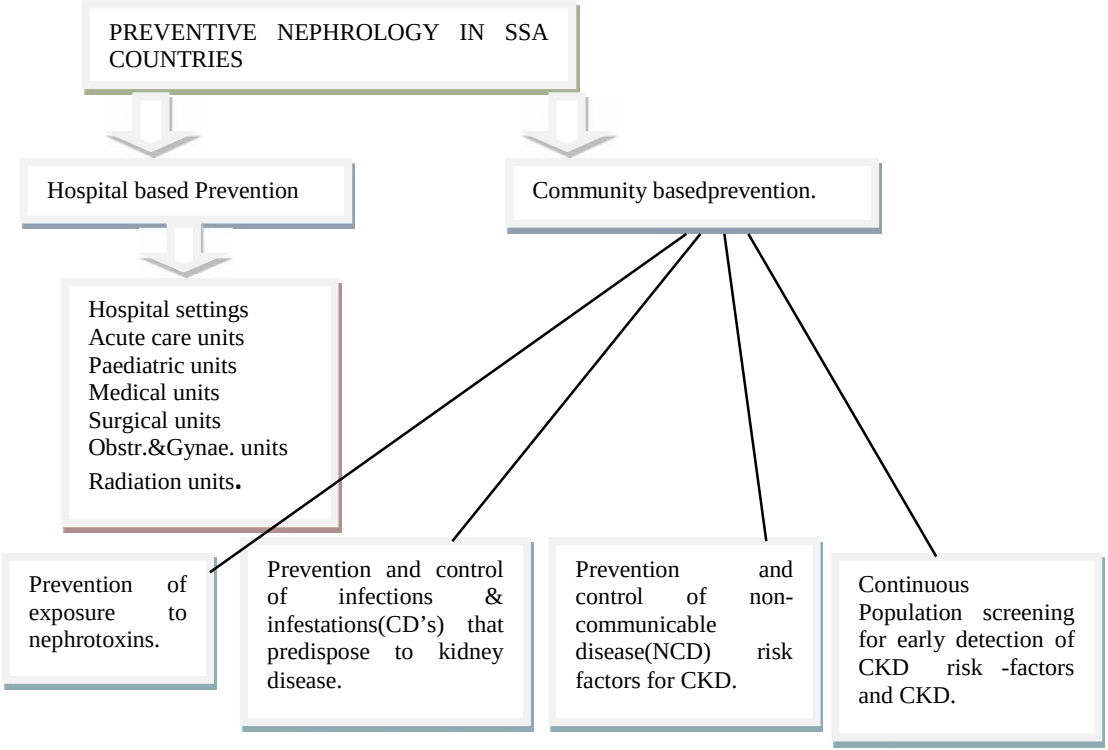
They include:

❖ Children with congenital abnormalities of the kidney and urinary tracts(CAKUT).	❖ Chronic Nephrotoxin exposures. (NSAIDs, Herbal medications, lead, mercury, gold, etc)
❖ Subjects with genetic or acquired cystic kidney disorders.	❖ Chronic glomerulonephritis(CGN)
❖ AKI from acute glomerulonephritis(AGN).	❖ Hypertensive Nephropathy(HTN)
❖ Acute kidney failure due to nephrotoxin exposures. (eg snake bites, herbal mixtures, Ethylene glycol, etc.	❖ Diabetic nephropathy(DN)
	❖ Sickle cell nephropathy.
	❖ Obstructive uropathies,
	❖ Others.

With the exception of the entities that present in acute forms such as AGN, snake bites and arthropod stings and acute poisonings, the rest can be detected by routine and periodic population screening . Even the acute ones can potentially be prevented through regular community health promotional activities that reduces kidney risk exposures.

Preventive nephrology in SSA countries can therefore be organized and delivered along these two broad levels : the hospital and community levels respectively. This is illustrated in fig.8.1.

Fig. 8.1: Schema for approach to preventive nephrology in SSA countries.



Strategies for the actualization of the Preventive nephrology program (PNP) in SSA countries.

Strategy1: Prevention of Hospital acquired kidney failure.

STRATEGY 1: (S1):PREVENTION OF HOSPITAL ACQUIRED KIDNEY FAILURE.(HAKI)

- **S 1.1 Prevention in peri-natal units.**
- **S 1.2 Prevention in the acute care & general medical units.**
- **S 1.3. Prevention in the Obstetrics& Surgical units**.

STRATEGY 2 (S2):PREVENTION OF COMMUNITY ACQUIRED KIDNEY FAILURE.(CAKI)

- **S 2.1 Prevention of nephrotoxic kidney failure in the community.**
- **S 2.2 Prevention of communicable diseases(Infections) related kidney Failure in the community.**
- **S 2.3 Prevention of non-communicable disease(NCD) induced kidney failure in the community.**
- **S2.3a. Pre-school screening detection.**
- **S2.3b. Pre-employment/insurance screening detection.**
- **S2.3c. General community screening detection(modified KEEP model).**

S1.1: Prevention in the Peri-natal units.

Pre-natal diagnosis of and intervention for some congenital /genetic renal collecting system disorders is possible,[**82**] but the expertise and the technology to enable such may not yet be available in most SSA countries.

Detailed examination of the uro-genital systems of **all new born babies** should be routine practice in SSA countries. Conditions such as ambiguous genitalia, undescended testes, phimosis, hypospaedia, congenital solitary kidneys, nephromegaly, etc, can be detected.

Early Intervention by the relevant specialists can be undertaken to prevent subsequent kidney damage.

As part of maternity lessons, nursing mothers should be taught how to maintain proper perineal hygiene of their babies to prevent ascending urinary tract infections.

The prolonged wearing of napkins and diapers by neonates and infants should be discouraged. Pampers should be changed as soon as they are soiled .This is to prevent perineal rash and

infections, the latter of which may become complicated by an ascending urinary infections. They should also be taught how to recognize signs of urinary infection in the neonate or infant and report same early to the doctor or nurse in good time.

S1.2: Prevention in acute care units

In all acute care hospital settings, patients are at risk of Pre-renal oliguria, and acute tubular necrosis (ATN) Such units include:

- Neonatal units.
- Children emergency units (CHEU).
- General accident and medical emergency units (A&E).
- Delivery suits (Labour units).
- Burns units.
- Intensive care units (ICU)/High dependency units.
- Coronary care units (CCU), etc.

Admission into the acute care units is a risk factor for AKI which account for significant proportion of mortality in such units [**83, 84**]. Most patients in the acute care settings suffer from serious metabolic, cardiopulmonary and haemodynamic instability as a result of a number of factors such as severe fluid and electrolyte derangements, acid-base disequilibrium, haemorrhages, sepsis & toxaemias, hypotension, hyperthermia, cardio-respiratory distress, etc. These conditions inflict ischaemic and toxic injury to the renal cells leading to ischaemic-perfusion kidney injury and impaired kidney function. AKI in acute care settings aggravate the primary indication for admission as well as inflicts AKI induced damage leading to increased morbidity and mortality. AKI complicating intensive care admission is associated with over sixty percent case fatality.

Preventive measures:

Clinicians working in acute care settings should always be conscious of the very likelihood of renal function impairments and renal failure in these patients. Proactive measures should be taken to anticipate and prevent the situation. Such proactive measures include:

Proactive measures to prevent AKI in Intensive care/high dependency units.

- ❖ Routine determination of baseline renal function status upon first entry into the ICU facility and regular monitoring of same throughout the period of admission.
- ❖ Continuous monitoring of haemodynamic and biochemical parameters.
- ❖ Monitoring of daily fluid balance.
- ❖ Prompt correction of any fluid, electrolyte and acid base disequilibrium.
- ❖ Use of prophylactic antibiotics(if high index of suspicion of infection), and the use of appropriate antibiotics for proven infection.
- ❖ Prompt correction of anaemia.
- ❖ Where available early detection of AKI with Biomarkers.

These measures should continue until patient is stabilized and discharged from the acute care unit.

Patients at the extremes of age, septic patients and postoperative patients are most vulnerable.

Proactively nephrologists should be involved in the management as soon as there is an early indication of acute renal injury in such patients. Early referral and early nephrologists intervention have been shown to improve morbidity and mortality in intensive care patients with renal function impairment [**85**].

All patients discharged from acute care units should be followed up for up to six months during which their renal parameters are monitored. Those whose admission were complicated by AKI, should be followed up by the nephrologists for much longer periods to ensure full clinical and full renal recovery. AKI is a risk factor for CKD and subsequent ESRD.

S1.3: Prevention in the general medical settings (Out patient, wards, etc).

The renal unit in any hospital should take the responsibility of sensitizing and creating awareness of all doctors in the hospital of the problem of hospital acquired acute kidney injury (AKI) and the role of pro-active measures in the prevention, early detection and prompt intervention in achieving better outcomes of AKI in the hospital setting. This should be done through periodic hospital seminars and clinical ground rounds.

Due to the busy nature of most outpatient departments in SAA countries, baseline clinical and routine laboratory investigations are often ignored at first patient encounter. Patient are often treated symptomatically.

All adults presenting at the general out patient clinics in SSA countries should have the under listed examinations and tests done at the first encounter as routine to establish baseline parameters. These include:

BMI determination.

- Blood pressure measurement.
- Urine analysis and microscopic examination.
- Complete blood count.
- Plasma urea, creatinine, and uric acid concentrations.
- Chest xray.
- Electrocardiogram.

In this way patients baseline data are established and archived for future reference, risk factors for CKD and other NCD's are detected for early for commencement of risk factor modification. Patients with early CKD or other NCD'S are diagnosed and patients referred early to nephrologists care.

For patients admitted into the wards the above listed routine parameters should be determined while the patient can further be investigated for the specific indication for hospitalization.

In the wards, state of dehydration should be prevented or detected early and prompt measures taken for adequate correction. Inadequate hydration of patients on admission is a common observation in SSA countries. Medications with nephrotoxic properties should be avoided, but where use is inevitable, dose adjustments for e-GFR levels should be made.

There are formulae and nomograms for this. Patients on cytotoxic therapies should be adequately hydrated, and hyperuricemia corrected.

Radiation injuries to the urinary system should be avoided in patients undergoing radiation therapies. Necessary precautions

should be taken for patients undergoing contrast radiologic studies to prevent radio-contrast nephropathy [**86, 87**].

Patients with cardiac and chronic liver diseases are at special risk of **cardio-renal and hepato-renalsyndromes**, so cardiologists and gastroenterologists should be aware of these complications. Similarly patients with acute and chronic intestinal fluid and blood losses are at special risk of renal impairment. Repeated clinical evaluations, fluid and electrolyte balance checks will lead to early detection and early intervention.

In developed countries, the issues raised in this sub-heading are routine, because standard **protocols of care** exist and are strictly adhered to by all practitioners. Peer review and close supervisory mechanisms are institutionalized. In most SSA countries however, such standard protocols of care are in short supply, peer review structures are weak. In the hospital wards of most SSA countries, patient ***fluid balancecharts*** for clinical decision making are poorly kept even in medical wards.

The current prevailing practice of use of adult pampers in ill and unconscious adult patients in most hospital wards, make measurement of daily urine output difficult. Such patients should have in-dwelling urinary catheter inserted, to enable accurate measurements of urine output.

S1.4: Prevention in Obstetrics and surgical care settings.

Acute renal injury (AKI) occur commonly in obstetric and surgical care settings leading to increased maternal morbidity and mortality **[88**]. Risk factors for AKI is often due to:

- **Obstetric haemorrhages.**
- **Prolonged labour.**
- **Puerperal sepsis.**
- **Peri-operative blood losses. (Emergency caesarean sections, etc).**
- **Operative Iatrogenic injury to the Kidneys, ureters and or urinary bladder.**
- **Post operative sepsis.**

Often, AKI in these settings is only recognized by the managing obstetric or surgical team, when the patient becomes oligo-anuric, few days after the surgical procedure.
The nephrology unit then get invited, by which time pre-renal AKI have transformed into full blow ATN with grave consequences.
Prevention can be achieved by being proactive and anticipatory. All pregnant women should register early for ante-natal care. Anaemia in pregnancy, ante-partum haemorrhages should be prevented or adequately managed before onset of labour. Women in labour should be adequately hydrated.

