

**UNIVERSITY OF PORT HARCOURT**

**THE BURDEN OF THE FOOT IN DIABETES:  
A PREVENTABLE AGONY**

**An Inaugural Lecture**

**By**

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## **ORDER OF PROCEEDINGS**

2.45P.M. GUESTS ARE SEATED

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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:

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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, invite the Vice-Chancellor to make his opening remarks and introduce the Lecturer.

The Lecturer shall remain standing during the Introduction.

## **THE INAUGURAL LECTURE**

The Lecturer shall step on the rostrum, cap and deliver her Inaugural Lecture. After the lecture, 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.

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### **THE VICE-CHANCELLOR'S CLOSING REMARKS.**

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- ❖ Captains of Industries
- ❖ Cherished Friends and Guests
- ❖ Unique Students of UNIPORT
- ❖ Members of the Press
- ❖ Distinguished Ladies and Gentlemen.

## **DEDICATION**

This lecture is dedicated to the evergreen memory of the  
greatest men that crossed my path:

My beloved father, Mr. Isaac Ezekwesiri Okwandu

And

My cherished husband, Pharm. Eddy Chukwuemeka

Unachukwu

## ACKNOWLEDGMENTS

I thank the Almighty God who has been my pillar and has remained sufficient for me in all situations.

Today as always, I celebrate the sweet memories of my late father Mr. Isaac Okwandu and my husband Pharm. Eddy Unachukwu through whose support, love and directions my dreams for a day like this have come true.

My special gratitude to my lovely children: Chukwuemeka, Chukwuebuka, Ijeoma, and Ogochukwu for their immeasurable love, care, and support.

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My unreserved thanks go to my colleagues in the Endocrine unit (Prof S. Chinenye and Dr. IF Korubo) and all the resident doctors (past and present), who have passed through my tutelage in the Unit, for their roles in my career and their commitment to the growth of the unit.

I thank all my colleagues, the nurses and the entire staff of the Department of Medicine for their love and support in various ways, especially during my trying moments.

I thank Prof. Ndu Eke, Prof. K.E.O Nkanginieme and Prof. A.O Okpani for facilitating my learning to write and publish papers.

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I appreciate my spiritual fathers and prayer networks for being a pillar of support in the midst of storms.

I am grateful to Prof Joseph Ajenka, the immediate past Vice-Chancellor of the University of Port Harcourt for his commitment to excellence and finding me appointable as a Professor of Medicine. I thank the present Vice-Chancellor, Professor Ndowa Lale for making today a reality.

I acknowledge the past and present Provosts of the College of Health Sciences, the past and present Deans and Heads of Departments in the College for giving me the



opportunity to acquire and contribute to knowledge, training, and service to humanity.

I thank the past and present Chief Medical Directors of the University of Port Harcourt Teaching Hospital for providing an enabling environment for training, service, and research.

My special thanks to Dr. Eno Gomba and her family who, through their labour, love and hard work contributed immensely to this manuscript. My deep gratitude to Professors O. J. Odia, Ndu Eke and A. C. Onwuchekwa for proof reading this manuscript.

I salute all my patients and students without whom my vision and journey of life will be incomplete.

Thank you all for being here for me today.

## ACRONYMS

ABI	Ankle brachial index
ADA	American Diabetes Association
DCCT	Diabetes Control and Complications trial
DFU	Diabetic foot ulcer
DFS	Diabetic foot syndrome
DKA	Diabetic ketoacidosis
DM	Diabetes Mellitus
DN	Diabetic Nephropathy
EDM	Endocrinology Diabetes and Metabolism
HbA1C	Haemoglobin A1c
HONK	Hyperosmolar non -ketotic state (currently referred to as Hyperosmolar hyperglycaemic state)
IDF	International Diabetes Federation
IWGDF	International Working Group on the Diabetic Foot
LOP	Loss of protective sensation
LGA	Local Government Area
OHA	Oral hypoglycaemic agents (currently referred to as oral anti-diabetic agents)
PAD	Peripheral artery disease
UKPDS	United Kingdom Progressive Diabetic Study
UPTH	University of Port Harcourt Teaching Hospital
VPT	Vibratory perception threshold
WHO	World Health Organization

## TABLE OF CONTENTS

<b>Order of Proceedings</b> .....	iii
<b>The Inaugural Lecture</b> .....	iv
<b>Protocols</b> .....	v
<b>Dedication</b> .....	vi
<b>Acknowledgments</b> .....	vii
<b>Acronyms</b> .....	x
Preamble .....	1
Introduction .....	2
A Bit of History .....	2
What Is Diabetes Mellitus? .....	4
Diabetes in Nigeria .....	11
Pattern of Diabetes Mellitus in Rivers State .....	12
Complications of Diabetes: The Need for Good Glycaemic Control .....	15
Mortality among People Living With Diabetes .....	17
The Need for Good Glycaemic Control-Legacy Effect .....	18
The Foot In Diabetes .....	20
The Foot Bears the Brunt of Diabetes Complications.....	21
The Burden of the Diabetic Foot.....	22
Cost of Care of a Diabetic Foot Ulcer .....	24
Psychosocial Burden of Diabetic Foot Syndrome .....	25
Diabetes Burnout and Syndrome of Willful Self Neglect.....	26
Factors That Lead To Development of a Diabetic Foot Ulcer .....	27
Social Factors Contributing To Diabetic Foot Ulcers.....	27
Classification and Staging of Diabetic Foot Ulcers .....	27
The Role of Neuropathy (Nerve Damage) .....	30
Diabetic Neuro-Arthropathy (Charcot’s Foot) .....	35
Role of Ischaemia (Poor Blood Flow) .....	36
Peripheral Neuropathy and Macroangiopathy in Diabetics with Foot Ulcers in Port Harcourt .....	38
The Role of the Immune System/ Infections .....	39
The Bacteriology of Diabetic Foot Infections .....	39
Bacteriologic Analysis of Foot Ulcers in Port Harcourt.....	41
Pattern of Presentation of Foot Ulceration in Our Environment .....	43

Agonizing Sights Of Diabetic Foot Ulcers-----	45
Hand Ulcers/Infections and Diabetes Mellitus in Port Harcourt, Rivers State, Nigeria -----	48
Management of the Diabetic Foot Syndrome -----	49
Antimicrobial Therapy-----	51
Emergence of Antimicrobial Resistant Organisms -An Obstacle to Successful Treatment of Foot Infections -----	53
Wound Debridement -----	56
Causes of Poor Wound Healing-----	58
Length of Hospital Stay and Outcome of Management of Patients with Diabetic Limb Ulcer/Gangrene -----	59
Recovering after Limb Loss -----	65
Challenges of Managing Diabetic Foot Ulcers in Nigeria -----	67
Refusal of Amputation and the Role of Cultural Beliefs -----	68
Levels of Prevention of Diabetic Foot Ulceration -----	69
Primary Prevention Of Foot Ulcers In Persons With Diabetes -----	72
Examination of the Feet-----	74
Testing For Vibration Using a 128-Hz Tuning Fork -----	76
Vascular Assessment -----	78
Education on Foot Care-----	81
My Contribution to the Prevention of Diabetic Foot Ulcers -----	87
Structured Training Programs on Diabetes Foot Care for Health Care Professionals in Port Harcourt-----	88
Various Activities At The Diabetes Foot Clinic In Upt (Diabetes Education, Foot Inspection, Testing For Sensation And Peripheral Vessels ) -----	90
Challenges in the Prevention and Management of Diabetic Foot Ulcers in a Resource Poor Setting-----	94
We Can Prevent Diabetic Foot Ulcers!!! Yes, We Can!!!-----	94
A Call on Government to Help Save the Foot in People With Diabetes-----	95
<b>Conclusion -----</b>	<b>95</b>
<b>References -----</b>	<b>98</b>
<b>Citation -----</b>	<b>104</b>

## **PREAMBLE**

“This is the day that the Lord has made, we will rejoice and be glad in it” (Psalm 118:24).

Permit me, Mr. Vice-Chancellor Sir, to appreciate the Almighty God who has been ‘my all in all’. To Him be all the glory.

I have chosen to share my experience and thoughts on a subject matter that is so dear to my heart as a Professor and medical doctor who specialized in the field of internal medicine and subspecialized in Endocrinology and diabetology. My passion and empathy for people living with Diabetes mellitus; more so those with the foul-smelling sores on the foot is the highlight of this inaugural lecture, hence the title.

**“The Burden of the foot in diabetes: a preventable agony”.**

**Endocrinology** is the branch of medicine concerned with the study of chemicals called hormones and their disorders.

An **Endocrinologist** is a medical practitioner that is specialized in the treatment of hormonal disorders.

**Hormones** are chemicals produced by organs in the body (endocrine glands) and secreted into the bloodstream to control a wide range of physiologic activities in the body such as growth, development, puberty, reproduction, sugar level, appetite, bone growth, level of alertness, etc. Examples of these endocrine glands are the pancreas, adrenal, thyroid and pituitary glands.

**Diabetology** is the specialized field of endocrinology that focuses on the study of diabetes, its diagnosis, and treatment.

A **Diabetologist** is a specialist endocrinologist whose focus is mainly on diabetes care.

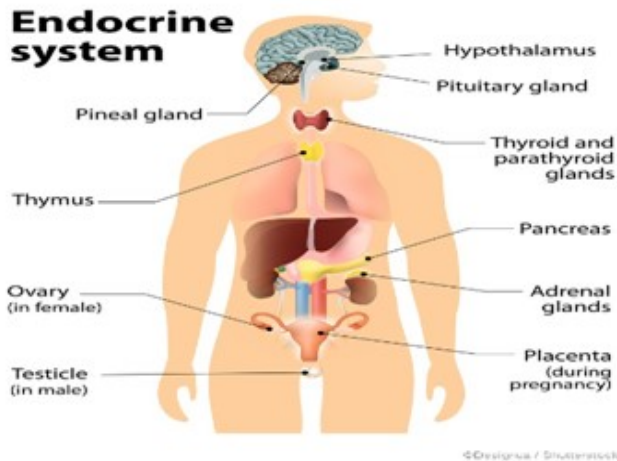


Figure 1: The endocrine system.

Source: <https://www.epa.gov/endocrine>

## INTRODUCTION

**Diabetes Mellitus (DM)** is a non-communicable (non- infectious) disease that has become a global concern. In simple language, it can be regarded as a threat to the human race. It is associated with a significantly reduced level of health and wellbeing and increased death rates. It also constitutes a huge economic and psychosocial burden on the affected individual, family, and country. Despite the huge amount spent to curtail this problem, it still remains a scourge. Diabetes foot syndrome is one of the most dreaded complications of diabetes. It is the commonest cause of non-traumatic amputation globally. In our own setting, it is the commonest reason for prolonged hospital admission in people living with diabetes. Most of the problems resulting from diabetes foot syndrome are due to ignorance and poverty. It is therefore highly preventable.