All pre-operative patients in these settings should have pre-operative haematologic and renal function assessments done to establish **a pre-operative renal base line** and to exclude possible existing back ground CKD. Patients should be adequately hydrated and anaemia corrected preoperatively.

Practice point.

ALL ANTENATAL AND PRE-OPERATIVE OBSTETRIC AND SURGICAL PATIENTS SHOULD HAVE PRE-OPERATIVE BASELINE KIDNEY FUNCTION TESTS DONE.

Patients for assisted or operative delivery should be properly prepared before the procedure. Arrangement should be made to have blood in the hospital blood bank before surgery.

Prophylactic antibiotics should be instituted for at risk cases before theatre. Intra-operative surgical blood loss should be minimized through the application of modern intra-operative haemostatic techniques which minimize operative blood loss [**89, 90**].

Obstetricians and surgeons performing emergency abdominal surgeries should always be conscious of iatrogenic injuries to the urinary system especially when operating in bloody fields. Tissue handling should be gentle so as not to traumatize fragile tissues. In this way surgical injuries to the kidneys, ureters and the urinary bladder will be minimized. In the immediate post

operative period patient should be evaluated daily with attention to urine output, fluid balance, renal and hematologic indices in the immediate and early post operative period.

Practice point.

"Obstetricians and surgeons performing abdominal surgeries should always be conscious of iatrogenic injuries to the kidneys, ureters and the urinary bladder"

The prevention and early detection of hospital acquired kidney failure is the business of every clinician. Nephrologists in SSA countries have the primary responsibility for the initiative and its sustainability in their respective hospitals. The concept of early nephrologists' involvement in all at risk patients should be promoted within the hospital community. Hospital nephrologists can develop ***discipline based customized operational algorithms*** for the prevention, early detection and intervention in hospital acquired kidney injury. These should be posted at strategic points in the operational units to guide care providers.

In summary, it is hoped that if Hospital managements, the hospital nephrologists, National renal societies of SSA countries collaborate to ensure the implementations of the suggestions in all SSA hospitals, hospital acquired kidney failure would be reduced to barest minimum.

Practice point:

"Hospital acquired AKI carries over 50% case fatality. Survivors are at risk of CKD/ESRD in the future."

Strategy 2: Prevention of Community acquired kidney failure

As stated earlier community acquired kidney failure is either **acute** such as AKI from snake bites and arthropod stings or acute drug poisoning or **chronic**, in subjects with long term risk factor exposures, who develop chronic kidney disease with subsequent progression to kidney failure. The strategies for their prevention are categorised and discussed in accordance with the different risk factorexposures.

S2.1 Prevention of Nephrotoxic kidney failure:

Nephrotoxic renal injuries leading either to acute kidney injury or chronic kidney disease (CKD) constitute a significant cause of kidney failure in sub-Saharan African countries [**91-93**]. The nephrotoxins vary widely according to the population in question but fall into the under listed categories in table 8.1 below.

Table 8.1: Sources of Nephrotoxins.

Categories	Sources
Venoms.	Snake venoms, Insect stings (bees,Scorpion etc.)
Herbal remedies.	Roots and bark of trees &shrubs. (Dogon- Yaro, Chinese herbs & teas (Aristolochia)
Nutritional supplements.	Ginseng, St Johns wort, Saw-Palmette, Ginko, etc.
Chemicals and Environmental toxins.	Diethylene glycol, formalin. methanol Clioquinol, Heavy meals (Lead, Mercury, Gold etc)
Nephrotoxic drugs.	NSAIDS (All). Aminoglycosides, ACEI/ARB, Tetracyclines, Anti-cancer agents, Calcineurin inhibitors (Ciclosporin, Sirolimus, tacrolimus, etc.), Anti-retroviral agents (Tenofovir, Rotinavir, Abacavir, etc)
Hydrocarbons.	Crude oil, and other petroleum substances.

i) Traditional herbal remedies.

Herbal potions and concoctions are widely used in traditional African societies from time immemorial. Today they are used even in modern urban populations for the treatment of a wide spectrum of medical conditions among all age groups, particularly in infants and children in the SSA countries. It is estimated that traditional and

alternative medicare are commonly practised in over 80 percent of world populations especially in Africa, China, India etc [91,92].
Traditional herbal medicines are derived from plants and trees with acclaimed medicinal properties (phytomedicine). They may be in the form of extracts from roots, leaves, barks or the branches of certain plants and trees. Some are prepared in **water based** formulations, while others are **alcohol based,** other categories are chewed and swallowed whole.

In most SSA countries, their use is quite popular among the rural, urban poor and even elite populations, with tacit government encouragement. They are used for a wide range medical indications of the different body systems. The trado-medical practitioners in many SSA countries, such as Nigeria, have organized themselves into pressure and lobby groups and have been pushing governments and the legislature to recognized their practice and integrate them into orthodox medical practice.
Some countries have such as Nigeria, have trado-medical boards to regulate traditional and herbal medical practice [**94**] The extent to which these boards are functional is however unknown.
The new generation trado-medical practitioners have gone beyond the terrain of the uneducated **"native doctor" ," medicine man" or "Babalawo", and** other practitioners, to a modern brigandage of **schooled tradomedical practitioners**.

In Nigeria, these group include college and university drop outs, and graduates with some bio-science background in biology, chemistry, physiology, pharmacology, biochemistry, anatomy etc.
Factories have been established for the production of herbal based mixtures, with claims of multiple cures, which they market openly via the public media, market places, commercial transit buses, etc.
These days they deceptively add orthodox drugs(crushed tablets, capsules or syrups) such as analgesics, NSAIDS, antibiotics, anti-hypertensives, cardiotonics, etc into the herbal mixtures.
With their knowledge of science they even communicate in medical jargon using anatomical teaching models and mannequins, computer based machines etc, to convince the gullible public as to the effectiveness and potency of their products with the emphasis on " **naturalness**" of their products. Trado-medical hospitals have been

established in some places with Government knowledge and approval. There is a well patronized big trado-medical hospital in Ibadan,Nigeria with full knowledge of government. With this level of encouragement, the patronage for traditional and herbal medicine is on the increase in many SSA countries. Figs 8.1 to 8.5 show newspaper clips and pictures of some trado-medical preparations in Nigeria.

Fig 8.2 : Herbal (Traditional) medicine in Nigeria

Fig .8.3: Herbal (Traditional) medicine in Nigeria.

Source: Nigerian Guardian newspaper 14/11/2014.

Fig. 8.4 : Herbal (Traditional) medicine in Nigeria.

Fig. 8.6: Nutritional supplements.

Fig. 8.5 : Herbal (Traditional) medicine in Nigeria.

Herbal medicines	Types of Kidney damage
Chinese yew(Taxus celebica,djenkol beans) Khat(Catha endulis) Spanish fly(Lycca vusicatoris), etc	Acute tubular necrosis
Chinese herbs.(Aristolocchia spp.)	Rhabdomyolysis. Fibrosis.
Wilow bark	Papillary necrosis
Chaparal(Larrea tridentate)	Kidney stones
Chinese herbs(Aristochoia spp)	Urolitheal malignanacy.
Alfalfa(Madicgo sativa)	
Birdflower(crotolaria labumifolia)	Hepatorenal damage
Bladderwack,Chinese herbs,liquorice, st johns worth ,Cats claw(uncaria tomentosa)	Interstitial nephritis &fibrosis.

The problem with trado-medical practice remains the absolute lack of standardization of practice and the lack of peer review mechanism based on objective measurable and reproducible attributes. There is often no delineations between herbal therapies, spiritual healing and sorcery. The exact ingredients, of the traditional remedies and potions are not known. They are not purified to extract the active agents, no safety and toxicological studies and no dose specifications. Both the active and toxic molecules are dispensed in a completely unregulated manner with the resultant effect that quite a number of the commonly used ones have been associated with life threatening complications such as:

Some life threatening conditions associated with use of herbal medicines.

- **Acute hepatic (liver) failure.**
- **Acute and chronic kidney failures.**
- **Acute gastritis &Upper gastrointestinal haemorrhages.**
- **Acute pancreatitis.**
- **Severe life threatening skin rashes *(Steven Johnson syndrome (SJS), Toxic epidermal necrolysis (TEN),etc.***
- **Acute multi-organ failures, etc.**

Table 8.1 Some herbal medicines and commonly associated kidney damage.

Herbal medicines	Types of Kidney damage
Chinese yew (*Taxus celebica,djenkol beans*) **Khat** (*Catha endulis*) **Spanish fly** (Lycca vesicatoris), etc	**Acute tubular necrosis**
Chinese herbs, *(Aristolocchiaspp,).*	**Rhabdomyolysis. Fibrosis.**
Wilow bark	**Papillary necrosis**
Chaparal (*Larrea tridentate*) **Chinese herbs** (*Aristochoia spp*) **Alfalfa** (*Medicgo sativa*)	**Kidney stones** **Urolitheal malignanacy.**
Birdflower (*crotolarialabumifolia*)	**Hepatorenal damage**
Bladderwack, **Chinese herbs**, liquorice, St Johns worth, **Catsclaw** (*uncaria tomentosa*)	**Interstitial nephritis & fibrosis.**

ii) Nutritional supplements

A new dimension to herbal remedy practice among urban dwellers in some SSA countries is the recent advent of "**Nutritional supplements".** Nutritional supplements are imported herbal products from mostly the United states of America, China and India into SSA countries.

As a result of widespread use of these products the US ,Congress passed the nutritional supplement health education Act (DSAEA) of 1994. [**95**)] **The** "**ACT" permit the sale and use of herbal supplements without test of proof of efficacy and safety because they are not regarded as drugs but supplements.** They contain mainly Ginseng, Garlic, St John's Wort, Ginko, Echinesia, Saw palemette, etc, with some other micro-nutrients.

In the US however herbal supplement preparations are made according to good manufacturing practices and their product labels show details of their contents and clear health warnings for their use. They are not recommended for the treatment or cure for any specific medical condition(s) and they carry warnings of potential health risks.

***Warning Statements from the US Institute of Health on Nutritional supplements.**

1.	"Dietary supplements are products intended to supplement the diet. They are not drugs and, therefore, are not intended to treat, diagnose, mitigate, prevent, or cure diseases. The term natural does not always mean safety."
2.	"A supplement safety depends on many things such as the chemical make up, how it works in the body, how it is prepared and the dose used. Certain herbs (for example comfrey and kavao) can harm the liver."
3.	The federal government can take legal action against companies and Web sites that sell dietary supplements when the companies make false or deceptive statements about their products, if they promote them as treatments or cures for diseases, or if their products are unsafe."

Source: U.S. Department of Health and Human Services 2011.

In SSA countries such as Nigeria, Nutritional supplements trade have become big business. Business persons of various descriptions, including some health professionals import these supplements into the SSA countries. They are marketed and distributed via the public media, market places, chemist shops, and pharmacy shops, public buses and taxis, churches etc.

They are marketed as "**medicines**" for sundry medical conditions such as diabetes, hypertension, peptic ulcer disease, asthma, arthritis, etc. Some are labelled "**forever living products"** with claims of immortality.

Whereas the use of these Nutritional supplements may be relatively safe,(even though there are no proven scientific evidence for their claimed therapeutic indications)their use may pose some un-towards medical implications which include:

Clinical implications of use of Herbal Supplements..

- ❖ Abandonment of prescribed medications for Nutritional supplements with consequent disease progression and life threatening complications.
- ❖ Combined use of prescribed medications together with Nutritional supplements, with possible drug-drug interactions.
- ❖ Indeed some of the products contain harmful ingredients such as plant pollen, steroid oestrogens, arsenic, mercury lead and pesticides which are injurious to the kidneys.

iii) Hydro carbon derivatives.

Hydrocarbons such as crude oil, insecticides etc, are often used in rural communities and some urban based people for the treatment of febrile illness and other medical conditions such as acute and chronic convulsive disorders in children. These often lead to hydrocarbon induced inhalational pneumonitis, sepsis and renal failure.

Sludge in crude is a direct nephrotoxin as it contains heavy metals such as lead, mercury etc and several other toxic chemicals such as benzene, toluene which are injurious to several organs in the body including the kidneys. [**96, 97**].

iv). Chemicals and heavy metals.

Inorganic and organic chemicals such as ***hydroquinones, clioquiniones, mercury, lead,*** etc. used in skin lightening and bleaching creams and soaps are established nephrotoxins. The use of such soaps and creams is popular among young females, males, and celebrities in SSA who want to enhance their appearance for better public acceptance. Other sources of exposure to heavy metals are among petroleum industry and petrochemical workers, as well as pipe and arch welders, automobile battery workers. [**98, 99**] .

In a 2012 study of the blood lead levels among petrochemical industry workers, petroleum products vendors, tyre vulcanizers, etc, in Port Harcourt area, we found significantly higher blood lead levels in the study subjects (50.37ug/dl) than in

controls (41.4ug/dl) subjects. Also the subjects had higher risk factors for CKD (and lower eGFR than in the control Subjects [**100**].

v). Nephrotoxic drugs.

There is widespread access to and abuse of potentially nephrotoxic over the counter(OTC) drugs and preparations such as ***non-steroidal anti inflammatory agents (NSAIDS), antibiotics such as the tetracyclines, aminoglycosides, sulphonamides*** etc in SSA countries. Some drugs for HIV/AIDS therapy such as tenofovir, nelfinavir, abacavir, etc are also known to adversely affect the kidneys through several mechanisms [**101-103**].

In most of SSA, these drugs , herbal potions and nutritional supplements, etc are openly hawked in market places, commuter buses, motor parks and the streets in most the major cities in SSA countries such as Nigeria. They are regularly advertised and promoted in both public and private media (Radio, television news papers etc) on a daily basis without government intervention. The promoters even organise open herbal drug and nutritional supplemen ***trade fairs*** for these potentially nephrotoxic agents with government permission.

Nigeria has one of the largest multi-million dollar open drug markets in the world. Large drug markets exist in big cities like Lagos, Ibadan, Abuja, Onitsha, Aba, Nnewi, Kaduna, Kano, etc.

The drug merchants import all manners of substandard and adulterated drugs into the country in collusion with their Chinese and Indian counterpart dubious manufacturers. Locally the merchants collude with corrupt customs and immigration officials, who help to clear the drugs at the import destinations and through the borders. The importers constitute an organized **drug-mafia /cartel** that are ready to harm or kill any government agents that threaten their illicit business. Every effort by Government agents to close down these illicit drug markets in the past have failed.

Fig. 8.8: Open drug sales (Nigeria)

Fig. 8.9: Herbal medicine and Nutritional supplement trade fair boot (Nigeria)

vi) Accidental/Intentional industrial chemical contaminations of drugs.

Accidental and intentional toxic chemical contamination of drugs by manufacturers often lead to epidemics of kidney failure and deaths especially in children and adolescence.

In 2005 **diethylene glycol** was used in place of glycerine (antifreeze) in the manufacturing of children teething powder syrup named "**my pikin**" led to the deaths of over **84 children** in South western parts of Nigeria from acute kidney failure (**104**). Similar

episode was recorded again in 2008 at the Ahmadu Bello University teaching hospital, Zaria which lead to death of **27 children** from AKI,(**105**). Much earlier the same substance diethylglycol contaminated paracetamol syrup in parts of Eastern Nigeria which also caused the death of several children.

After protracted legal contest, the directors of the company which caused the contamination of the teething syrup in 2005 were sentenced to 7 years imprisonment by the court(news paper report). Figs 9.10&9.11 are Nigerian newspaper clips of the tragedy of diethylene glycol poisoning.

Figs. 8.10: Diethylene glycol poisoning: "MY PIKIN SAGA".

The Guardian

FOUNDER: ALEX U. IBRU (1945 – 2011)

Editorial

My Pikin saga and NAFDAC's challenge

IT is a relief of sorts that the agony of the multiple deaths caused by the administration of *My Pikin* baby teething mixture is finally coming to an end. At least, that is the implication of the conviction the other day and 14-year jail sentence handed to the drug's manufacturers. Before the drug was found to be contaminated and then withdrawn from the market in 2008, it had unfortunately killed 84 babies to whom it was administered. That this saga occurred five years ago and a semblance of justice has just come, of course, dilutes the relief of the moment. Five years is too long a time to unravel the truth of a drug responsible for the untimely death of 84 infants, considering that the prosecution and punishment should primarily aim to deter other people engaged in adulterating or manufacturing drugs without the due care of preserving human lives. This long period in investigating and prosecuting just one instance of drug contamination also portends grave danger in a country where many people perpetually engage in faking and adulterating products. It therefore raises questions on the capability of the National Agency for Food and Drug Administration Control (NAFDAC) to wholesomely counter the propensity of some Nigerians to endanger the lives of fellow citizens for purely commercial gain.

Delivering judgment in the charge of unlawful production, adulteration and sale of the drug, the Federal High Court found the manufacturers guilty of conspiracy and sale of the drug. It therefore sentenced the company's Production Manager, Adeyemo Abiodun, and the Quality Assurance Manager, Egbele Eromosele, to 14 years imprisonment each. The court ordered that the company, Barewa Phamaceutical, be compulsorily wound up and its assets forfeited to the Federal Government. They were all prosecuted under the Counterfeit and Fake Drugs and Unwholesome processed foods (Miscellaneous Provisions) Act No. 25 of 1999.

Fig. 8.11:Newspaper clip on "My pikin"

Convicted 'My Pikin' producers ask S'Court for bail

Ade Adesomoju, Abuja

Two engineers of Barewa Pharmaceutical Ltd, producer of the killer baby teething mixture, *My Pikin*, who are serving seven years jail terms for the sale of the medicine, have asked the Supreme Court to grant them bail pending the determination of their appeal.

The judgment delivered by now retired Justice Olanchukwu Okeke of the Federal High Court in Lagos on May 17, 2013, was affirmed by the Court of Appeal in Lagos on December 31, 2013.

The convicts, Adeyemo Abiodun and Ebele Eromosele, had filed 19 grounds notice of appeal, numbered SC/79/2014, before the Supreme Court.

One of the convicts, Eromosele, through his lawyer, Ogbeneni Ideh, in his application dated October 27, 2014, asked the Supreme Court for bail on the grounds of ill health, which he said was not being properly treated with the facilities available in the prison.

for hearing.

The Court of Appeal had in its lead judgment delivered by Justice Dalhia Bage, affirmed the seven years sentence passed on the convicts by the trial court, but reversed the order of winding up and forfeiture made by the court.

vii) Environmental contaminants.

Contamination of food and domestic water with industrial wastes or heavy metals from industrial and mining sites is common in SSA countries. A recent incidence of contamination of source of domestic water with lead in Zamfara state (North western Nigeria) occurred as a result of illegal gold mining. This led to the death of several children, from **acute lead nephropathy and encephalopathy**. The blood lead levels in the children ranged from **171.5-224ug/dl** as against safe levels of less than **10u/dl**. In accordance with WHO safe blood levels of lead. Figs 22a and 22b are Nigerian newspaper stories of the events. In most parts of SSA countries illegal mining by foreign companies is common. However the governments of the SSA countries are incapable of regulating the activities of such foreign companies due to corruption and the economic benefits which accrues to the impoverished countries.

viii) Biological nephrotoxins

Biological nephrotoxins from Snakes and arthropod venoms exposure following snake bites and arthropod stings are quite common among rural based farmers and fishermen, hunters and people working in farms and forests in SAA countries. AKI resulting from arthropod and snake venom nephrotoxins account for about 5% of community based AKI in most SSA countries [**106, 107**]. Most Snake and arthropod venom induced AKI are severe enough and often requiring dialysis intervention for survival. The case fatality is often high and survivors may end up with CKD/ESRD.

Chronic kidney disease induced by nephrotxins is often insidious spanning over years before ESRD ensues. Examples include Balkan nephropathy, Chinese herb nephropathy, NSAID induced nephropathy, Lead and mercury induced nephropathy etc. They often constitute the bulk the over 30% “unknown” causes of CKD/ESRD in most CKD prevalence series.

Figs. 8.12: Zamfara and Niger states, Nigeria: lead poisonings from crude Gold mining activity.

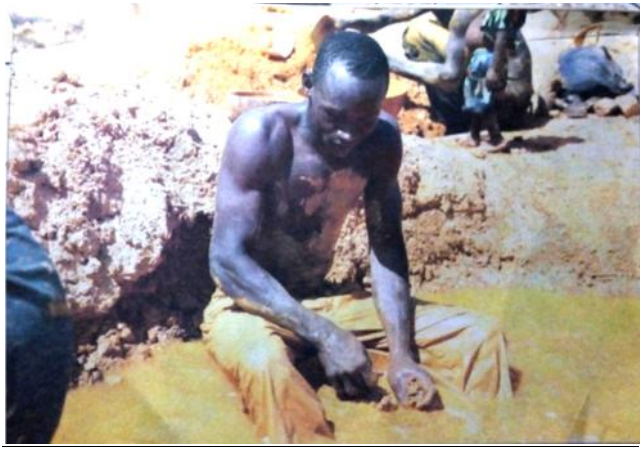


Fig. 8.13: Lead poisoning.

PUNCH

news

Lead poisoning kills 27 children in Niger State

...FG orders stoppage of mining activities

Friday Olokor, Abuja

THE Federal Government has confirmed the death of 27 children in a fresh outbreak of lead poisoning from illegal mining in Niger State.

The Minister of State for Health, Fidelis Nwankwo, stated this during a press briefing on Wednesday in Abuja. He said 63 cases of the outbreak had been confirmed by the government in the state while many animals in affected communities had died.

He said there is palpable fear among neighbouring communities in Kaduna State. However, he said the disease is in Zamfara in 2011, in which 400 people were killed.

According to him, the public should not have excessive fear over the outbreak but should instead take all precautionary measures against its spread.

On his part, Nwankwo said the Ministry of Health received report of the outbreak on May 7 and immediately swung into action.

He said, "The lead poisoning was confirmed and it is confirmed that most of the people affected are children below the age of five years. The affected children were found to have high serum lead levels of between 171.5 - 2244µ Pb/dl (normal is less than 10ug Pb/dl). That means, 17-22 times higher than the acceptable limits, as established by the World Health Organization.

"The rapid assessment by the NCDC/FMOH/MMSD revealed that as at May 12, 2015, 65 cases and 27 deaths had occurred, giving a case fatality rate of 43 percent. All the 27 cases were children below the age of five made up of 17 females and 11 males.

"Additionally, the finding revealed a serious impact on our livestock with cows, goats and chickens most affected. The devastating impact of this outbreak is associated with new mining sites which were found to contain more leaded ores which are often brought home for crushing and processing."

He listed efforts made by the government to include advocacy meeting with community leaders in the state, including sensitization of communities in the state.

Nwankwo explained further that the government had commenced the process of establishing incident command structure to enhance routine coordination of the outbreak response.

Besides, the minister said government was already mobilizing health facilities in Nigeria and Zamfara State to commence action.

He ordered that all laws affecting mining in the country should be respected while illegal mining should stop in the state.

From the foregoing, the need therefore to reduce the burden of kidney failures caused by nephrotoxin exposures in SSA countries cannot be over emphasized. The process must be Government driven with the support of the Nephrology Societies and Foundations, NGO's the media etc, to be effective and successful.

Prevention and control of Nephrotoxic kidney failure in SSA

The prevention of and reduction of exposure to nephrotoxic agents in the SSA countries can only be achieved through well articulated and sustainable public health measures that would be multisectorial interventional approach at National, regional and rural community levels. The active participation and involvement of the under listed stake holders is mandatory to ensure effective kidney disease preventive program.

Stake holders for effective kidney disease prevention program.