## A BIT OF HISTORY

Diabetes Mellitus, simply called “diabetes,” is a disease that is as old as 3000 years. It was described as a strange and rare disease that was more or less a death sentence in the time of old<sup>1</sup>. The disease

has claimed the lives of the great and mighty and is still doing so. For instance, ancient history suggests that King Herod in the bible may have died of Fournier's gangrene as a complication of diabetes<sup>2</sup>.

Many great scholars, scientists, and physicians have played significant roles in the discovery and scientific breakthrough of this disease. To date, diabetes mellitus is not completely understood and extensive research is still ongoing to understand the disease better and possibly get a cure.

The first-ever mention of diabetes was by the Egyptian Physician, Hesy-Ra in his writings in the Ebers Papyrus, a document published by an Egyptologist, George Ebers, that dates back to 1550 BC. These writings described a rare disease characterized by "too great emptying of the urine"- excessive urination (polyuria).<sup>1</sup>

Ancient Indians at about the same time noticed that urine from individuals with this disease attracted flies and ants. They referred to the condition as "madhumeha" meaning "honey urine," because the urine of these individuals tasted sweet (perhaps due to the presence of glucose, a kind of sugar in the urine). In addition to this, they also noted that people with honey urine also had an extreme thirst and foul breath (ketosis)

The ancient physicians regarded diabetes as a disease of the kidney (which they referred to as 'diarrhea of the kidney') and could not differentiate excessive urination caused by diabetes mellitus from that caused by other conditions. The first person to suggest that diabetes mellitus was not a disease of the kidney was Aretaeus of Cappadocia, a Greek physician, who practiced in the second century AD. He suggested that diabetes mellitus was a "disease of the stomach" and gave the first accurate description of what we now call diabetes mellitus. Aretaeus wrote:

*"Diabetes is a dreadful affliction, not very frequent among men, being a melting down of the flesh and limbs into urine. The patients never stop making water and the flow is incessant, like the opening of the aqueducts."*

*Life is short, unpleasant and painful, thirst unquenchable, drinking excessive and disproportionate to the large quantity of urine, for yet more urine is passed... If for a while they abstain from drinking, their mouths become parched and their bodies dry; the viscera seem scorched up, the patients are affected by nausea, restlessness and burning thirst, and within a short time they expire... ”<sup>1</sup>*

By this, Areteus had implied that this disease was rare and more of a death sentence.

In 1776 Mathew Dobson discovered that the sweet taste of the urine in patients with diabetes mellitus was due to sugar (which was later found to be glucose in 1815 by Eugene Chevreul). He also discovered this same sugar in the blood of these patients. Thomas Cawley in 1788 was the first to suggest the link between the pancreas and diabetes after he observed that people with injury to the pancreas developed diabetes.

In 1798, the term “mellitus” (Latin, “sweet like honey”) was coined by the British Surgeon General John Rollo, to distinguish this diabetes from diabetes insipidus in which the urine was tasteless. In 1869, a German medical student Paul Langerhans discovered a cluster of unknown cells in the pancreas (Islet of Langerhans) later found to produce the hormone insulin<sup>1</sup>.

A major turnaround occurred in 1921 following the discovery of insulin by Frederick Grant Banting (1891-1941) and Charles Best (1899-1978) which earned Frederick Grant Banting the Nobel prize for physiology in 1923<sup>1</sup>. Not only did they discover the hormone whose deficiency led to diabetes, but they had by so doing discovered a treatment that had changed the outlook of diabetes for the better.

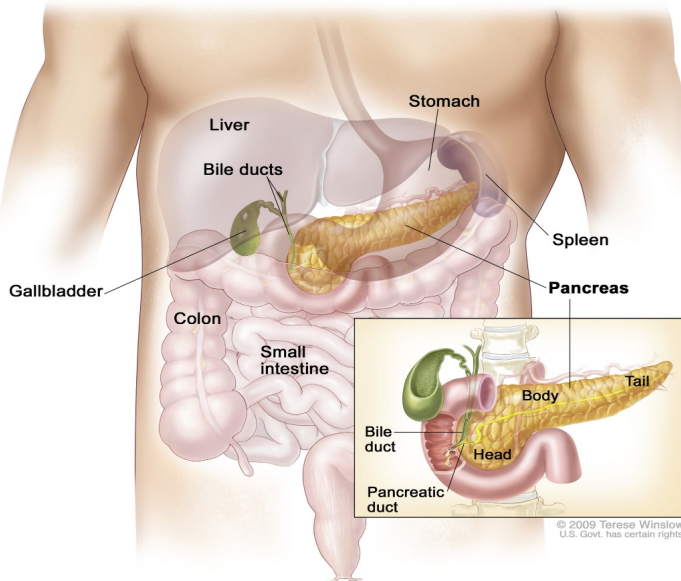
## **WHAT IS DIABETES MELLITUS?**

Diabetes mellitus (DM) is a chronic metabolic disorder resulting from disturbances of protein, carbohydrate and fat metabolism. Its main characteristic is the presence of persistently high glucose



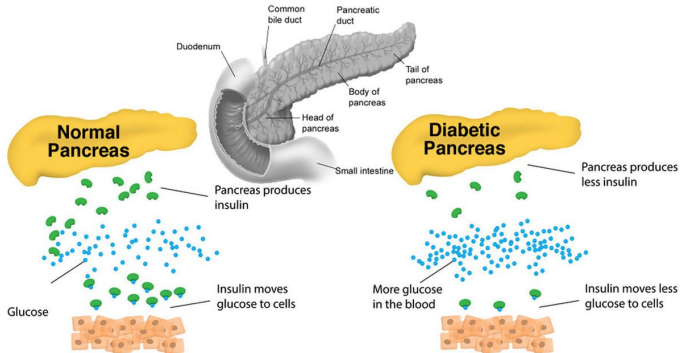
levels in the blood. This persistent presence of glucose in the blood referred to as “hyperglycaemia”, results from either a deficiency of insulin secretion, defective insulin action or both.

Insulin is a hormone produced by cells called beta cells located in the pancreas (an endocrine gland located behind the stomach). Its main function is to drive glucose into the cells where it can be used to generate energy. In diabetes, where insulin is deficient or ineffective, glucose remains in the blood causing hyperglycaemia. This chronic hyperglycaemic state leads to damage in virtually every organ system in the body.



**FIGURE 2: THE PANCREAS**

Source: <https://www.ohsu.edu/knight-cancer-institute/understanding-pancreatic-cancer>



**FIGURE 3:ACTION OF INSULIN**

Source:www.pinterest.com

### CLASSIFICATION OF DIABETES

Diabetes mellitus is currently classified into 6 types. Of these, three types are commonly found in clinical practice. These are Type 1, Type 2 and hyperglycaemia in pregnancy. These forms of diabetes have their peculiar characteristics and modalities of treatment. <sup>4</sup>

TABLE 1

CLASSIFICATION OF DIABETES	
TYPE	DESCRIPTION
TYPE 1	Autoimmune (self-destruction) of the beta cells of the pancreas leading to insulin deficiency
TYPE 2	Characterized by insulin resistance and relative insulin deficiency
HYBRID FORMS OF DM	These are the slowly evolving immune-mediated diabetes of adults and ketosis-prone type 2 diabetes. These forms of diabetes

	exhibit characteristics of both type 1 and 2 diabetes
<b>OTHER SPECIFIC FORMS OF DM</b>	Diabetes due to genetic defects in beta-cell function and insulin action, diseases of the exocrine pancreas, endocrinopathies, drugs or chemical induced diabetes and other rare forms of diabetes.
<b>UNCLASSIFIED DIABETES</b>	Diabetes that does not clearly fit into any category
<b>HYPERGLYCAEMIA FIRST DETECTED IN PREGNANCY</b>	Type 1 or type 2 diabetes first diagnosed in pregnancy (pregestational diabetes) or hyperglycaemia below diagnostic threshold in pregnancy (gestational diabetes)

Source: WHO Classification of diabetes, Geneva 2019

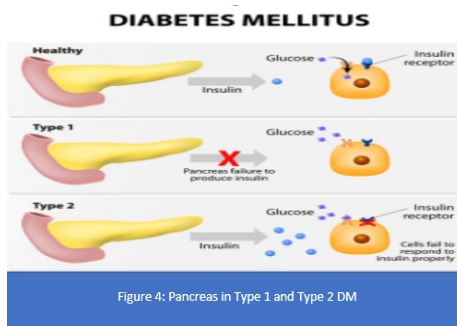
Type 1 diabetes tends to manifest earlier in life especially in childhood and the teenage years. It is due to an absolute deficiency of insulin, resulting usually from an immune-mediated (self) destruction of the insulin-producing cells of the pancreas. It is therefore characterized by an absolute (total) deficiency of insulin and hence affected individuals require treatment with insulin to survive.

Type 2 diabetes is the commonest type, accounting for about 90% of cases. Its onset is usually in adulthood but can develop even in childhood. This form of diabetes is common in obese individuals and has the tendency to run in families. It is mainly due to the ineffective action of insulin on the tissues rather than insulin deficiency. In other words, the tissues do not respond appropriately to insulin (insulin resistance).

Hyperglycaemia in pregnancy is a special type of diabetes that is first noticed in pregnancy. It can either be “pregestational” (which is type 1 or type 2 diabetes first noticed in pregnancy) or gestational diabetes. Gestational diabetes is mainly due to the effect of placental hormones (pregnancy-related hormones) on insulin sensitivity. This

form of diabetes is associated with fetomaternal (mother and baby) complications including congenital abnormalities and fetal death if not treated. It usually resolves after delivery but may progress to full-blown diabetes.

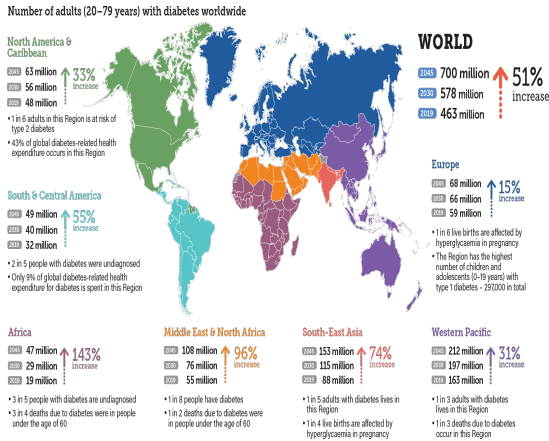
Other specific types of diabetes include the monogenic forms of diabetes and secondary diabetes. Monogenic forms of diabetes result from an alteration in the gene and manifest early in life. They are very rare accounting for 1-5% of all cases of diabetes. Secondary diabetes, on the other hand, arises as a complication of other diseases. These include diseases associated with an excess steroid (Cushing's syndrome), excess growth hormone (acromegaly), diseases of the pancreas (e.g. chronic pancreatitis), Down's syndrome, etc. It may also result from treatment with certain drugs such as steroids. Some of the forms of secondary diabetes are potentially reversible.



## BURDEN OF DIABETES MELLITUS

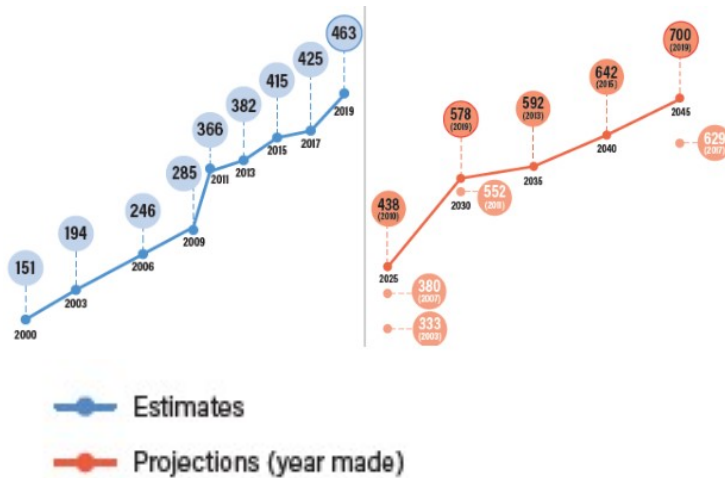
Diabetes is a global threat; a threat to the human race. It affects people of any colour, age, and social class. It drains the national health care budget, reduces the productivity of the workforce of a country, shortens the life span of affected individuals and overwhelms the healthcare systems. It ranks among the 10 leading causes of death globally and has been declared as one of the largest global health emergencies of the 21<sup>st</sup> century.

## THE GLOBAL PICTURE



**Figure 5: Global prevalence of Diabetes according to regions**  
Source: IDF Atlas 9th edition 2019

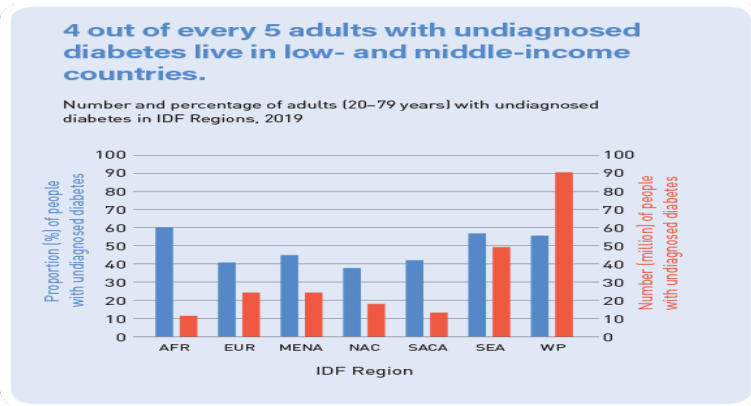
According to the latest estimates by the International Diabetes Federation (IDF), 463 million adults aged 20-79 years (9.3% of the world’s population in this age group) are living with diabetes and this is projected to increase to 700 million people by 2045. This current prevalence shows an exponential increase in the prevalence of about three-fold from the year 2000. In addition, an estimated 374 million people have impaired glucose tolerance (pre-diabetes) and these will likely develop diabetes in the nearest future increasing the prevalence rate. The number of children and adolescents (aged under 20 years) currently living with type 1 diabetes is about 1.1 million.<sup>5</sup>



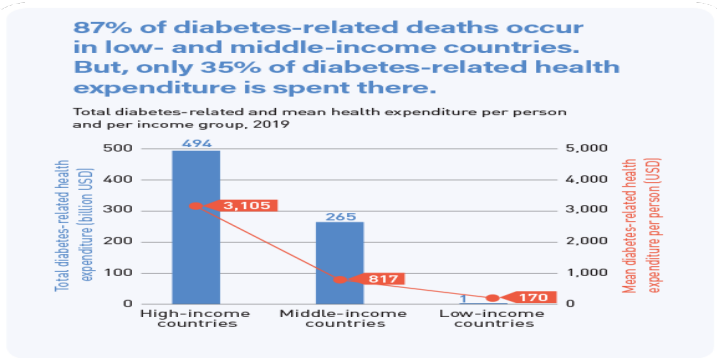
**Figure 6: Estimates and projections of the global prevalence of diabetes in the 20- 79year age group (millions)**

Source: IDF Atlas 9<sup>th</sup> edition 2019

An estimated 20.4 million live births were affected by hyperglycaemia in pregnancy in 2019 and approximately 4.2 million deaths worldwide were attributable to diabetes in the 20-99 years age range. The annual global healthcare expenditure on people living with diabetes is huge. It was estimated to be USD 760 billion with a projected increase to USD 825 billion by 2030 and USD 845 billion by 2045. Despite this high prevalence, about half of the people living with diabetes are undiagnosed and thus at risk of complications.<sup>5</sup>



Source: IDF Atlas 9<sup>th</sup> edition 2019



Source: IDF Atlas, 9th edition 2019

About 80% of people living with diabetes reside in low- and middle-income countries and unfortunately, the projected increase in prevalence is expected to occur more in these countries. It is, however, worrisome to note that only 35% of the health care budget for diabetes is spent in these countries that also have the highest rates of diabetes-related deaths. Africa has the highest proportion of undiagnosed cases of diabetes (59.7%) with 4 out of 5 persons unaware that they have diabetes. This puts developing countries at a disadvantage as they bear the brunt of the burden of diabetes.

### DIABETES IN NIGERIA

Nigeria is not spared from the global rise in the prevalence of diabetes. More so, being the most populous country in Africa, it

shares a large chunk of the burden. Adoption of western lifestyle, urbanization of rural communities, and rural-urban migration which has contributed immensely to obesity are partly to blame for this rise. The prevalence of diabetes in Nigeria has increased exponentially from 2.2% in 1992 to 5.77% as of 2017 indicating that 1 in 17 adults are living with diabetes<sup>7,12</sup>.

The pooled prevalence of DM, according to the six geopolitical zones of Nigeria as shown in the table below revealed that the South-South zone has the highest prevalence (9.8%) of DM in Nigeria<sup>7</sup>

**Table 2: Pooled prevalence of DM in Nigeria<sup>7</sup>**

Geo-political zone	Prevalence (%)	Range 95% CI
North-West	3.0	1.7-4.3
North -East	5.9	2.4-9.4
North-Central	3.8	2.9-4.7
South-West	5.5	4.0-7.1
South -East	4.6	3.4-5.9
South-South	9.8	7.2-12.4

Diabetes mellitus is a substantial health problem in the Niger Delta region and Rivers State in particular. Our study in Port Harcourt showed that diabetes mellitus ranked high among non-communicable diseases as is the trend globally<sup>8</sup>. In fact, a recent study shows that diabetes alone accounted for 15.6% of all medical admissions at the University of Port Harcourt teaching Hospital<sup>10</sup>.

Earlier studies in Rivers State found the prevalence of diabetes in Port Harcourt to be about 6.8%<sup>11</sup>. A more recent study done in a rural community in Rivers state revealed a prevalence of 8%. This indicates a worrisome rise in prevalence even in the rural



communities where the prevalence was previously low when compared to urban areas<sup>16</sup>.

### **PATTERN OF DIABETES MELLITUS IN RIVERS STATE**

We conducted a cross-sectional study over 10 years ago involving 10,518 people living with diabetes to ascertain the pattern of diabetes mellitus in Rivers State. This study revealed that the Port Harcourt Local Government Area had the highest prevalence of diabetes in Rivers State.

The majority of the patients living with diabetes were adults (93.9%) and females were equally affected as males (ratio =1.04:1). Type 2 diabetes was the commonest form (94%) while type 1 diabetes accounted for 3.0%. Gestational diabetes and other specific types accounted for 1.8% and 1.2% respectively. In this study, it was found that a lot of patients with type 2 diabetes already had complications at the time of diagnosis viz: neuropathy (56.3%), erectile dysfunction (36.3%), nephropathy (9.2%) and retinopathy (7.3%).etc<sup>18</sup>.

**Table 3: Distribution (by LGA) of people living with diabetes in Rivers State<sup>18</sup>**

<b>LOCAL GOVERNMENT AREA</b>	<b>NO OF DIABETICS</b>	<b>% DIABETICS</b>
<b>AHOADA -EAST</b>	213	2.0
<b>ASARI- TORU</b>	540	5.1
<b>BONNY</b>	274	2.6
<b>DEGEMA</b>	310	3.0
<b>ETCHE</b>	502	4.8
<b>TAI</b>	258	2.3
<b>IKWERRE</b>	484	4.6
<b>KHANA</b>	600	5.7
<b>OBIO-AKPOR</b>	800	7.6
<b>OKRIKA</b>	496	4.7
<b>PORT HARCOURT</b>	<b>1420</b>	<b>13.5</b>
<b>OGBA/ EGBEMA/NDONI</b>	620	5.9
<b>ABUA/ODUAL</b>	434	4.1
<b>AKUKUTORU</b>	468	4.5
<b>EMOHUA</b>	516	4.9
<b>OYIGBO</b>	367	3.5
<b>ANDONI</b>	620	5.9
<b>GOKANA</b>	510	4.9
<b>AHOADA-WEST</b>	413	3.9
<b>ELEME</b>	207	2.0
<b>OGU/BOLO</b>	156	1.5
<b>OPOBO-NKORO</b>	165	1.6
<b>OMUMA</b>	145	1.4
<b>TOTAL</b>	<b>10,518</b>	<b>100</b>

**Table 4: Clinical features of 830 diabetics in Rivers State<sup>18</sup>**

<b>PARAMETERS</b>	<b>TYPE 1</b>	<b>TYPE 2</b>	<b>OTHER TYPES</b>	<b>GDM</b>
<b>TOTAL NUMBER (n) %</b>	<b>25 (3%)</b>	<b>780 (94%)</b>	<b>10 (1.2%)</b>	<b>15 (1.8%)</b>
<b>Positive family history of DM (1<sup>st</sup> Degree)</b>	<b>3(12%)</b>	<b>408(52.3%)</b>	<b>-</b>	<b>8 (53.3%)</b>
<b>Recurrent cabuncles (Boils)</b>	<b>9 (36%)</b>	<b>79 (10.1%)</b>	<b>-</b>	<b>-</b>
<b>Hypertension</b>				
• <b>Antedated</b>	<b>-</b>	<b>106(13.6%)</b>	<b>-</b>	<b>-</b>

- Simultaneously - 197(25.3%) - 5 (33.3%)

#### Retinopathy

- Background - 57 (7.3%) - -

- Proliferative - - - -

Dietary(Mono) therapy - 7 (0.9%) - -

Oral hypoglycaemic agents (OHA) - 593 (76%) - -

### **COMPLICATIONS OF DIABETES: THE NEED FOR GOOD GLYCAEMIC CONTROL**

Following the introduction of insulin and other drugs to treat diabetes, the control of diabetes has considerably improved. The major problems now facing people living with diabetes are the complications. Often diabetes is not diagnosed until complications have set in. And in a lot of cases, patients present for the first time because of a complication that may be life-threatening.

These complications could be of early (acute) or late (chronic) onset.

The acute complications include:

- a). Diabetic Ketoacidosis (DKA): Characterized by the production of excess blood acids due to deficiency of insulin.
- b.). Hyperosmolar hyperglycaemic state: Characterized by extremely high blood sugar and excessive urination that may lead to severe dehydration.
- c). Hypoglycaemia: Low blood sugar (may result from inappropriate use of anti-diabetic drugs)
- d) Lactic acidosis: Not common but also characterized by excess acid (lactic acid) in the blood due to diabetes.