- **The central and regional health ministries.**
- **the National Kidney Professional Societies (e.g Nephrology Association of Nigeria (NAN).**
- **the National drugs and food regulatory authorities.**
- **Regulators of the Chemicals and Drug industries.**
- **The mass Media.**
- **The Legislature.**
- **Non- governmental organisations (NGO's) in health advocacy& Faith based organisations.**
- **Target communities.**

The process has to be driven by the central and regional ministries of health in collaboration with professional Renal Societies such as Nephrology Association of Nigeria (NAN), National kidney foundation (NKF). The process will involve:

i) Public health campaigns against use of herbal, non proprietary drugs and nephrotoxic chemical exposures.

The ministries of health in collaboration with Renal society/NKF develops the right public health educational/instructional materials to be used for renal health education, promotion and prevention.

The mass media and the civil advocacy groups will professionally deliver the message to the target audience using the appropriate medium such pamphlets, leaflets, radio and television messages and jingles, play- lets as well as the electronic social media on a sustainable basis.

While the general community can be reached through the mass media, focused groups such as faith based organisations, trade and occupational groups, educational institutions, military and paramilitary institutions etc are reached through direct advocacy(periodic seminars and workshops etc.) working through their respective leaderships/unions.

Such activities can be organised at timed periods and on special occasions such as the *world kidney, hypertension or diabetes days respectively*. Such campaigns must be far reaching continuous and sustainable. It must be taken to the market places, commuter buses, places of worship, schools, military barracks, primary health centers, public and private general out -patient clinics, and the rural communities.

The key content of the message is to expose to the public the short and long term kidney and other health risks associated with exposures to different types of nephrotoxins.

ii). Regulation of trado-medical practice and the use of traditional remedies.

In most SSA countries, legislations and regulations against the use, manufacturing, importations and distribution of nephrotoxic substances are either non existence , weak or largely dysfunctional due to weak enforcement mechanisms or failure to apply the rules).

The ministries of health in collaboration with renal associations, the legislature and the judiciary should ensure regulatory enforcement and where necessary reinforcement of obsolete regulations.

There is need to control the practice of herbal and trado-medical practice in SSA countries.

A special regulatory body backed by appropriate legislation, to regulate the manufacture, marketing, distribution, sale and consumption of herbal preparations and Nutritional supplements

should be established. Such products must undergo very strict safety evaluations before approval**.**

There should be a minimum certification and licensing for practice with strict code of conduct.

All acclaimed herbal preparations and nutritional supplements must be certified safe (i.e not injurious, even if of doubtful efficacy) for human use or consumption by Government authorized agencies.

Herbal preparations and nutritional supplements must have contents labels clearly stating the ingredients in their quantities, nutritional values as well as **literature insert** which shows the pharmacological ingredients, content, properties, indications and contraindications, dose and toxicology of such products.

iii**). Regulation and control of use of conventional drugs and other medicinal products.**

In a number of SSA countries, the control and regulation of use of conventional drugs and medicinal products are rather weak Regulations and legislations against the manufacturing, importation, distribution, prescription and dispensing of drugs exist (**108, 109**), but the mechanisms of their enforcement is often weak and deficient due to a number of factors. These include large populations and geographic areas to deal with (most of which are rural), infrastructural and human capacity deficiencies, deficient technology and lack of IT capabilities, budgetary deficits, and of course the lack of the political will.

As a result both over the counter (OTC) and ethical drugs are readily and freely imported, distributed sold and dispensed by persons not authorized to do so. Drugs with serious side and toxic effects are openly marketed and sold. This is even more prevalent in the rural areas where there are no clinics, pharmacists and doctors. Only patent medicine shops exist where virtually all drugs(OTC and ethical drugs) are sold and dispensed to the gullible public with all the potential hazards involved. Adverse drug reactions are never documented nor reported.

Measures to contain toxic kidney injuries.

There should be stringent legislation outlawing the operation of open drug markets in the SSA countries.

Stringent Legislation should prohibit government and private media organisations from accepting and airing drug promotional adverts from trado-medical practitioners and others.

Drug fairs in which drugs, herbal preparations and nutritional supplements are promoted should also be outlawed.
Tradomedical and alternative medical practice should be regulated and controlled.

Governments should have the courage to enforce the regulations and legislations.

In the urban areas where hospitals, clinics doctors and pharmacists abound all ethical drugs must be prescribed by **licensed prescribers** and dispensed by duly **registered pharmacists**. All prescriptions Should be endorsed with the **Physician stamp** reflecting the name and registration number with the physicians regulatory council such as the Medical and Dental Registration Council of Nigeria (MDCN).

Similarly, dispensing pharmacists, should also counter stamp the prescription (after dispensing) with **Pharmacists registration council stamp** reflecting the pharmacist's name and registration number. By this all prescriptions can be verified. In the rural areas with lack of qualified personnel, outlets that dispense **Only OTC** drugs should be permitted. Such outlets should be manned by persons with some basic health care training such as Nurse/ Midwives, nurse assistants, pharmacy attendants, etc. Such category of health staff should be exposed to short **certificate course on OTC drug dispensing management**.

Regulatory health personnel from the LGA and the regional ministry of health should conduct regular supervisory visitations to such outlets to ensure compliance with code of practice. The need for prompt referal of cases beyond their capability and recording of any adverse drug reaction must be emphasized.

All drug to be used in SSA countries must have the stamp of authority and approval of the government Food &Drugs regulator

authority such as the National Food and Drugs administration commission of Nigeria(NAFDAC) in Nigeria. In Nigeria NAFDAC have introduced mechanisms of authenticating genuineness of most drugs with the aid of electronic scratch cards embedded in the packaging of drugs.

iv) Enforcement of Industrial and manufacturing best practices.

As stated above under drug regulations, legislations and regulations for industrial best practices, exist in most SSA countries [**110, 111**] but the major impediment remain that of strict enforcement. This is so for the same reasons listed earlier and the problem of corruption of regulatory officials who deliberately ignore their responsibilities or even collude with fraudulent manufacturers and dealers.

Central and Regional governments in SSA counties should ensure that private and public drug and medicaments manufacturing entities within their jurisdictions, always adhered strictly to industrial best practices at all times. Regular industrial inspections and supervisions should be enforced at all times. Chemical products must undergo stringent quality control before being released into the market. Regulators should not hesitate to sanction any manufacturer found liable. Officials of regulatory bodies should avoid the temptation of accepting gratifications from manufacturers and dealers.

In this way such costly deliberate and inadvertent contamination of drugs and foods with nephrotoxins and other poisons would be prevented. All industrial activities with potential hazards of worker exposure to nephrotoxins such as lead, mercury, cadmium , petrochemicals etc, must operate in accordance with international industrial safety regulations.

Local inspectorate and regulatory agencies such as the **Standards Organization of Nigeria (SON)** must be legislatively empowered to deal with any erring corporate organizations including government owned organizations.

Environmental protection agencies must be legislatively empowered to handle all issues of environmental breeches by the Industry

It gratifying to note that the chief executive officer of the company that adulterated paracetamol syrup with ethylene glycol, which led to death of many children from renal failure, was successfully prosecuted and sentenced to life imprisonment (fig. 9. 2)). That would serve as a deterrent to other manufacturers. The outcome of the Zamfara gold mining disaster is still being awaited.

v) Introduction of drug safety education in school curriculum.

Safe drug and food education should form part of school curriculum at the pre-primary, primary and college levels so as to inculcate good drug and food habits into the psyche of children in their formative years. The central and regional ministries of health in collaboration with the NKF/Renal society and the ministries of education ensure the policy formulation and implementation. School proprietors and teachers should undergo periodic drug and food safety trainings.

Indeed in Nigeria, since the incorporation of the National food and drug administration commission(NAFDAC), which has worked to create awareness of the dangers of fake and adulterated drugs among Nigerian populace, ***Nigerian children are becoming increasingly conscious of "expiry dates" on manufactured and packaged drinks, foods and drugs . It is common these days to see school children in Nigeria wanting to see the expiry dates of packaged fruit drinks, beverages etc before accepting to consume them.***

This is as a result of media publicity against fake and adulterated food and drugs campaigns mounted by NAFDAC in Nigeria in the last couple of years. With such continuous safe drug education among school children, the new generations in SSA countries will stop patronizing untested herbal preparations, drug hawkers, open drug markets as well as the use of traditional potions. In this way exposures to nephrotoxic substances would be substantially reduced. Other SSA countries without such agencies as NAFDAC could come to Nigeria to under study NAFDAC and implement same in their countries.

vi) Regular availability, Access, and Affordability of safe drugs in the community.

One major reason, other than poverty and traditional beliefs, people in SSA countries patronise herbal medications and open sale of drugs, is the prevailing gross shortage of functional government health facilities in the rural communities. Where such health centers exist, stock-outs of basic essential drugs and medicaments is often the norm. Over 90% of drugs and medicaments consumed in most SSA countries are imported, they are expensive and not affordable to majority of the consumers. These factors lead to poor access to basic essential drugs by the rural communities [**112**]. As the people have no access to basic essential drugs, they resort to alternative remedies'.

Government and the ministries of health of SSA countries should endeavour to have functional, affordable and readily accessible primary and secondary health facilities in the rural communities.

SSA Governments should encourage the local manufacturing of essential drugs and medicaments in their respective countries. ***Foreign drug manufacturers should be encouraged or coerced to set up their drug manufacturing plants in the SSA countries rather than importing the drugs. This will lead to a dual benefit of cheaper drugs and employment opportunity for the local populace.***

Regular availability and access to basic essential drugs and medicaments to the rural community dwellers would substantially reduce the need to patronize the alternative sources. SSA ministries of health should ensure to have functional and effective PHC's manned by appropriate health personnel with regular stock of essential drugs within easy reach of the rural populace. Such facilities provide basic health care, basic maternal and child care as well as immunization and disease control care such as DOTS/Malaria program. Such centers can also be used for community screening for CKD and other non communicable disease(NCD) risk factors such as proteinuria, hypertension, Impaired glucose intolerance, metabolic syndrome etc.

vii). **Political will.**

Government at all levels in the SSA countries should demonstrate the **political will** to deal with these problems and mechanism to ensure sustainability. The processes outlined above are inherently cost intensive. Health being an essential social service, SSA countries must summon the necessary political courage to initiate and sustain the efforts.

The political-will encompasses the courage to make the necessary financial, policy, legislative and administrative input to ensure the safety and good health of its citizens. In return Government would ensure that citizens play their own role by way of health and other social taxation or insurance schemes compliance. All rate able adults and corporate organizations must be made to make their tax contributions to enable government have enough funds to execute health and other social services. A strong political will is necessary to enforce regulations and to deal with any erring individual or organization that violate regulations.

A strong political will is necessary for SSA governments to have the courage of closing down all open drug markets in their jurisdiction and to confront the drug cartels.

S2.2: Prevention and control of infections which predispose to kidney diseases.

A host of infective disorders are directly or indirectly (via immune reactions) associated with kidney disease and kidney failure. It is envisaged that control or eradication of such infections would lead to reduction in the burden of kidney failure in the society. In Europe and N. America regular immunizations which are integrated into the health care system and public health measures have led to drastic reduction in the incidence of some of these infections, with consequent reduction of incidence of glomerulonephritis as a leading cause of ESRD.

Some of the infections associated with kidney diseases are grouped as follows:

- Viral infections: Hepatitis B, C, HIV, etc. [**113, 114**].
- Bacterial infections: Nephritogenic streptococcus and staphylococcus species, etc. are associated immune complexmediated acute and chronic glomerulonephritis [**115, 116**].
- Parasitic infections (e.g P.falciparum, P.malarie, S.mansoni, S.haematobium, W.bancrofti, etc) [**117, 118]**.

These infections and infestations cause renal diseases either by direct attack on kidney tissues (pyelonephritis, HIVAN), through immune complex response reactions, (AGN, CGN, HIVAN, HIVIK), or renal fibrosis leading to obstructive uropathies (S.haemtobium), respectively. They are all communicable disorders which are potentially preventable or controllable through appropriate public health measures. They are endemic in most SSA rural and urban communities and continues to exact morbidity and mortality tolls in the region. The control and eradication of communicable disease continues to be a major public health challenge in SSA countries.

This failure is due a host of developmental challenges facing poor countries which include limited resources, lack of requisite technology, manpower shortages, poor health priorities, political instability as well as the vast geographical areas of coverage, etc. Often the little efforts made are not sustainable on the long term. So these infections remain endemic in most SSA countries.

The control or eradication of these communicable diseases in the SSA countries would go a long way in the reduction of the burden of CKD/ESRD in the SSA sub- region.

Immunization against hepatitis B, should be integrated into the national routine immunization programs of SSA countries. International efforts at developing effective vaccines for the control and eradication of Malaria and HIV [**119, 120**] are on going. It is hoped that when fully developed they would also be integrated into the National immunization program of SSA countries.

In SSA countries, Chronic glomerulonephritis (primary and secondary) remains the leading cause of CKD/ESRD despite some observed changing trends in recent times [**121**].

While some of the CGN are due to primary immune GN, the others are secondary to immune reaction to streptococcal, staphylococcal infections and other infections. There is need therefore for SSA countries to intensify efforts for controlling infections by these organisms. Improved standards of living and avoidance of overcrowding in homes(improved housing) and schools would reduce the rate of streptococcus and staphylococcus infections in children.

Efforts should be made to develop vaccines against nephritogenic streptococcus and staphylococcus species in SSA countries. Improved standard of living through higher educational attainment of families, would lead to less overcrowding in homes and schools, thereby reducing the incidence of these conditions.

The current campaign against prevention of HIV infection in SSA countries through the Global funds mechanismis yielding positive results as the population sero- prevalence of HIV in some SSA countries is showing decline and the mortality rate is also on the decline, though new infection rates remain high.

This improvement have been due to the public health campaign efforts, less stigmatization and wider access to ART in most SSA countries. These measures should be continued while research efforts for the development of an effective HIV vaccines is developed.

While universal access to anti -retroviral therapy(ART) should be the ultimate goal, physicians responsible for ART therapy should be careful with the use of nephrotoxic ART combinations. The use of Tenofovir- based combinations should be minimised. As recommended in the current ART guidelines, all newly diagnosed HIV patients should have baseline kidney function test among others done before commencement of HAART, and be monitored regularly thereafter. [**122-124.**]

The reduced incidence of Quartan malaria nephropathy (QMN) in children in most SSA countries in recent times, have been attributed to wide spread use of antimalarial drugs**[125]** ***in the region. This is a classic example of the role of infection control in the reduction or elimination of a disease burden in a geographic region.***

Public health measures such as improved environmental control, improved housing and living conditions , improved nutrition , improved educational attainments, behavioural changes etc, were dominantly responsible for the control and eradication of most communicable disease epidemics such as cholera, plague,(**the black death**), malaria, tuberculosis, etc in Europe and north America, following the industrial revolution and rather than the use of drugs. The pioneering efforts of Fathers of Public health such as **Paracelcus (1453-1600), John Snow (1813-1858), John Simon (1816-1904),** etc, led to the idea and the practice of environmental management in the control of diseases and epidemics during this era.[**126**].The activities of these sage pioneers lead to the passage of the first Public health "ACT" in the UK in 1848.The knowledge acquired from control and eradication of some communicable diseases led to the development of the concept of **Risk Factors** of Non communicable diseases(NCD). Risk factor prevention, modification and control have been amply demonstrated to prevent and reduce the burden of NCD's in the society.

This formed the premises for the ambitious WHO **2008-2013 Action Plan for the Global Strategy** for the reduction of the 35million deaths caused by NCD's annually , of which 80% occur in the middle and low income countries.[11] . Importantly therefore, strident efforts should be made by Governments of SSA countries to enable good governance and upscale the socioeconomic standards of the people. It is well known that education and socioeconomic empowerment enhance standard of living and enable better health seeking behavior of people. Communicable disease prevalence in any community is inversely proportional to the literacy rate and the GDP of such communities.

S2.3: Population Screening for early detection and intervention.

Focused and General population screening.

Apart from the public health strategies for prevention of nephrotoxic injuries and kidney disease induced by infection related conditions as discussed earlier, another major plank in the strategies for the prevention of kidney failure is the early detection of traditional risk factors such as obesity, hypertension, diabetes mellitus,

dyslipidaemia etc, and markers of kidney damage (proteinuria, haematuria). This process involves the screening detection for risk factors in target population groups. Screening detection schemes have been in practice in Europe, North America and some other jurisdictions in the 1990s [21,22]. It was however made popular in recent times by the International Society of Nephrology (ISN), following the introduction of the World Kidney Day (WKD) program, introduced to create global awareness of the problem of kidney diseases and kidney failure [**127**].

WKD exercises hold annually worldwide in the 2nd week of March. The first edition held in March, 2006. Each WKD has a **year theme** which emphasizes an aspect of kidney disease and kidney failure. During WKD, the nephrology community worldwide organizes public health campaigns, symposia and lectures around the year theme as well as engage in community kidney screening exercises. During the screening exercise, extensive general and kidney health education is usually given to volunteers. Volunteers have some biophysical and biochemical risk factors of kidney disease measured.

These include body mass index(BMI), blood pressure, urine examination, blood glucose, blood lipids measurements, etc. Volunteers who have significant risk factor abnormalities detected, such as significant proteinuria, blood in the urine, high blood pressure, high blood glucose, abnormal lipid profiles etc were counseled, administered some medications and referred to the nearest medical facilities with nephrology care services for further evaluation and interventions.

There have been arguments about the extent to which population screening for kidney disease should be done. Some schools of thought are of the view that since the prevalence of CKD is less than 20% in most populations, is not cost effective to screen entire population, with low yield at prohibitive cost [**128, 129**].They rather advocate screening of at-risk groups. This model is suitable for developed countries of Europe and .America where routinemedical examinations of all persons at birth and at certain critical milestones in life is compulsory. This enables early detection of risk factors of CKD quite early. This is not the case for SSA

health systems where for broad majority of subjects, their first encounter with the health system is when they become sick.

For SSA countries therefore a continuous population screening method that is an integral component of the National healthcare delivery system would be cost effective and capable of detecting potentially risk persons early and at risk persons before they become symptomatic. In CKD once patients become symptomatic the tendency to progression to ESRD becomes inevitable. Thus early detection and early intervention in SSA countries should be the goal. This would be most appropriate for SSA countries with poor resources.

Given below are my proposal on how CKD screening programs can be integrated into the National health systems of SSA countries that would not incur much extra costs. The major problem would be installing the process and the close monitoring of the implementation on a continuous and sustainable basis.

S2.3a: Focused grouped screening.

Routine and Compulsory screening at birth and pre-school screening detection. Under the prevention in neonatal units discussed earlier, the need for possible intrauterine diagnosis and possible intervention in-utero as well as the need for compulsory examination of all new borns for any congenital disorders have been stated. Most congenital kidney disorders are likely to be detected at birth and during the early childhood years.

It should be **a compulsory government policy backed with legislation** in SSA countries to ensure that all children before enrolment into nursery, primary, and secondary schools undergo pre-school medical check-ups which should include physical examination, urine analysis and microscopy, blood count, haemoglobin, genotype, blood glucose and chest x-ray. Such legislation would empower schools health inspectors to monitor all primary and secondary educational institutions, both public and private for compliance. In this way risk factors for childhood renal disease can be detected for early intervention thereby reducing the incidence of CKD and subsequent ESRD.

Any child found to have any significant abnormal finding is referred to the paediatrician or paediatric nephrologists for further

evaluation. Screening of this age group would lead to early detection of entities such as:

- Congenital abnormalities of the kidneys and urinary tracts(CAKUT) which may have been missed at birth and infancy.
- Autosomal dominant polycystic kidney disease (AKPDS)
- Congenital nephrotic syndrome & minimal change disease,
- Chronic glomerulnephritis,
- Sickle cell nephropathy, etc, before they become symptomatic.
- Infection related kidney disease, etc

S2.3b: Compulsory Pre-employment/ pre-military recruitment & pre- Insurance screening detection.

Although it is customary in most SSA countries for medical examinations to be undertaken for the purpose of employment, military service recruitment and for life insurance purposes, the enforcement process is weak. Often times, the pre-employment/recruitment medical examinations are often over looked or fraudulently done. No attention is given to kidney abnormalities. Subjects with renal dysfunction thus not detected early. The are referred only when the condition become manifest long after the time of employment or recruitment.SSA countries should have legislations that make it compulsory for people to undertake comprehensive medical examinations duly conducted by qualified medical doctors for the above purposes. Subjects with significant risk factors for kidney disorders or other NCD's should be referred to next level of care for proper evaluation and management. Such medical examinations must be comprehensive capable of detecting common abnormalities that may require further attention. Subjects detected to have any significant kidney or cardiovascular abnormalities should be referred to the physician or nephrologists for further evaluation. In this way risk factors for CKD and early CKD as well as other risk factors for CVD can be detected for early intervention. Hospitals and regional ministries of health should Endeavour to establish data bases/registries for such medical evaluations.

S2.3c: Antenatal screening detection

Though the incidence of chronic kidney disease and ERSD in pregnant populations is low [**130**], CKD3-5, in pregnancy is associated with poor feto-maternal outcomes, while ESRD in pregnancy is associated with near 100% IUFD and high maternal mortality [**131**].

Routine screening detection of markers or risk factors of CKD during all ante-natal visits from the second trimester of pregnancy, would lead to early nephrologists' intervention and co-management of the patient with the obstetricians throughout the pregnancy for a better feto-maternal out comes.

Previously undiagnosed renal disease, such as nephrotic syndrome, chronic glomerulonephritis, Lupus nephritis, etc may become manifest for the first time in pregnancy or in the post partum period.

Routine urinalysis and microscopy during antenatal visits would uncover these conditions for early intervention. Traditional ante-natal services in SSA countries, rarely include baseline kidney function tests. It is recommended that all antenatal patients should have baseline urinalysis, microscopy and kidney function tests done at antenatal registration and periodically as indicated throughout the pregnancy and post partum period. This would help in early detection of underlying kidney disease in antenatal patients as well as help establish a renal function baseline for the mothers who may develop AKI in pregnancy (Severe pre eclampsia, peripartum haemorrhages, sepsis, etc.) and in the pueperium. The cost for basic antenatal screening can be built into the antenatal registration fee. So patients make one lump sum payment at registration.

Given the expected low yield of CKD in pregnancy, it may be argued that the addition of renal indices as part of ANC care, would not be cost effective, constituting extra financial burden on the low income ANC population. The corollary to the argument is that such screening would ensure early detection and early intervention in the those few who may have kidney related complications of pregnancy with consequent reduction in perinatal deaths and maternal mortality in the SSA sub region.

S2.3d: General population screening detection.(KEEP model)

This is the process of screening members of the general public or at risk target populations for the detection of risk factors , markers of CKD and the early detection of chronic kidney disease to enable early intervention. Early detection and early intervention have been proven to retard progression of CKD [**132, 133**] .

This is the philosophy behind the KEEP program [21] being implemented in the USA and parts of the world with encouraging reports. The KEEP program in various countries is often designated after the name of the country or city where it is implemented. There is thus:

The US-KEEP, Mexico city & Jalosco state KEEP, Japanese KEEP, Australian KEY(Kidney disease early detection and you project, Indian Kidney help Trust, Guatamalia FUNDAINER project, the Dutch PREVEND programs ,etc [74-76].

They are all patterned along the US KEEP but with some local modifications. The United states NKF-KEEP program is perhaps globally, the most sustained CKD screening, detection and awareness program. The program commenced in the year 2000 with KEEP population drawn from among Americans, 18 years and above across most of the states. It is strictly volunteer based recruitment program . All racial groups in America (whites, African Americans, Hispanics, Native Americans Asians, etc) are represented. Recruited subjects are screened for family and personal history of major risk factors of CKD (obesity, hypertension, diabetes, etc.).