Prompt treatment of these acute complications reduces the morbidity and mortality associated with the disease.

The late complications of diabetes tend to manifest ten to twenty years after diabetes is detected in young patients but present earlier in older patients who may have had unrecognized diabetes for months or even years prior to diagnosis. Such late complications include peripheral vascular disease (narrowing of the blood vessels), stroke, retinopathy (damage to the eye), neuropathy (damage to the nerves) and nephropathy (damage to the kidneys). Some patients may have one or more of these complications simultaneously. The bases for these complications are small vessel (microvascular) and large vessel (macrovascular) damage as a result of diabetes. Other eye conditions like cataract and glaucoma also tend to be more common in people living with diabetes and occur at an earlier age than people without diabetes.

People living with diabetes are also generally more prone to infections especially of the skin and urinary tract. Such infections include boils, fungal infections, and tuberculosis. Some infections uniquely associated with diabetes include malignant otitis media, rhinocerebral mucormycosis, necrotizing cellulitis and fasciitis, emphysematous cholecystitis and emphysematous pyelonephritis. These can be life-threatening and constitute medical emergencies.

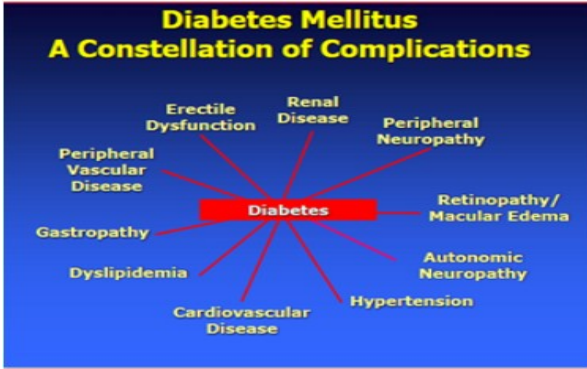


Figure 8: Complications of Diabetes source:<https://www.google.com/amp/s/slideplayer.com>

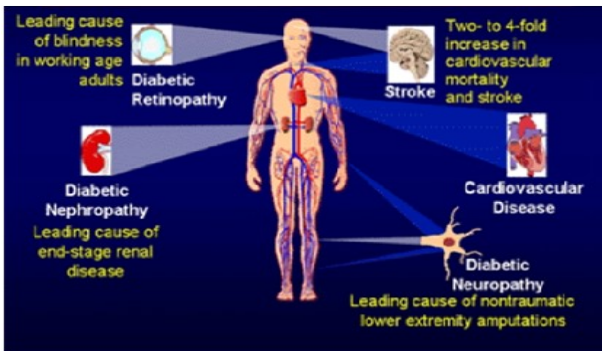


Figure 9: Diabetes, a leading cause of major organ damage and death

Source: <https://www.slashdiabetes.com>

### MORTALITY AMONG PEOPLE LIVING WITH DIABETES

Diabetes-related deaths are a consequence of the complications of diabetes. These complications and deaths are to a large extent preventable by early detection of diabetes and ensuring good control of blood sugar.

A retrospective study we conducted to determine the death rate among diabetics on admission in UPTH over a ten-year period (1995-2004) revealed that diabetes alone accounted for 10.4% of all medical admissions and 11.1% of all medical deaths. More deaths occurred in males than females (58.5% versus 41.5%) and in the age

group 51-60years. Acute complications of diabetes such as diabetic ketoacidosis, hyperosmolar hyperglycaemic state and hypoglycaemia accounted for more than 39% of deaths due to diabetes. Among the chronic complications, diabetic foot syndrome was the commonest cause of death accounting for 19.5% of all diabetic deaths.

This study showed that diabetes is a significant cause of medical admission and preventable deaths in the oil-rich Niger Delta region<sup>20</sup>.

**Table 5: Case fatalities of diabetes mellitus in UPTH<sup>20</sup>**

YEAR	DIABETIC ADMISSIONS	NUMBER OF DEATHS			CASE FATALITY RATES (%)
		MALE	FEMALE	TOTAL	
1995	51	7	7	14	27.5
1996	49	6	2	8	16.3
1997	64	6	1	7	10.5
1998	82	4	5	9	11.0
1999	54	4	6	10	18.5
2000	82	6	9	15	18.3
2001	77	6	4	10	13.0
2002	76	12	6	18	23.7
2003	69	13	2	15	21.7
2004	82	5	7	12	14.6

**Table 6: Causes of death in patients with diabetes in UPTH<sup>20</sup>**

<b>Disorder</b>	<b>N (%)</b>
DKA	25 (21.2)
HONKS	10 (8.5)
Hypoglycaemia	12 (10.2)
DMFS	23 (19.5)
Renal failure	15 (12.7)
Cerebrovascular disease	12 (10.2)
Septicaemia	6 (5.1)
Respiratory disease	6 (5.1)
Others	9 (7.6)
<b>Total</b>	<b>118 (100)</b>

**DKA: Diabetic Ketoacidosis**

**HONKS: Hyperosmolar non-ketotic state**

**DMFS: Diabetes mellitus foot syndrome**

### **THE NEED FOR GOOD GLYCAEMIC CONTROL-LEGACY EFFECT**

Data from the Diabetes Control and Complication Trial (DCCT) strongly suggest that tight control of blood sugar (glycaemic control) greatly reduces the risk of diabetic complications and their subsequent costs. The researchers concluded that in persons with Type 1 diabetes, intensive therapy effectively delays the onset and slows the progression of diabetic retinopathy, nephropathy, and



neuropathy. Similar results were also obtained for Type 2 diabetes in the United Kingdom Prospective Diabetes Study (UKPDS). In addition, it was also concluded from both the UKPDS and DCCT trials that achieving good blood sugar control early in the course of diabetes confers a legacy effect such that the beneficial effect of good blood sugar control is maintained even if followed by a return to poor glycaemic control.<sup>21, 22</sup>

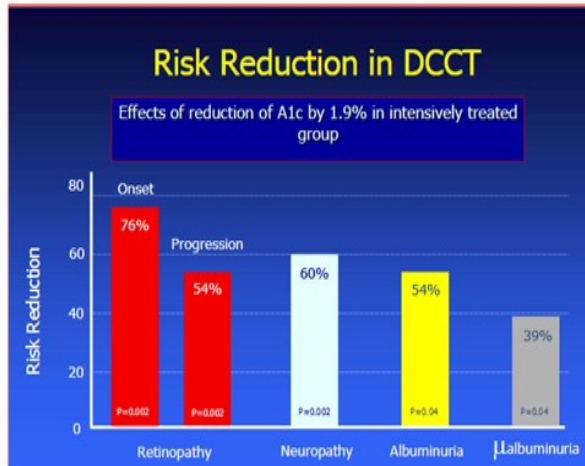


Figure 10: Showing impact of good glycaemic control in the DCCT trial

Source:<https://slideplayer.com/slide/259913/>

## UKPDS: Tight glycaemic control reduces complications

Epidemiological extrapolation showing benefit of a 1% reduction in mean HbA<sub>1c</sub>

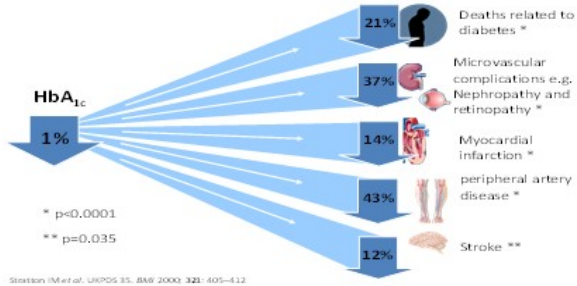


Figure 11: Showing impact of good glycaemic control in the UKPDS

Source: <https://www.google.com/images>,

Achieving earlier glycaemic control may generate a “good legacy effect”, with multiple benefits for patients

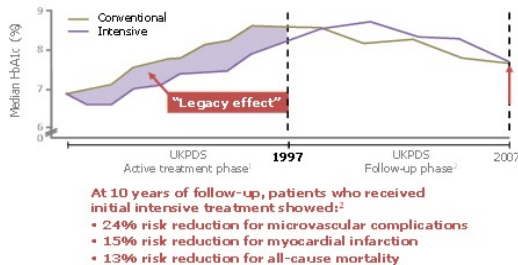


Figure 12: Legacy effect of good glycaemic control as seen in UKPDS and DCCT trials

Source: <https://image.slidesharecdn.com>

## THE FOOT IN DIABETES



Source: <https://i.pinimg.com>

**Movement is a fundamental aspect of life. The importance of movement to health and wellbeing was highlighted in the story of the paralytic at the pool of Bethesda. He had nobody to move him into the pool when the water was stirred up/ moved by the angel for healing and hence remained unhealed by the pool for 38 years... JOHN 5:1-15.**

**The foot is crucial to movement...**

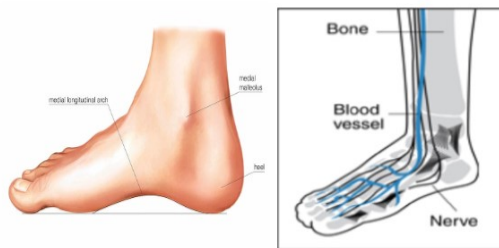


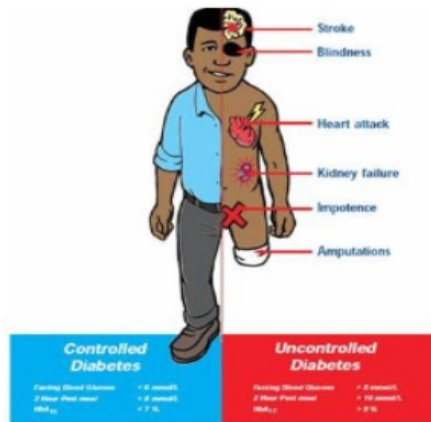
Figure 13: The normal foot

Source: <https://surgery.ucsf.edu/conditions--procedures/diabetic-foot-ulcers.aspx>

The foot is the region of the leg below the ankle (on which we stand). It is a complex structure with 26 bones, 33 joints and more than 100 muscles, tendons and ligaments. It supports body weight and provides leverage for walking and running. It is unique in that it is constructed in the form of arches to allow it to adapt its shape to

uneven surfaces. It also serves as a resilient spring to absorb shock such as in jumping. Just like every other part of the body, it has blood vessels and nerve supply.

## THE FOOT BEARS THE BRUNT OF DIABETES COMPLICATIONS.



Source: <https://diabetesswaziland.wordpress.com>

Diabetes affects every part of the body but frequently affects the foot first. People living with diabetes are at risk of developing a variety of foot problems termed diabetic foot disease or syndrome. The term “diabetic foot” refers to the variety of disease conditions that might affect the feet of a person living with diabetes. These range from ulcers (sores), infections, gangrene (tissue death) or destruction of the tissues of the foot (such as muscles, joints, tendons, and bones).

The World Health Organization (WHO) defines a diabetic foot as infection, ulceration or destruction of deep tissues associated with neurological abnormalities and various degrees of peripheral vascular diseases in the lower limb. Similarly, the International Working Group on the Diabetic Foot, (IWGDF) described a diabetic foot ulcer as “a full-thickness wound penetrating through the dermis (the deep vascular and collagenous inner layer of the skin) in the area below the ankle in a diabetic patient”<sup>23,24</sup>.

These diseases of the foot are complex and disabling. They are the commonest and most dreaded complications of diabetes and the major reason for hospital admission among people living with diabetes. They are quite dehumanizing both physically, psychologically and economically. They can impair patients' quality of life and affect social participation and livelihood. Every diabetic has a 15-25% lifetime risk of developing a foot ulcer. An ulcer occurring on the foot of a person living with diabetes is a huge challenge because they take a very long time to heal (if they do). Often times, these ulcers get infected and may require amputation of the affected limb if there is gangrene (tissue death) or life-threatening infection.

### **THE BURDEN OF THE DIABETIC FOOT**

Mr. V.C Sir, diabetic foot problems are of great importance. The burden is enormous on the patient and the society in general. It ranks among the 10 global causes of disability with a global prevalence of 6.3%. They cause more in-patient bed occupancy and prolonged hospital admissions than all the other medical complications of diabetes put together. For instance, it takes about 12 weeks on average for a diabetic foot ulcer to heal without surgery which translates to the high cost of care.

In the past and up until now, amputation remains a common outcome of diabetic foot syndrome. Currently, diabetes mellitus is the commonest reason for non-traumatic amputation of the lower limb accounting for 40-60% of all lower extremity amputations globally. More than 85% of diabetic-related amputations are preceded by a foot ulcer and by estimate; a lower limb is being amputated every 30 seconds globally because of diabetes (i.e. over one million amputations per year).

The role of diabetic foot syndrome in morbidity and mortality in Nigeria and other African countries cannot be overemphasized. The prevalence of foot ulcers in people living with diabetes in Nigeria is high, ranging from 11 to 32% with amputation rates as high as 12%-53% and mortality rate ranging from 8.7 to 40%<sup>28, 36</sup>. It accounted for about 16% of diabetic admissions in a study in Lagos.<sup>36</sup> In Port Harcourt, it accounts for 14% to 19% of all

diabetic admissions, and it is the commonest cause of diabetic death<sup>20</sup>. The 5-year survival following presentation with a new DFU ranges from 50 to 60% and thus it is worse than many common cancers.

Having a foot ulcer increases the risk of another. The annual risk of developing DFU is 2% but the risk increases to between 17 and 60 % over the next 3 years in those with a previous ulcer. The recurrence rate of foot ulcers within the first year of a successfully treated ulcer is between 30% to 40%.

Diabetic foot ulcers and amputation have psychological, social, economic and rehabilitative implications for the patient. In certain settings, the need for preservation of all human anatomy for use in the “other world” militates against consent for amputation. This is even made worse by the harsh burial customs that discriminate against persons dying from chronic limb lesions<sup>58,59</sup>. Most of the patients, after amputation, suffer social and economic handicaps from the inability to afford an artificial limb. Multiple amputations are also alarmingly common. For instance, an estimated 9% to 20% of patients will require another amputation (on the same side or on the opposite side) within 12 months and 28% to 51% will need a second amputation within 5 years. These high rates of recurrent amputations appear to result from the persistence of risk factors for foot ulcerations after wound healing as well as behavioural factors. Survival following amputation is poor. The mortality ranges from 39% to 65% five years after amputation because of its negative impact on the quality of life.

### **COST OF CARE OF A DIABETIC FOOT ULCER**

Diabetic foot ulcers usually affect middle-aged individuals who are the workforce and breadwinners of the community. It, therefore, constitutes a huge economic burden (direct and indirect cost) to the family and the community at large. The estimated global cost of diabetes in 2015 was \$1.3 trillion and up to one-third of diabetes expenditure is on lower-limb-related problems in the U.S. The latest data from the U.K. estimates that the total annual cost of management of DFUs exceeds £1 billion (\$1.32 billion) and represents almost 1% of the total National Health Service budget.

The equivalent figure from the U.S. has been estimated to be \$9–13 billion. The cost of treatment of diabetic foot has been estimated to be higher than that for treating major heart disease<sup>29,56</sup>.

In Nigeria, as of 2006, the direct cost of care of diabetic foot ulcers for individual patients was about N181,000.00<sup>44</sup>. In a recent study in a resource-poor setting in Northern Nigeria where the majority of patients earned less than one hundred dollars monthly, the average cost (direct and indirect cost) of diabetic foot ulcers was estimated at 140,735.56 US dollars<sup>30</sup>.

The estimated direct cost of care of diabetic foot ulcers in Port Harcourt as of 2017 was in the range of 1.5 to 2 million naira. These high costs have been linked to frequent outpatient appointments, laboratory tests, drugs/medications, hospital stays, and secondary complications of osteomyelitis (bone infection) and amputation. The economic burden of diabetic foot ulcers in Nigeria is enormous due to the late presentation of the patients to the hospital as a result of ignorance and patronage of non-orthodox care. These make the management more complicated with longer hospital stays and hence higher cost of care. The problem is compounded in our setting by poverty, lack of access to specialized health care services, lack of national welfare schemes and health insurance coverage for diabetes which culminate in patients paying out of pocket for their care.

## **PSYCHOSOCIAL BURDEN OF DIABETIC FOOT SYNDROME**



## **“LIFE IS MOVEMENT” IS THE INSCRIPTION AT THE ENTRANCE TO THE ORTHOPAEDIC DEPARTMENT OF UPTH.**

Patients with diabetes mellitus have a higher tendency to have psychological disturbance possibly due to the chronic nature of the disease. Most notable is the issue of depression and its association with diabetes. Psychological disturbances could lead to the deterioration of blood sugar control, subsequently increasing the risk of complications of diabetes including foot ulcerations. When ulcers develop, the slow healing, as well as associated discomfort, make patients experience negative emotions such as feelings of loss, powerlessness, low self-esteem, anxiety, and depression.

The psychological burden in patients with foot ulceration results from:

1. Lifestyle changes as part of the treatment of diabetes (e.g. dietary restriction, repeated pricking for blood sugar testing and injection of drugs like insulin)
2. Repeated hospitalization and hence absenteeism from work and poor work performance.
3. Restriction of day to day activities due to reduced mobility and social isolation resulting in low self-esteem.
4. Stigmatization – people with chronic ulcers are often stigmatized. If we remember, even Lazarus in the Bible was stigmatized and treated badly because of his chronic ulcers (LUKE 16:19-21-The parable of the rich man and Lazarus)

The associated physical restrictions of therapy, including the need to offload the limbs (pressure reduction), negatively affect the quality of life and further worsens depression. Progression of DFU to lower limb amputation may also cause further loss of mobility. This might not only negatively affect the psychological state of these patients (worsening their quality of life) but could also impact their socioeconomic status.

Patients with the diabetic foot can thus enter a vicious cycle—the mental stress resulting from physically-limiting management strategies (designed to facilitate healing of DFU) can lead to chronic stress which could negatively impact the outcome. This stress also affects the immune system potentially increasing the



risk of serious infectious complications of foot ulceration possibly resulting in lower limb amputation.

### **DIABETES BURNOUT AND SYNDROME OF WILLFUL SELF NEGLECT**

Diabetes burnout refers to a state of frustration, disillusion, and submission to diabetes occurring usually after years of battling with the condition. When burnout sets in, the patient completely disregards blood sugar measurements, no longer adheres to medical regimen or appointment with healthcare providers and may even engage in self-destructive behaviours (such as eating an unhealthy diet). Such an individual no longer bothers about foot care and will not take action when he develops a foot ulcer<sup>15,33</sup>. Diabetes burnout and self-neglect has been found to be linked to depression. Such individuals will benefit from care by a psychologist.

### **FACTORS THAT LEAD TO DEVELOPMENT OF A DIABETIC FOOT ULCER**

Key factors that increase the probability of developing a foot ulcer include<sup>14,15,38</sup>:

1. Longer duration of diabetes (>10 years)
2. Poor blood glucose control (HbA1c >7%)
3. Nerve damage (diabetic neuropathy)
4. Disease of the artery causing poor blood flow (peripheral artery disease)
5. Poor foot care/ hygiene, walking barefoot, inappropriate footwear
6. Foot deformity
7. Previous foot ulceration or amputation
8. Poor vision
9. Kidney damage (diabetic nephropathy)
10. High blood cholesterol
11. Overweight /Obesity
12. Smoking
13. Male sex
14. Race (blacks, Indians especially Oklahoma Indians)

15. Occupation e.g. farming, fishing

## **SOCIAL FACTORS CONTRIBUTING TO DIABETIC FOOT ULCERS**

Social factors that lead to diabetic foot ulcers include

1. Low educational status
2. Low socioeconomic status
3. Lack of awareness about diabetes and foot care among patients, relatives and healthcare providers.
4. Preference for non-orthodox treatment and home care
5. Poor living conditions which can lead to animal bites (e.g. rat bite) that can easily get infected in an unhygienic environment.
4. Lack of health care facilities

## **CLASSIFICATION AND STAGING OF DIABETIC FOOT ULCERS**

There are several staging systems for diabetic foot ulcers with their individual merits and demerits. These staging systems help in planning treatment and predicting outcome. The Wagner classification system is the most widely used<sup>57</sup>.

<b>THE WAGNER DIABETIC FOOT ULCER CLASSIFICATION SYSTEM</b>	
<b>Grade</b>	<b>Clinical Manifestations</b>
<b>Grade 0</b>	No ulcer in a high risk foot
<b>Grade 1</b>	Superficial ulcer involving the full skin thickness but not underlying tissues
<b>Grade 2</b>	Deep ulcer, penetrating down to ligaments and muscle, but no bone involvement or abscess formation
<b>Grade 3</b>	Deep ulcer with cellulitis or abscess formation, often with osteomyelitis
<b>Grade 4</b>	Localized gangrene
<b>Grade 5</b>	Extensive gangrene involving the whole foot

*Diabetes Care. 2001;24(1):84–88.*

Grade 0	Grade 1	Grade 2
No ulcer in a high-risk foot 	Superficial ulcer involving the full skin thickness but not underlying tissues 	Deep ulcer, penetrating down to ligaments and muscle, but no bone involvement or abscess formation 
Grade 3	Grade 4	Grade 5
Deep ulcer with cellulitis or abscess formation, often with osteomyelitis 	Localized gangrene 	Extensive gangrene involving the whole foot  MD:A.N.