Patients have their BMI ,blood pressure, blood glucose, urine protein, Haematocrit, blood urea, creatinine and electrolytes, lipid profiles, serum calcium and phosphorous, plasma total protein and albumin, etc measured. The renal function status (spot urine albumin: creatinine ratio(ACR) and estimated glomerular filtration rate(e-GFR) of the participants is determined using the appropriate formulae. These are done on first encounter to establish baseline status.

Subsequently all these parameters are re-determined annually to show trend over time, monitor progression and determine outcomes. Participants found to have significant risk

factors for CKD are counseled on life style modification while those with various stages of CKD are referred to nephrology service and enrolled into the Medicare program. Annual KEEP reports are issued. Between 2000 and 2011 a cumulative total of **127, 972** participants have been enrolled into the program and followed up annual

Benefits derived from analysis of KEEP data.

- KEEP have succeeded in establishing the baseline CKD and cardiovascular risk factor data base of participants across the USA which is a veritable resource for planning and future projections.
- KEEP data has shown that a significant proportion of participants were not aware of their CKD and CVD risk factor burden at time of first encounter.(Iceberg phenomenom)
- A significant proportion of those with self reported risk factors were not on any medically supervised therapy or lifestyle modification.
- KEEP data provides information on the distribution of stages of CKD as well as the rate of disease progression in participants over time.
- KEEP data demonstrates evidence based data on the benefits of early detection, early referral and early intervention in CKD.
- KEEP data provides the baseline and time trend progression from referral to a nephrology service and early intervention in slowing the progression of CKD and thereby reducing the morbidity and mortality associated with CKD and reduction of cardiovascular deaths associated with CKD/ESRD.

Though opinion differ on the cost effectiveness of such screening programs , experience with KEEP programs in the US, Canada, Mexico, Japan and some other countries have demonstrated significant reduction in the incidence of ESRD and delayed progression to ESRD following intervention in those countries.

KEEP Model and SSA countries.

A major set back of the KEEP program is that it is not a primary CKD preventive initiative.

KEEP focuses mostly on non-communicable disease (NCD) risk factors of CKD/ESRD ie. obesity, diabetes, hypertension and dyslipidaemia as the risk factors for CKD among adults 20 years and above in a cosmopolitan population. This is understandable given the CKD-epidemiology of the operational environment in Europe and N. America.

Some of the inadequacies of US and European KEEP model as applied to SSA countries are that:

- KEEP does not cover children and young adults below 20 years. This age groups constitute the first demographic peak in CKD prevalence in SSA countries .[13,14]
- KEEP is not designed to prevent and detect infection and nephrotoxin related CKD such as post infectious chronic glomerulopathies (CGN), Chronic pyelonephritis, (CPN), and toxic nephropathies.
- KEEP also does not cover early detection of Congenital abnormalities of the kidneys and the urinary tract (CAKUT) , etc. which are all important causes/risk factors for CKD in SSA countries.

KEEP-like screening and preventive program in SSA countries should therefore be modified to be encompassing and holistic to cover all the vulnerable groups in the SSA populations such as new born and infants, pre-school children, pre-employment/military recruitment population, ante-natal populations and the general adult populations.

Proposed kidney health promotion and CKD Screening detection program for SSA countries. In the SAA countries three approaches to community CKD screening detection can be adopted.

1. Focused group screening.(This have been discusses above).
2. Periodic cross sectional CKD population screening & prevention:

3. Primary health care clinic (PHC) - based Integrated continuous CKD screening & prevention.

Periodic cross sectional CKD population screening &prevention: This is the World kidney day screening model except that it can be made more frequent than WKD screening activity which come once a year. The process for the cross sectional model involves identifying and choosing target population(s) for screening detection. This is then followed by sensitisation and mobilization of the chosen community, through opinion leaders of the of the community. Such target screening populations include Rural communities, communes within an urban populations, focused groups such as educational institutions, military and police barracks, trade/vocational unions and Faith based organizations (churches, mosques etc). The public media (electronic and print), town criers and other local information dissemination methods, are used through community leaders, to sensitize and mobilize members of the target community for the exercise.

On the appointed date volunteer members of the target community present themselves for the screening detection exercise. The exercise starts with health education on healthy living followed by kidney specific health education. The subjects demographic data and brief medical history are recorded in pre-designed data sheet or register. Parameters for measurement include biophysical measurements (weight, height, waist and hip circumferences, BMI-determinations etc), Blood pressure measurements, Urine sampling for micro-albuminuria, dipstick proteinuria and urine microscopy.

Others are blood sampling for determination of blood glucose, lipid profiles, electrolytes ,urea creatinine and uric acid. The baseline e-GFR of the subjects are derived using the EPI-CKD formulae. Subjects found to have risk factors are counselled and kept under surveillance, while detected cases of CKD are referred to the nearest medical facility with nephrology services, for further evaluation and early intervention.

In this way the population receive kidney related health education, those with risk factors such as hypertension, diabetes, etc, are counselled and referred for further education and treatment, while cases of established CKD are referred to kidney

centers for early intervention. Such exercises are carried out either on ad-hoc basis or during designated world health celebration days such as world kidney day, world hypertension day, world diabetes day, etc. respectively. In recent times, a number of **nongovernmental organizations (NGOs)**, faith-based organizations. etc embark medical outreach programs.

Most of their activities are however not coordinated by the health ministries so the data generated by such NGOs are hardly available for planning. Renal societies and Governments of SAA countries should partner with such organizations to coordinate their activities, retrieve data generated for health and kidney disease planning. The adult and paediatric renal units of the University of Port Harcourt teaching hospital carry out such community CKD screening detection exercises. Fig 8.14 and 8.15 show a scene at WKD screening exercise, while table-19 shows summary data of WKD and community risk factor screening exercises by the adult renal unit between 2009 and 2015 respectively.

Fig. 8.14: Kidney health education to students in Port Harcourt during 2016 World kidney day activity.

Fig.: 8.15: Kidney disease populations screening exercise during 2016 World kidney day activity.

Outcome of Population screening for Risk factors of CKD by the Renal unit, UPTH (2009-2015).

Table 8.2: Prevalence of Risk factors of CKD in communities in Rivers state.

Parameter	**Barako (Gokana LGA)**	**Ogbodo (Ikwerre LGA)**	**Obuama (Degema LGA)**	**Ogu (Ogu-Bolo LGA)**	**Uniport. (Obio/ Akpor LGA)**	**Average.**
Year Population screened. Mean age (years)	2009 154 49.7 ±13.9 (18-85)	2010 125 47± 12.7 (20-88)	2011 137 50.4±5.6 (17-93)	2013 120 50.1 ±14.7 (15-84)	2015 259 28.3 ±9.7 (16-66)	**Total 795** **Av(159)** **45.1+11.32** **(15-88**)
Risk factors(%) Proteinuria Obesity Pre-hypertension Hypertension Diabetes ======== Prevalence of CKD. (e-GFR less than 60ml/min/1.73m^2)	 29.6 33.3 27.9 29.6 5.0 ===== 	 57.7 27.2 28.6 28.6 2.4 ===== 	 35.0 59.1 17.2 51.1 7.0 ====== 	 27.4 27.5 29.1 48.7 2.5 ==== 	 12.4 12.2 xx 20.8 4.3. ======= **1.9**	 **32.4** **31.9** **25.7** **35.8** **4.2**

LGA-Local government area; e-GFR -estimated glomerular filtration rate.

Inferences form screening for Risk factors of CKD by the Renal unit, UPTH (2009-2015).

- **There is a high prevalence of risk factors of CKD among adults in Rivers state communities.**
- **There is a large reserve of future hypertensive individuals (Pre-hypertension) among adult Rivers state communities.**
- **Adult Rivers state populations are at high risk of chronic kidney disease and cardiovascular diseases, such as heart failure, coronary artery disease and stroke.**
- **These entities constitute the commonest causes of hospital morbidity and mortality in the Riverine environ.**
- **There is need for continuous population health education, health promotion, and early intervention to prevent these catastrophes among adult Rivers state population and by extension Nigeria and SSA populations.**

Proposed PHC-integrated continuous CKD screening & prevention program for SSA countries.

As stated earlier whereas, the periodic cross sectional CKD screening detection approach is useful, it is often ad-hoc, periodic and limited to a small segment of the population. Its operation is not structured and therefore lack sustainability. A CKD prevention, screening and detection system that is integrated into an existing health system would have the attributes of **continuity, sustainability and wider population coverage**. It would operate at little or no extra financial burden on the existing health system. This would be most suitable for middle and low income economies as the SSA region. The **PHC-integrated CKD screening& prevention model is thus** strongly recommended for adoption in SSA countries.

Though not an entirely new concept [**134**], but it has not been universally implemented nor adopted. I shall be propounding a modified form of the program that would be most suitable, cost effective and sustainable in all SSA countries.

Program concept and philosophy:

The primary health care (PHC) system is the health system closest to the people and the first port of entry of most persons into the health care delivery system of any country. With an efficient PHC systems, significant number of illness are encountered for the first time at the PHC level before referral to other levels of care.

Most chronic ailments especially the NCD disorders (hypertension, diabetes, stroke chronic lung disorders, CKD etc.) are often insidious in onset, remain asymptomatic for a long time before manifestation of symptoms. With simple tools most of the NCD's can be detected early at PHC level from where they are referred to other levels of care.

This is the norm in most developed countries with well structured referral systems. Every patient enters the health system through their General Practitioners (GP) or Family physician, from where they are referred to subsequent levels of care.

This is responsible for early detection and intervention in chronic illnesses in those jurisdictions.

Unfortunately in most SSA countries the PHC system is largely dysfunctional and poorly organizmed. The referral system is unstructured and chaotic. A significant proportion of patients enter the health system for the first time at the tertiary care facilities. This leads to service overload at the tertiary health care level, with stunting of tertiary level care and research.

Using Nigeria as a surrogate case, the country is geopolitically divided into 36 semi-autonomous states and **774 local government areas (LGA's)** by the 1999 Nigerian constitution. Each of the 774 LGA have a no less than 10 primary health centers (PHC) which translates to a minimum of about 7,740 PHC centers.(1 PHC to21,964 persons).

Integrating CKD screening program into the PHC system would no doubt provide a very wide and sustainable coverage for CKD tracking in the country. This can be applied to other SSA countries. What is important is the strengthening of the PHC system to be functional and effective in each of the SSA countries.

Learning point.

SSA COUNTRIES SHOULD ENDEAVOUR TO STRENGHTEN THEIR PRIMARY HEALTH CARE SYSTEMS FOR MORE EFFECTIVENESS.

The aim of the proposed program is integrate kidney health promotion, early detection and early intervention into the existing PHC system in SSA countries.

Objectives of the Program:

- To ensure continuity and sustainability of the CKD screening program,
- Ensure regular source of subjects for screening,
- Establish a structures and sustainable Renal referral system.
- Reduce costs of screening,
- To develop CKD data base for communities for research and planning of renal services.

Operational modality of program.

- All patients from the target community registered and attending PHC-clinic are screened for risk factors and markers of for CKD upon first entry into the PHC to establish a CKD risk factor baseline data.
- All PHC patients with significant CKD risk markers would be sorted for the attention of a visiting **Community Preventive Nephrology Practitioner (CPN- practitione**r) trained to provide first line renal care for at risk subjects and those in the early stages of CKD at the primary care level.

The CPN – practitioner shall serve as linkage between the community, the PHC-center and a **Center-Based nephrology Service (CBNS**) such as the Renal unit of University of Port Harcourt teaching hospital.

- All registered PHC patients with CKD risk factors such as over - weight/obesity, hypertension, diabetes etc, are given kidney health promotion and preventive health education regularly. Intervention measures are also initiated by the PHC doctor and the CPN-practitioner.
- The CPN- practitioner evaluates all such subjects for determination of CKD status. Subjects with risk factors or in

CKD 1-2 continue life style risk factor modification care and regular follow-up at the PHC level under the supervision of the PHC medical officer and the CPN- practitioner.

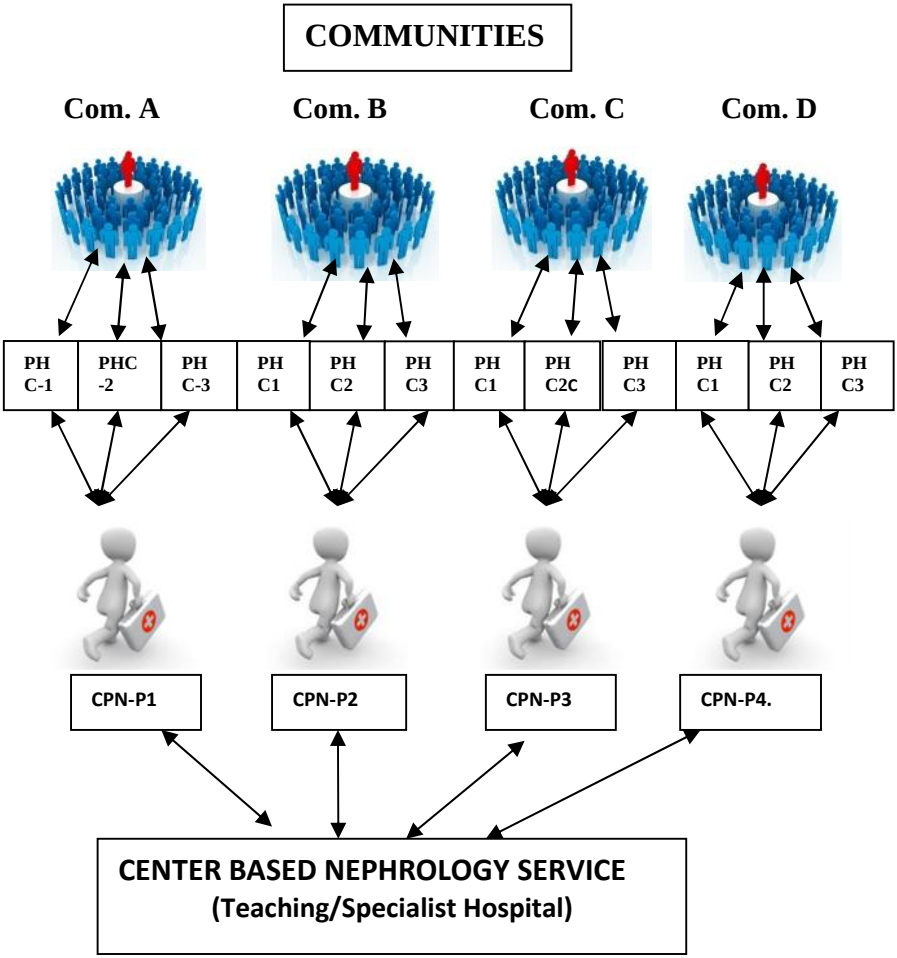
- PHC registered patients who at first encounter are in CKD-3a or those who progress to CKD 3a, from CKD1-2 are then transferred to the collaborating center- based nephrology service, by the CPN-practitioner for further evaluation and care by the Nephrology Service .
- The PHC medical officers and nurses shall be given basic training on CKD-risk factor and CKD marker detection and **red flags** to initiate referral.
- The CPN- practitioner serves as the liaison between the PHC's and the center-based nephrology service.
- The CPN- practitioner would be specially trained for the job.

Attributes of the PHC integrative CKD preventive program.

- The process would be community based with linked with a **Center-Based Nephrology Service** (CBNS) on a continuous basis. It would be integrative, delivered as part of Primary health care service.
- It would be proactive through the promotion of **kidney health promotion** and healthy life style to all PHC attendees within the community, on a continuous basis.
- It would provide continuous CKD screening detection for all patients attending the primary health care units as well as to members of the host community.
- It will achieve a **double barrel** effect of detecting shared risk factors for CKD and other NCDs such as cardiovascular and cerebrovascular disorders, etc, for early detection and intervention, thereby enhance collaboration with other stake holders in the prevention of non-communicable diseases (NCD'S).

Fig 24 below is a sketch of the spatial relationship of the proposed scheme.

Fig.8.16: show the sketch for the operational modality, for the proposed scheme respectively.



Requirements for the proposed program.

1) Infrastructure.

- ❖ The primary health centers (PHC's) which shall provide operational base and window to the community.
- ❖ Out patient units of secondary health centers and private clinics which are equivalent to PHC'S.
- ❖ Center- based nephrology service within the locality of the PHC'S (eg.nephrology service of teaching or specialist hospitals in the area).

2) Human resource.

- ❖ The community preventive nephrology(CPN) – practitioner (CPN-P)
- ❖ The core-PHC staff (medical officers, nurses, laboratory technicians, medical records officers etc).
- ❖ Nephrologists and nephrology nurses at the center based nephrology service.

3) Government policy and political will for program ownership and program sustainability.

Infrastructure.

Primary health care centers. (The Nigerian template).

The contemporary administrative structure of Nigeria is a three tier system comprising the Federal Government at the center, the state Governments at regional level and the Local governments at the rural areas. There are **774 LGA'S** in Nigeria which are further split into wards or communes.

By the Constitution of the Federal republic of Nigeria and the Nigeria national health policy [**135, 136**] as revised, health care is on the concurrent jurisdictional list. All three tiers of Government have a role to play in health service delivery. The Federal government directs health policy formulations and play the major role in tertiary and international health care delivery, the State governments take charge of mainly secondary and some primary health care services, while the LGA's take charge of primary healthcare services. Thus the primary health centers (PHC) are administratively under the jurisdiction of the LGA's. In practice however, due to the financial weakness of the LGA's the state

governments play the key role in the running of the PHC centers through the **Primary health Care Directorates** of the state ministries of health. Primary health care co-ordinators, (who are senior medical officers of health) are appointed to supervise the activities of the PHC in the rural communities on behalf of the state ministry of health (SMOH).

The PHC staff comprises the medical officer in- charge, head nurse of the rank of Chief Nursing officer, Community health nurses and midwives, few laboratory staff, etc.

Services rendered at the PHC levels include simple medical and surgical disorders such as uncomplicated malaria and febrile disorders, appendicectomies, lumpectomies Incisions and drainages, repair of lacerations, etc. Others include antenatal services and simple vaginal deliveries for uncomplicated pregnancies. Complicated problems are referred to the nearby comprehensive health center (General hospitals) or to the specialist and teaching hospitals. In addition the PHC also serve as outlets for routine immunizations, National TB-control units and HIV/AID treatment centers.

The PHC's are thus well suited for first contact for the screening of the population for risk factors of kidney disease, early kidney health promotion and prevention and for linkage with a center based nephrology center.

1b) Outpateint departments of private and missionary health centers.

In Nigeria private medical centers, missionary health units and the outpatient departments of some teaching and specialist hospitals offer primary health care services. Such outlets could also serve as infrastructure for the program, where the Preventive Community nephrology practitioner can interface with patients.

1c) Nephrology units of Specialists and teaching hospitals.

The Nephrology units of specialist and teaching hospitals within the catchment area of a cluster of PHC'S will serve as the **referral infrastructure** for all cases of significant kidney disease at the PHC

level. The would constitute the **Center based Nephrology service (CBNS)** for the program.

2. Human resource.

2.1 Community Preventive Nephrology Practitioner (CPN-P)

The Preventive nephrology program shall be anchored around a specially purpose trained Community Preventive Nephrology Practitioner (CPN-P) who shall constitute the liaison between the Community/PHC's and the Center based nephrology centers. The CPN-P shall be full time a staff of the Nephrology unit who will be visiting the PHC's for the evaluation of all PHC patients for risk factors of kidney disease on a sustained basis, for early detection and early intervention.

The training would enable the CPN-P to be able to detect risk factors for kidney, manage uncomplicated cases and refer all established cases of CKD to the nephrology center. The CPN-P would also organize periodic kidney health education within the communities in the catchment populations of the PHC's as well as be able to guide the PHC medical staff on risk factor red-flags for kidney disease.

2.2 Medical staff of PHC'S.

The medical officers, nurses and midwives also constitute human resource base for the program. The program success is hinged on their willingness to cooperate and collaborate with the CPN-P. The are the first to encounter the patients. They would be trained to ensure that every patient attending their PHC had some basic checks done such as blood pressure measurement, determination of BMI, urinalysis for proteinuria and haematuria as well as urine microscopy and fasting blood glucose. The attention of the CPN-P sought for any patient with red flags for kidney disease.

2.3 The staff of the CBNS.

The consultant nephrologists and renal nurses must be active participants in the program in liaison with the CPN-P. A committee (**Community preventive nephrology program committee**) comprising consultant nephrologist(s), The CPN-P, Senior renal

nurse(s) and Senior Renal registrar(s) should be constituted to drive the program and reports to the head of the CBNS.

Duties and responsibilities.

The community preventive nephrology program revolves around the community preventive nephrology practitioner. The CPN-practitioner serves as the (**long missing**) link between the community, and the center- based nephrology services ie the teaching and specialist hospitals in SSA countries. The CPN-practitioner shall be full time staff of the center -based nephrology service, which coordinates the program in its area of jurisdiction.

- One CPN- Practitioner shall over see a cluster of PHC centers.
- Provides training for the PHC staff on the recognition, and documentation of at risk subjects.
- Attends to subjects whose risk factors can be managed at the PHC level in collaboration with the medical officer of the PHC. Ensures early detection of infections and nephrotoxin exposures and their prompt management. Such conditions as obesity (grades 1-3), pre-hypertension, hypertension (grade1) CKD grades 1-2 , uncomplicated diabetes, can be given first line treatments at the PHC level.
- Transfers all subjects with more significant risk factors and advancing CKD, who will require nephrologists' attention, to the supervising center- based nephrology care service.
- Ensures proper records keeping at the PHC centers. Keeps track of all registered patients by phone and conducts periodic home visits for subjects who may abscond form clinic visits.
- The community preventive(CPN) nephrology practitioner in collaboration with the center- based community nephrologists shall conduct periodic advocacy and renal health promotion and education seminars from time to time to all patients registered in PHC facilities.
- In collaboration with the center based nephrologists conducts periodic cross-sectional target community CKD screening detection surveys.

- Collates the community derived data for onward transmission to the center based nephrology service for the development of renal registry and research in the area.

Critical role of the CPN-P:

THE COMMUNITY PREVENTIVE NEPHROLOGY PRACTITIONER (CPN-P) IS KEY TO SUCCESS OF THE
THE COMUNITY PREVENTIVE NEPHROLOGY PROGRAM.

ANTICIPATED CHALLENGES

- **Program ownership and domestication**

The first major challenge is how to make the political and health policy formulators in the SSA region be convinced to enable them key into the program philosophy and take ownership of the program. Health policy makers in SSA regions need to be confronted with the hard facts and data of the magnitude of the CKD/ESRD problem, its horrendous magnitude of human sufferings and deaths, the huge financial requirement for care far beyond the reach of the victims and their families as well as the huge socioeconomic loss as a result of ESRD in the regions.

It is the responsibility of the National Renal Associations working in collaboration with other non-state actors in the SSA countries to continue exert necessary pressure to do the convincing based on evidence.

The respective SSA National ministries of health, should collaborate with their National Renal societies (eg The Nigeria Association of Nephrology) as joint stake holders) in taking ownership, planning and execution of the program.

- **Incentives for Primary health center staff.**

The second challenge to be anticipated is the cooperation of the PHC staff who may see the little extra attention to their patients (urine testing, better record keeping etc) as a burden and "extra work" for which they will be expecting extra remuneration. This is so because in most third world settings, especially in Nigeria, attitude to work by public health workers and most other sectors is relatively poor.

Without the necessary push most workers are reluctant to perform the responsibilities for which they are paid. They may show **antagonism and aggression** towards the program and the Community Nephrology Preventive –Practitioner.

In this respect, the regional (state) ministries of health, which employs the PHC staff would ensure that rural based health workers are given appropriate incentives for motivation such as "rural posting allowance".