Figure 14: Wagners grading of diabetic foot ulcers

Source:<https://i.pinimg.com/originals/9a/cb/84/9acb84224ca8d028e35987e8dd03edca.jpg>

## WHY THE FOOT IN DIABETES? PATHWAY TO DEVELOPING A DIABETIC FOOT ULCER

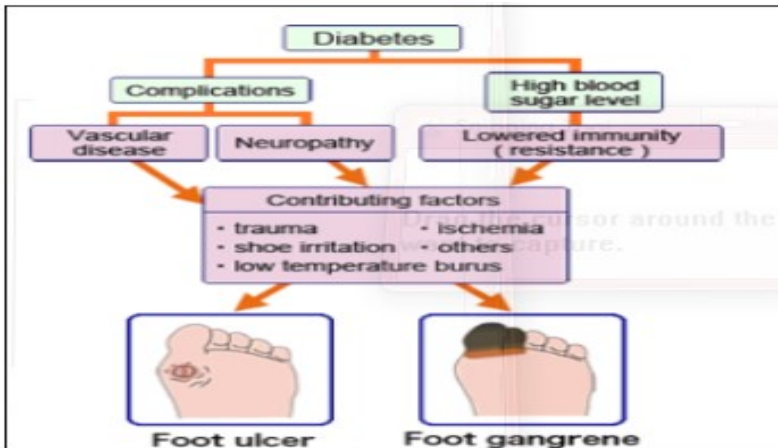


Figure 15: Pathophysiology of diabetic foot ulcer

Source:<https://kyoto.hosp.go.jp/html/guide/medicalinfo/footcenter/e/description.html>

It has been known for many years that people living with diabetes are prone to ulceration and gangrene (complete death) of the feet, often leading to amputation. However, a proper understanding of the cause of such ulceration dates from the report of Oakley et al (in 1956) (who described three factors- (arterial disease, nerve damage and infection) as the essential causes of foot lesions in people with diabetes. However, Mott had in 1818 described a round ulcer in the sole of the foot surrounded by a remarkably tough hardening of the thick cuticle, characterized by a great degree of insensitivity thus providing what was probably the first recognizable description of an ulcer due to nerve damage (neuropathic ulcer).

The mechanism of development of limb ulcer /gangrene in patients with diabetes is multifactorial. The triad of nerve damage, impaired blood flow (ischaemia) and altered immunity is presumed to contribute to the most serious limb infections and places the patient with diabetes at risk of amputation.<sup>15</sup>

### **THE ROLE OF NEUROPATHY (NERVE DAMAGE)**

Neuropathy (peripheral neuropathy) is damage to the peripheral nerves which are so named because they lie outside the brain and spinal cord. Peripheral neuropathy affects sensory nerves which are responsible for detecting sensation such as temperature or pain. It can also affect motor nerves that help the muscles to function. Peripheral neuropathy manifests as numbness or as a tingling or burning sensation in the feet or hands and other parts of the body. It tends to occur more frequently in people who have had diabetes for a long time and in whom blood sugar control is poor.

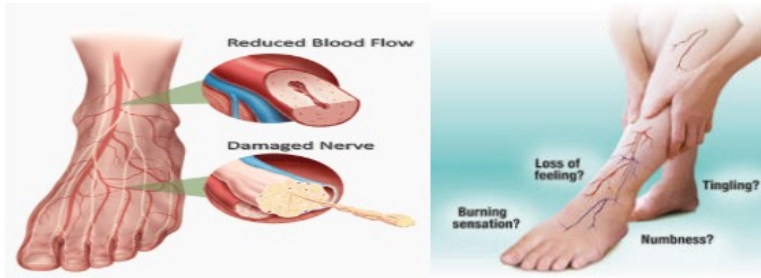


Figure 16: Diabetic peripheral neuropathy

Sources: <https://www.eliteptandbalance.com/articles/physical-therapy/peripheral-neuropathy-pain-or-tingling-in-your-feet/> and [www.pinterest.com](http://www.pinterest.com)

Neuropathy can affect any part of the body but DM neuropathy has a predilection for the long peripheral nerves of the lower limb thus the foot is mostly affected. There are different types of neuropathy in people with diabetes, but the symmetrical distal polyneuropathy, with motor, sensory and autonomic involvement, is important in the development of diabetic foot ulceration. Diffuse distal peripheral polyneuropathy, usually symmetrical in distribution, affects the lower limbs more severely than the upper. This partly explains why diabetic foot ulcers are commoner than diabetic hand ulcers.

Sensory neuropathy leads to the development of a foot that lacks sensation (an insensate foot). The person with an insensate foot may not feel pain, temperature or pressure. The insensate foot is thus highly vulnerable to repetitive injury that is usually unnoticed by the patient. It is important to note that though nerve damage causes pain, the presence of pain due to nerve damage does not mean that sensation is intact, rather the opposite applies, and positive symptoms of nerve damage are accompanied by reduced or absent sensation rendering the foot at risk of ulceration. The nerves of the hands are also frequently damaged alongside the feet giving a “glove and stocking” pattern of distribution of diabetic neuropathy.

Damage to the motor nerves leads to the weakness of the small muscles of the foot (motor neuropathy). This leads to foot deformities such as the typical cavus or high –arched foot and the clawing of the toes. In a normal foot, the toes bear 30% to 50% of

the load transmitted through the foot. With severe clawing, the fat cushioning under the foot is reduced and the toes become non-weight-bearing thereby increasing the load under the foot. The abnormal mechanical forces stimulate excessive callus (thickened layer of skin) formation under the foot which itself increases the pressure of the affected area. Foot ulcers develop at sites of maximal vertical loading and 90% of diabetic ulcers occur under pressure-bearing areas of the foot.

Diabetes causes thickening of the skin and stiffness of the joints. This stiffness or limited joint mobility which affects both the hands and feet is associated with high pressures under the feet and thus also contributes to neuropathic ulceration.

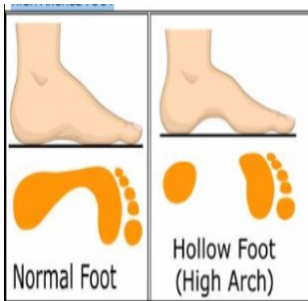


Figure 17: High arched foot (pes cavus)

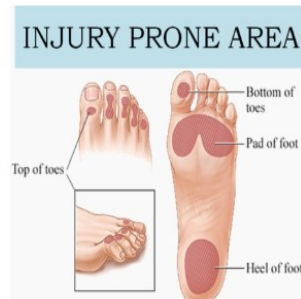
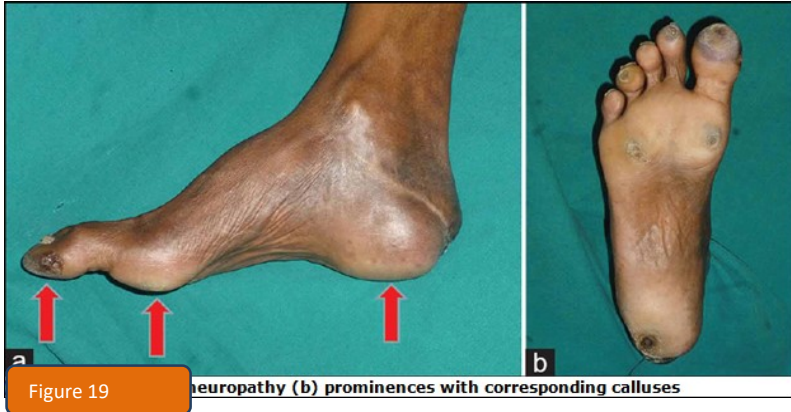


Figure 18: Pressure points at risk of ulceration

Sources: <https://guile-podiatry.doctorsinternet.com/library/higharches/>  
<https://www.healthlinkbc.ca/health-topics/zm6347>

Patients with Rheumatoid arthritis also develop high pressures under the forefoot which are equal to or higher than those in diabetics but rarely do ulcers develop in these patients because they have protective sensation. Loss of sensation secondary to peripheral neuropathy is, therefore, the single most important risk factor in the cause of foot ulceration in patients with diabetes.



Source: Indian journal of plastic surgery 2016

Chronic sensorimotor peripheral neuropathy affects about one-third of longstanding diabetic patients. Its onset is insidious and only 13-15% of patients with objective evidence of neuropathy have any symptoms. Thus, progression to insensate foot, at high risk of ulceration, can occur without the patient being aware of the disorder. Published data in Africa suggest that foot ulcers in diabetics are more likely due to peripheral neuropathy or infection than to peripheral vascular disease.

Damage to the autonomic nerves (autonomic neuropathy) in diabetes causes a variety of central complications such as postural hypotension (low blood pressure occurring on standing from a sitting or lying position), diarrhea and impotence among others. Autonomic neuropathy of the foot results in loss of sweating, leading to a dry foot that may fissure and crack.

It must be pointed out that the neuropathic foot does not ulcerate spontaneously. It is the combination of neuropathy and trauma {whether extrinsic from ill-fitting footweares or intrinsic from repetitive pressure on the metatarsal heads (the bone felt behind the big toe) during walking} that results in tissue breakdown.

The relationship between insensate foot and ulceration has been strengthened by the similarity of foot ulcers in diabetics and in leprosy (where there is no compromise of vascular status, but there is a dense sensory loss. Once a patient has an “insensate foot”,

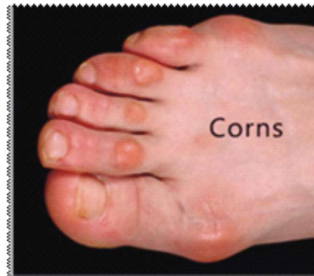
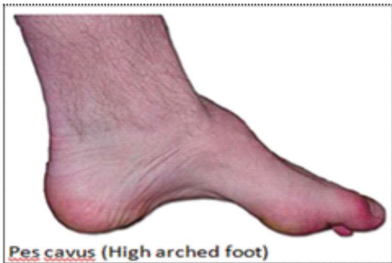
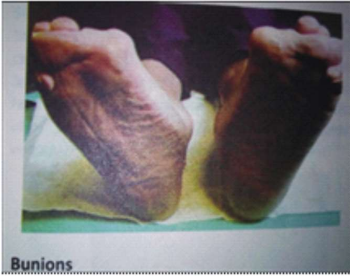
injury to the foot can occur either as a result of a single traumatic event (such as stepping on a needle or nail) or consequent to repetitive application of force. In neither case is the event perceived by the patient as disturbingly painful. It is, in fact, this lack of pain that permits the patient to ignore the wound.

### **FOOT DEFORMITIES PREDISPOSING TO ULCERATION IN PEOPLE LIVING WITH DIABETES**

Foot deformities lead to bony prominences, which are associated with high mechanical pressures on the overlying skin. These result in ulceration, especially in the absence of protective pain sensation and when footwears are unsuitable. Some of the deformities include;

1. Claw toes
2. Hammertoes
3. Hallus valgus (bunions)
4. Hallux rigidus
5. Pes cavus
6. Mallet toe
7. Charcot's foot
8. Fibro- fatty padding depletion
9. Nail deformity







**Figure 20: Some foot deformities**

Sources: Handbook on diabetes foot care for Nigeria

[https://www.asiamedicalspecialists.hk/en/health-](https://www.asiamedicalspecialists.hk/en/health-information/details.php?article_id=24)

[information/details.php?article\\_id=24](https://www.asiamedicalspecialists.hk/en/health-information/details.php?article_id=24)

[https://en.wikipedia.org/wiki/Pes\\_cavus](https://en.wikipedia.org/wiki/Pes_cavus)

<https://therapysocks.com/pages/mallet-toes>

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<https://www.beggshoes.com/blog/best-shoes-corns-calluses/>

<https://www.telmedicine.com/healthcare-news/geriatric-foot-care-108>

<https://accessmedicine.mhmedical.com/content.aspx?bookid=685&sectionid=45361286>

## **DIABETIC NEURO-ARTHROPATHY (CHARCOT'S FOOT)**

Charcot's foot is a condition that affects the bones, joints and soft tissues of the foot and ankles of people with neuropathy. It was first described in patients with syphilis. However, diabetes is now the commonest cause globally. It is a progressive condition characterized by dislocation, fractures and debilitating deformities of the foot that puts the foot at risk of ulceration and infection. It is rare, but a serious and potentially limb-threatening lower extremity complication of diabetes and poses many clinical challenges in its diagnosis and management. It is believed to be due to an inflammatory condition resulting from neuropathy, trauma, and disturbances of bone metabolism. Clinical presentation can range from mild swelling of the foot with no deformity to moderate deformity and significant swelling. Pain occurs in over 75% of patients. The hallmark is the development of the rocker bottom foot resulting from a collapse of the joints of the midfoot. Charcot neuroarthropathy increases the risk of foot ulceration. The risk of an

amputation also increases by 12% in patients with DFU in the presence of a Charcot's foot



Figure 21: Charcot foot

Sources:Charcot-Foot-and-Ankle-Centers-of-Western-New-York-2024143700929418/posts

Charcot Foot — An Update.MV Diabetes Specialties Centre and Madras Diabetes Research Foundation, Gopalapuram, Chennai, India.

<https://www.semanticscholar.org/paper/The-Charcot-Foot-An-Indian-Experience/fcd04c3a220df4ea9cd3d9805b52d338542f3743>

### **ROLE OF ISCHAEMIA (POOR BLOOD FLOW)**

Atherosclerosis (hardening of arteries) is probably present in all patients with diabetes of long duration. It leads to the narrowing of the arteries and poor blood flow to the tissue (ischaemia). Atherosclerosis occurs in people with diabetes about 20 times more common than people without diabetes. In diabetes, atherosclerosis also occurs at a younger age and progresses more rapidly than in non-diabetic individuals.

When the blood vessel in the lower limb is narrowed due to atherosclerosis, it is called peripheral artery disease. It usually causes pain in the calf, thigh, hips or buttocks when walking (claudication) It can also cause numbness or weakness in the limbs, coldness of the leg or foot, a dark discoloration of the limb, hair loss or slow toenail or hair growth on the feet and legs. Poor wound

healing, shiny skin on the limbs, weak or absent pulse in the feet and erectile dysfunction in men are also features.

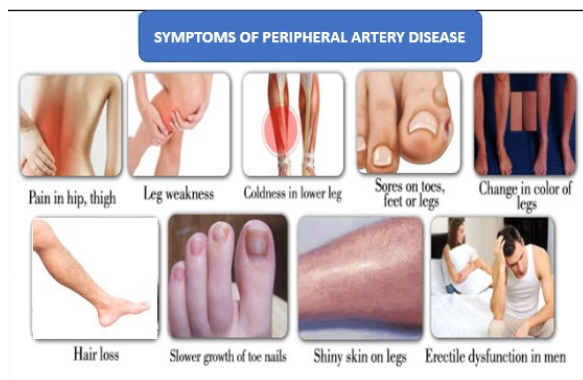


Figure 22: Features of Peripheral artery disease

Source: <https://www.pinterest.com/pin/841680617828683432/?lp=true>

Diabetic foot ulcers that are purely due to ischaemia are relatively uncommon, occurring in 10-15% of patients. On the other hand, about one-third of diabetic foot ulcers are due to a combination of nerve damage and ischaemia, the latter being a major factor in 38-52% of cases, and is responsible for 46% of amputations in diabetic patients. Spontaneous ischaemic ulceration is rare and the usual trigger is a minor trauma. Injury leads to increased demands on the circulation that cannot be met and ischaemic ulceration, sepsis and risk of amputation follow.

### **PERIPHERAL NEUROPATHY AND MACROANGIOPATHY IN DIABETICS WITH FOOT ULCERS IN PORT HARCOURT**

We conducted a cross-sectional prospective study in UPTH which aimed to determine the prevalence of peripheral neuropathy and macroangiopathy (large vessel disease) among adult patients with diabetic foot ulcer/ gangrene. In this study, diabetic foot ulceration contributed a significant proportion (16.5%) to diabetic admissions. There was a high prevalence of symptoms and signs of peripheral neuropathy (74.5% and 86.4% respectively) among diabetics with foot ulcers and/or gangrene. Only 13.7% of the subjects had neither

symptoms nor signs of neuropathy while 11.8% had neuropathy without symptoms.

The severity of symptoms of peripheral neuropathy in the subjects was directly related to the duration of diabetes (the longer the duration of diabetes, the higher the symptom grade). In 35.3% of the patients, there was objective evidence of peripheral artery disease; 16.7% of these subjects, had evidence of peripheral vascular disease alone, while 83.3% had peripheral vascular disease and peripheral neuropathy. In 52.9% of subjects, ulcers evolved spontaneously (no definite identifiable cause); while in 19.6%, ulcers were due to minor trauma; the rest from tight-fitting shoes, pedicure and nail puncture.

**Table 7: Peripheral neuropathy and vascular disease in diabetics with DFU in UPTH<sup>38</sup>**

<b>Contribution of DFU to diabetic admission</b>	<b>16.5%</b>
<b>Symptoms of neuropathy</b>	<b>74.5%</b>
<b>Signs of neuropathy</b>	<b>86.4%</b>
<b>No sign or symptom of neuropathy</b>	<b>13.7%</b>
<b>Asymptomatic neuropathy</b>	<b>11.8%</b>
<b>Evidence of PAD</b>	<b>35.3%</b>
<b>PAD alone</b>	<b>16.7%</b>

**PAD and peripheral neuropathy 83.3%**

**PAD-peripheral artery disease**

**Table 8: Symptom and sign grading of peripheral neuropathy in 51 cases of foot ulcers<sup>38</sup>**

	<b>n</b>	<b>% (95% CI)</b>	<b>Mean Duration of Diabetes (years)</b>
<b>Symptom Grade</b>			
<b>None</b>	<b>12</b>	<b>25.5 (14.3-39.6)</b>	<b>3.35</b>
<b>Mild</b>	<b>6</b>	<b>11.8 (4.4-23.9)</b>	<b>5.67</b>
<b>Moderate</b>	<b>9</b>	<b>17.6 (8.4-39.9)</b>	<b>7.17</b>
<b>Severe</b>	<b>23</b>	<b>45.1 (31.1-59.7)</b>	<b>11.00</b>
<i>p-value (ANOVA)</i>			<b>0.0158</b>
<b>Sign grade</b>			
<b>None</b>	<b>7</b>	<b>13.7 (5.7-26.3)</b>	<b>2.14</b>

<b>Mild</b>	<b>7</b>	<b>13.7 (5.7-26.3)</b>	<b>5.389.02</b>
<b>Moderate</b>	<b>27</b>	<b>52.9 (38.5-67.1)</b>	<b>9.02</b>
<b>Severe</b>	<b>10</b>	<b>19.6 (9.8-33.1)</b>	<b>9.78</b>

*p-value (ANOVA)*

*0.0850*

A high prevalence of peripheral neuropathy in diabetics with foot ulceration/gangrene was observed in this study. The study also revealed that peripheral artery disease alone may not play a major role in the causation of diabetic foot ulceration; further strengthening the important role of nerve damage in diabetic foot ulcers. A significant percentage of the study subjects (11.8%) had evidence of nerve damage without symptoms. Progression to an insensitive foot at risk of ulceration can, therefore, occur without the diabetic being aware of the disorder. This high prevalence of nerve damage amongst the subjects could explain why the antecedent events to ulceration were mainly due to unknown causes (52.9%) and minor trauma (19.6%)<sup>38</sup>.

### **THE ROLE OF THE IMMUNE SYSTEM/ INFECTIONS**

The immune cells that help fight infection and aid wound healing are reduced and ineffective in people with poorly controlled diabetes. Poor blood circulation also contributes to impaired immunity against infection in people with diabetes. In addition, the presence of oedematous (swollen) tissues, high blood sugar, and decreased insulin levels provide an environment that is favourable to bacterial growth. When the immune system can't function properly, wound healing is slower and the risk of infection is higher. Improved blood sugar control enhances immune response and healing.

Infection is not a primary factor in the development of diabetic ulceration but rather is responsible for the complications seen in the established ulcers. A major feature of diabetic ulcers is

that even after the factors responsible for the development or persistence of the ulcer have been dealt with, a prolonged period is usually required for healing to take place. Slow wound healing and increased susceptibility to infection increases the problems of foot ulceration and may predispose to amputation.

### **THE BACTERIOLOGY OF DIABETIC FOOT INFECTIONS**

Although gangrenous foot infections associated with diabetes mellitus were described as early as 1000AD, the overall morbidity and mortality of this complication were not significantly altered before the availability of insulin therapy in the early 1900s. Before the development of effective antibiotics in the second half of the 20<sup>th</sup> century, the severely infected diabetes foot with a typical mixed bacterial infection was almost always destined for amputation, regardless of peripheral circulation<sup>15</sup>. A better understanding of the nature of diabetic foot disease, the development of new antimicrobial drugs and more sophisticated methods of vascular diagnosis and reconstruction, as well as better techniques in wound care, have all resulted in a higher rate of control of infections together with a higher incidence of foot salvage.

Infections of the feet in patients with diabetes are often due to multiple infectious micro-organisms (polymicrobial), involving both gram-positive and gram-negative aerobes (requiring oxygen for survival) and anaerobes (not requiring oxygen). Clinical signs that are associated with anaerobic organisms include fever, the presence of foul odour and severe infection. The absence of any of these features, however, does not exclude the role of these pathogens. Aerobic bacteria isolated from diabetic foot infections include *Staphylococcus aureus*, Streptococci particularly group B, Enterococcus species, Corynebacteria species, and in complicated or previously treated infections, Enterobacteriaceae. The most frequently implicated anaerobic pathogens consist of Peptostreptococcus and Bacteroides species. Clostridial infections occur infrequently. The detection of crepitus in the foot or gas on x-ray increases the suspicion of infection by *Escherichia coli*, *Klebsiella* and *Proteus* species, *Enterobacter* species, anaerobic streptococci, and *Bacteroides* species. Gas forming infections are generally associated with more pronounced fever, high level of



white blood cells in the blood (leukocytosis) and increased incidence of bacteraemia (presence of bacteria in the blood) and a high mortality<sup>60,61</sup>.

The infective organism varies with the stage of foot ulceration with gram-positive cocci colonizing low-grade ulcers and anaerobes and gram-negative rods colonizing more advanced ulcers.