- **Incentive for the Community preventive nephrology Nurse practitioner.**

Thirdly, the CPN- practitioner around whom the success of the program is hinged should be given all the necessary support to ensure efficiency in service delivery. This staff would be bringing basic nephrology care to the community level and will be shuttling between the communities and PHC centres and the centre based nephrology service. Therefore, all necessary job incentives should be provided. These include:

- Appropriate job placement and career progression in respect of the new qualification acquired, within the teaching or specialist hospital remunerations system.
- They should also be entitled to rural posting allowance as other rural health workers.
- Provision of transport and other logistics for job efficiency..

- **Involving the staff of the Centre-based nephrology unit of the teaching and specialist hospital.**

The nephrologists and the renal nurses in the center based nephrology unit (CBNS) should be part of the program. Indeed a **Preventive nephrology unit** (PNU) with Consultant nephrologist(s) in charge, should be created as a subunit of nephrology units in SSA countries. The consultant(s) in-charge of this subunit shall oversee the work of the CPN-nurse practitioner. ***The National Renal Societies of SSA countries should examine the feasibility of developing "Preventive nephrology" as sub-discipline of Nephrology training and practice in the SSA countries.***

Conclusions

- Kidney failure is an emerging public health concern with increasing burden globally and especially in the Sub-Saharan African countries. With a Population of about 800million people, and CKD prevalence of about 13% . ESRD population prevalence of 0.2%, the annual burden of CKD in the region would be about 104 million people, and an annual ESRD burden of about 1.6million persons .
- At an estimated average annual cost of care for ESRD of $70,989.0 per person per year, the SSA countries will require **11.36 trillion US-Dollars** per year for the care of ESRD patients in the region. This amount far outstrips the total annual budget of all the SSA countries put together.
- It is thus evident that the SSA region does not have the financial capability to deal with this singular health challenge. Due to low level of socioeconomic development of most SAA countries, the human resource, infrastructural, medical equipments and medical consumables for optimum care of ESRD patients in the region are grossly deficient.
- The outcomes of ESRD care in the region is gross suboptimal care, manifest as very low health related quality of life, high morbidity and an unacceptable high mortality rates of over 80% within the first year of diagnosis.
- It therefore stands to reason that the only way out for SSA countries to ameliorate the horrible ESRD state in the region is to explore **the preventive option** .Fortunately a significant number of the risk factors or disease conditions underlying ESRD in the region are either potentially preventable non-communicable diseases or controllable communicable diseases
- Unfortunately at the present there is no coordinated efforts in most SSA countries aimed at the prevention and control of kidney failure in the region. Indeed in most SSA countries the problem and burden of ESRD in the SSA countries have not come to the consciousness and awareness of most Governments. Public awareness is only created through victims of ESRD,

soliciting for financial assistance, using the public media, especially in Nigeria.

- This exercise is an effort to bring to the attention of SSA countries the urgent need to pay attention to the prevention of Kidney failure in the SSA region as the primary strategy to control and manage serous burden of ESRD in the SSA region. The strategy for its actualization at minimal cost is proposed.
- Such Kidney failure prevention and control exercise must be **government driven** and in partnership with all stake holders which include the National Renal Associations, the National legislation, other related government sectoral ministries, the health related Non-governmental organizations(NGO's) the media, and the community.
- The ESRD prevention and control strategy must be comprehensive, holistic and an integral component of the Nation's health care delivery system with the Primary health care (PHC) unit serving as the pivot of the operation.
- The Programme should encompass community based kidney health education and promotion, prevention and control of communicable diseases that predispose to kidney failure as well as prevention and control of non-communicable diseases predisposing to kidney failure. It should also include the prevention of hospital acquired kidney failure in all clinical settings of hospitals.
- The program should be a close knit referral system between the PHC/Community and center-based nephrology centers in teaching or specialist hospitals nearest to the communities. A program specific specially trained **Community preventive nephrology - practitioner (CPN-P)** shall constitute the referral human resource link between the community and the center-based nephrology service(CBNS).
- This program as conceptualized is relatively cheap as it will not add much extra health budgetary constraints to the annual health budgets of SSA countries, because it is going to utilize already

existing human ,material and infrastructural resources to actualise the program with huge advantages.

- Successfully planned and operated, the program would lead to long term progressive reduction in the incidence and prevalence of the diseases which predispose to CKD and other NCD's in the region.
- The program can serve as a template for the WHO strategies for control of Non-Communicable diseases in the SSA countries.
- The success of the program depend on the political will of government and the willingness and dedication of all health personnel involved in the programme.

Ultimate socioeconomic benefit of program.

- Community awareness of kidney disease.
- Increased awareness of kidney health promotion.
- Reduced incidence of Risk factors.
- Reduced incidence and progression of CKD.
- Reduced incidence of ESRD.
- Reduced death rate from ESRD.
- Reduced Expenditure for ESRD.
- Improved the quality of life and greater productivity.

Progam success:

The success of the program depend on the political will of SSA Governments and the willingness and dedication of all health personnel involved in the programme**.**

The Challenge.

"THE CHALLENGE IS BEFORE SUB-SAHRAN AFRICAIS TO TAKE ITS DESTINY IN HER HANDS BY TAKING PROACTIVE MEASURES TO REDUCE THE BURDEN OF CKD/ESRD AND PREVENT THE UNACCAEPTABLY HIGH PREMATURE DEATHS OF PRODUCTIVE SEGMENT OF THE SSA POPULATION."

“YOUR KIDNEYS IN YOUR HANDS”

Thank you for patient listening.

Presentation of Lecture to the Vice Chancellor:

The Vice Chancellor Sir, it is my honor and privilege to present to you this 150th University of Port Harcourt Inaugural lecture, in the hope the Governments of Sub-Saharan African countries would implement the contents to ameliorate the gruesome burden of kidney failure in the sub region.

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PROFESSOR FRIDAY SAMUEL WOKOMA

Birth: Born January 14, 1954 to Late Oba (Kabiyesi) Godmade Ashade, of Ogba Kingdom, Ikeja, Lagos and Late Mrs Vidah Ashade (Nee Allen-Wokoma). The third and last son of his mother. He was later to be fostered by his maternal uncle Late PA Samuel Allen – Wokoma, junior brother of his mother at the instance of his maternal Grand mother. Late Madam Eugenia Jane Allen-Wokoma (nee Amadi) of Njemanze family stock, Owerri.

Growing up:
Brief stints in Lagos, Owerrri and the rest in Buguma and Port Harcourt. A bit rascally I was told, I jumped down from a high bed and sustained left hip disclocation, which Orthopaedic surgeons in General hospital, Owerri and Igbobi could not fix it properly, leaving me with a permanent limp which did not deter me in any way. I did every thing other children did. Following the death of my beloved grand mother, we moved to Buguma, where I had the rest of my growing up.

EDUCATIONAL CAREER:
Attended St Saviours school Buguma (1960-1966,) where he passed out with Distinction. Like other children I had a temporary in education due to the Civil war during which, I joined the Boys Scout movement rising to the rank of Troop leader. I was on Sentry duty

with Biafran soldiers at Buguma water side the day Nigerian troops liberated Buguma. So I was an original Biafran, not IPOB.

After the war, was enrolled into Kalabari National College (KNC) Buguma (1969-1973). Finished WASC in Grade-1 in 1973.The only Grade-1 candidates in the set. Due to good academic performance, was on scholarship through college by Governor Diette-Spiff Regime.

I, studied medicine at the prestigious Ahmadu Bello University, Zaria (1976-1981).Qualified MBBS,1981. I did my housemanship at the General hospital Port Harcourt and NYSC at the Muritala Mohamed hospital Kano, where I had some stint in Ophthalmology.

I commenced Residency training at the University of Port Harcourt teaching hospital in 1984, with some stint at UCH, Ibadan. Passed each stage of three stages of the exams at first attempt. Qualified FWACP (Part II Finals) in October, 1990, within stipulated period.

WORK EXPERIENCE AND POSITIONS HELD WITH DATES.

Appointed Lecturer-I, in the College of Health Sciences, University of Port Harcourt and Honaorary Consultant nephrologist to the affiliate University of Port Harcourt teaching hospital in 1991, rising through the ranks to Professor in the college of Health Sciences in 2013. I have held several professional and academic positions between UPTH and the University, as pioneer head of haemodialysis and renal unit (1991-2016), coordinator of the department of medicine, CHS,(1996-1998), Head of department of Medicine, UPTH (1996--2001) and Chairman medical advisory committee of UPTH (2001-2006), respectively.

ACADEMIC/PROFESSINAL ACTIVITIES.

Teaching of Nursing students didactic lectures and bedside.
Teaching of Undergraduate clinical medical and dental students in the form of didactic lectures tutorials and clinical simulations and bedside demonstrations in General medicine.

Teaching of Graduate medical doctors (Resident doctors) in General medicine and Nephrology in the form of didactic lectures,

seminars, tutorials, clinical simulations and demonstrations, and bedside procedures etc.

Research areas and publications.

Have been involved in all types of medical scientific research works relevant to the practice of general and Renal medicine in the tropical environment. Research areas include clinical and community based works in **hypertension, diabetesmellitus, metabolic medicine, acute kidney injury (AKI), chronic kidney disease (CKD), Nephrotic syndrome, chronic glomerulonephritides, Polycystic kidney disease, kidney dialysis and kidney transplantation etc.**

Involved in rural and community hypertension, diabetes and other risk factors of chronic kidney disease surveys cutting across many LGA's of Rivers state. Have been involved in both local and international multicenter clinical drug trials. I have supervised a number of dissertations for the Post graduate medical college examinations.

These research endeavours have led to the publication of over **40 medical scientific publications** in local and reputable international journals. Contributed chapter in a College bedside clinical manual for students. Solely authored "**Understanding Kidney failure"** and lead author in **"Living with Diabetes in Nigeria"** for the health promotion and education of Nigerian general population and victims from kidney failure and or diabetes mellitus. Two morbidities responsible for over fifty percent of non-communicable disease (NCD) deaths in adult Nigerians.

Scientific and professional conferences attended.

As a clinical researcher, research finding s necessarily have to be shared with fellow workers in related areas of endeavour. I have in the course of my teachings and research work attended several local professional and international conferences during which, scientific papers on my work are presented and abstracts and or full papers published in the conference proceeding of the journal.

University, Community and professional service

I have served the University of Port Harcourt at the Departmental, Faculty ,College and University wide level as well as the University of Port Harcourt teaching hospital in various capacities. Member of a number of standing and ad-hoc committees and panels such as faculty committee on establishment of Family medicine, department, faculty representative in University Enterprenual committee, faculty representative in University Research and Development Fair. A number of College investigative panels. Member College Research day committee Member, College advancement committee, etc.

Served as Chairman, secretary and member several standing and ad-hoc committees of UPTH. Member of the Niger Delta Environmental survey (NDES), Technical Report committee. R/State Government committee on Improvement of Health services in the state. Served on the Exco of NMA and several committees Founding member and pioneer Secretary general, Medical& Dental consultants Association of Nigeria (MDCAN), UPTH Chapter.

MEMBERSHIP OF ACDEMIC AND PROFESSIONANL BODIES.

Fellow, West African College of Physicians. (WACP),Member, Nigeria Association of Nephrology (NAN), member, African Association of Nephrology (AFRAN), International society of Nephrology (ISN) and several other academic professional societies.

EXTRA CURRICULAR &SOCIAL ACTIVITIES.

Member Rotary international (2000 to date) and former President of Rotary club. A Paul Haris fellow (PHF).Engaged in global humanitarian services.

FAMILY, & LIFE PHILOSOPHY

Married with two adults and one adolescent. Guided by Boys scout motto “Be prepared” and “Rotary 4-way test”. Nominal Christian who Interrogates religion. Moderation in all things. Center right-Center left, Market Economy with a human face.

Colleagues, ladies and gentlemen, I present to you an astute academic and teacher, hospital administrator, thorough and meticulous clinician, a Rotarian humanitarian, a family man, and a detribalized Nigerian, Professor Friday Samuel Wokoma.

Professor N. E. S. Lale
Vice-Chancellor