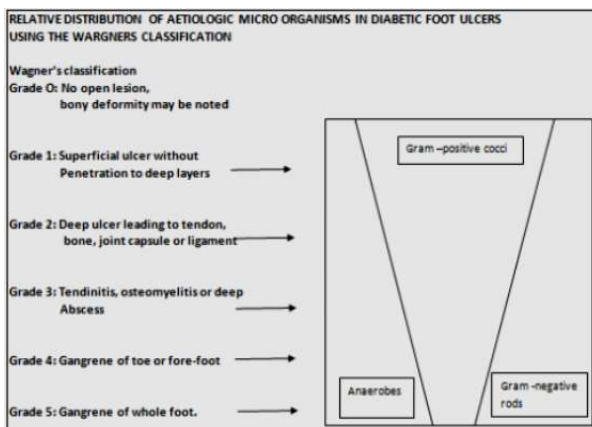


Figure 23: Distribution of aetiologic microorganisms in DFU<sup>45,57</sup>

## BACTERIOLOGIC ANALYSIS OF FOOT ULCERS IN PORT HARCOURT

In our analysis of the bacteriology of 59 cases of diabetic foot ulcers in UPTH, a total of 131 organisms were isolated from the patients with an average of 2 organisms per patient indicating the polymicrobial nature of diabetic foot infections. Seventy-five percent (75%) of the patients had already taken various antimicrobial agents before presentation. This shows the high degree of anti-microbial abuse in our environment. The isolated organisms were mainly aerobes (gram-positive cocci, gram-negative bacilli) and anaerobes. The predominance of aerobes (89.8%) compared to anaerobes was significant in this study and may be due to the fastidious nature of anaerobes, prior use of anti-microbial agents by the patients and inadequacy of anaerobic facility. Staphylococcus aureus was the commonest bacteria isolated in this study.

All cultures with anaerobes yielded more than 3 different bacterial isolates. Perhaps these act synergistically to cause progressive tissue damage. Monomicrobial cultures were obtained in 13.8% of cases and were mainly from less severe limb lesions (grade 1 and II). The monomicrobial cultures also yielded mainly staphylococcus (62.5%). This may suggest the dominant role of gram-positive cocci especially *Staphylococcus aureus* in milder foot infections. *Staphylococcus aureus* is a common skin commensal and can easily infect ulcers. Of the 6 anaerobes isolated, 50% were from gangrenous lesions and 33.3% were from grade III ulcers with associated osteomyelitis while 16.7% were from a chronic grade II ulcer. These findings suggest a higher frequency of anaerobes in chronic and advanced gangrenous infections<sup>45</sup>.

**TABLE 9: BACTERIAL ISOLATES FROM DIABETIC FOOT ULCERS IN UPTH<sup>45</sup>**

TYPE OF ORGANISM	NO (%) OF ALL PATIENTS WITH ISOLATE	% OF TOTAL ISOLATE n=131
<b>Staphylococcus aureus</b>	<b>32 (54.2)</b>	<b>24.4</b>
<b>Streptococcus specie</b>	<b>21 (35.6)</b>	<b>16.0</b>
<b>Escherichia coli</b>	<b>20 (33.9)</b>	<b>15.3</b>
<b>Pseudomonas specie</b>	<b>20 (33.9)</b>	<b>15.3</b>
<b>Klebsiella specie</b>	<b>14 (23.7)</b>	<b>10.7</b>
<b>Proteus specie</b>	<b>18 (30.5)</b>	<b>13.7</b>
<b>Anaerobes</b>	<b>6 (10.2)</b>	<b>4.6</b>

## **RESULTS BY**

### **BACTERIAL GROUP**

<b>Aerobes only</b>	<b>53 (89.8)</b>
<b>Anaerobes only</b>	<b>0</b>
<b>Anaerobes and aerobes</b>	<b>6 (10.2)</b>
<b>Monomicrobial infection</b>	<b>8 (13.8)</b>
<b>≥3 organism per patient</b>	<b>21 (35.6)</b>
<b>All cultures sterile</b>	<b>2 (3.4)</b>

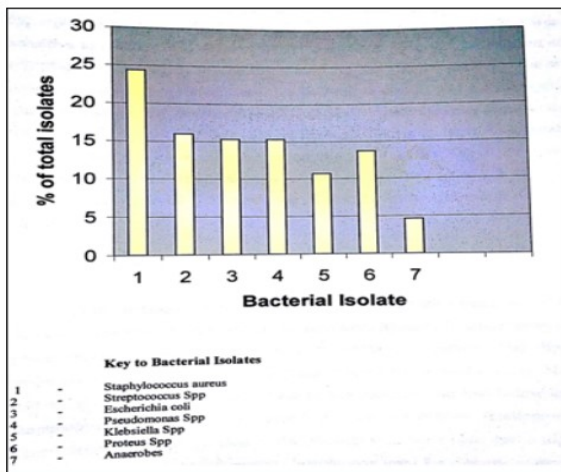


Figure 24: FREQUENCY OF BACTERIAL ISOLATES

## PATTERN OF PRESENTATION OF FOOT ULCERATION IN OUR ENVIRONMENT

Patients presenting with a diabetic foot ulcer in our clinical setting often present late. In our study, the mean duration of ulcer before presentation was approximately 6 weeks. The characteristic presentation is with an infected ulcer or foot gangrene that may end up with an amputation. In many cases, they present with overwhelming infection with complicating anaemia and even kidney failure. A lot of the time, the patients are unable to recall when and how the ulcer developed. They may only recall observing smelly fluid discharging from the foot. In some cases, the ulcer may have developed from a small blister or a boil that was either ruptured by the patient or ruptured spontaneously. One other common presentation, especially in patients with nerve damage, is an ulcer that was inflicted by hot water or fire in an attempt to self-manage the discomfort of nerve damage. Patients with ulcers due to poor blood flow will typically present with relative coldness, and dark discoloration of the limb and destructive nail changes. The pain in the legs due to poor blood flow is often absent due to the presence of nerve damage.

In our study, most patients were found to have mixed lesions (ulcer, cellulitis, abscess, and gangrene). However, the

presence of ulcers ranked highest at 98.3% with most patients presenting with Wagner’s stage 3 ulcer<sup>45</sup>.

**TABLE 10: Presentation of DFU in UPTH (using Wagner’s classification)<sup>45</sup>**

<b>GRADE OF ULCER</b>	<b>NO OF CASES (%)</b>
<b>Grade 0</b>	<b>0/60 (0)</b>
<b>Grade 1</b>	<b>7/60 (11.7)</b>
<b>Grade 2</b>	<b>16/60 (26.7)</b>
<b>Grade 3</b>	<b>21/60 (35)</b>
<b>Grade 4</b>	<b>10/60 (16.7)</b>
<b>Grade 5</b>	<b>10/60 (16.7)</b>

**EVOLUTION OF DIABETES FOOT ULCERS**

Typically, the antecedent events to diabetes foot ulceration identified in our environment include spontaneous bullae/boils, (51.7%), minor trauma (20%), burns (11.7%), ill-fitting shoes (6.7%), nail puncture (5%), and pedicure (5%)

**TABLE 11: ANTECEDENT EVENTS OF DIABETES FOOT ULCERS IN PORT HARCOURT<sup>45</sup>**

<b>ANTECEDENT EVENT</b>	<b>NO OF PATIENTS (%)</b>
<b>Spontaneous</b>	<b>31 (51.7)</b>
<b>Minor trauma</b>	<b>12 (20.0)</b>
<b>Burns</b>	<b>7 (11.7)</b>
<b>Ill-fitting shoes</b>	<b>4(6.7)</b>
<b>Nail puncture</b>	<b>3 (5)</b>
<b>Pedicure</b>	<b>3 (5)</b>
<b>TOTAL</b>	<b>60 (100%)</b>

## AGONIZING SIGHTS OF DIABETIC FOOT ULCERS











## **DOES DIABETES SPARE THE HAND?**

### **HAND ULCERS/INFECTIONS AND DIABETES MELLITUS IN PORT HARCOURT, RIVERS STATE, NIGERIA**

Hand ulcers and infections, though less common than foot ulcers, do occur in people with diabetes. They are equally associated with significant morbidity and mortality just like the diabetic foot. In a prospective study conducted between 2001 and 2002 in UPTH (which aimed to determine the prevalence, predisposing factors and outcome of hand ulcers in people living with diabetes), the prevalence of hand ulcers was 1.6%. This gave an incidence of about 2 cases per year<sup>46</sup>. This prevalence has however increased up to 6 to 10 per year in the past 3 years<sup>35</sup>.

Most of the ulcers resulted from minor domestic trauma on a background of poor blood sugar control. The ulcers were worsened by the application of local herbs to the existing wound and delayed presentation to the hospital. Low socioeconomic status was also a significant predisposing factor to hand ulceration. All the hand ulcers were infected and *Staphylococcus aureus* was the commonest organism isolated. The mortality rate of hand ulcers was 20% in this study.

What was striking in this study was that more females (especially in the middle-aged group) were affected. This is due to

the fact that women are more involved in domestic work, and fishing in the coastal region of Nigeria, which exposes them to frequent hand trauma. Also cultural practices, leading to women (being regarded as “the weaker sex”) attending hospitals less frequently than men have been noted to contribute to late presentation and infections in females compared to males<sup>46</sup>.



**Figure 25: Diabetic hand infections /ulcers in UPTH**

### **MANAGEMENT OF THE DIABETIC FOOT SYNDROME**

The management of diabetic foot syndrome requires prompt and accurate assessment and treatment to prevent infection, amputation, and death. Because diabetes is a multi-organ disease, diabetic foot ulcer and its management is complex. Its management, therefore, requires a multidisciplinary approach to tackle all co-morbidities. This involves a dedicated team of healthcare providers as shown in the figure below:

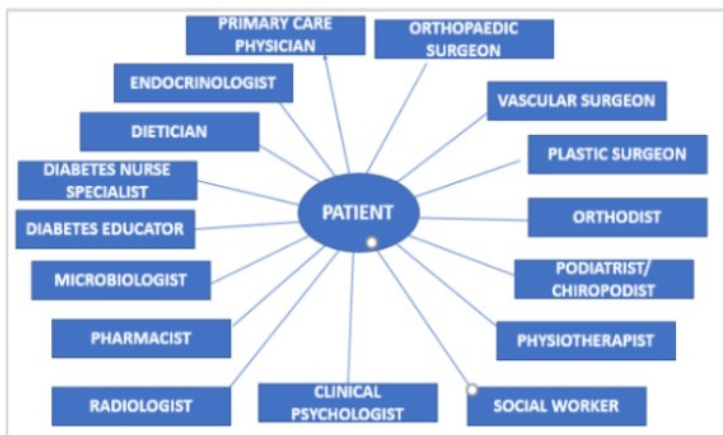


Figure 26: Members of the multidisciplinary diabetic foot team

Source: Adapted from: Managing the complications of diabetic foot. BMJ 2009

The goal of this team is to provide an integrated care approach to management with the aim of reducing the risk associated with foot ulceration such as ulcer recurrence, amputation, and death.

## **IMPORTANT MEASURES IN TREATMENT OF DIABETIC LIMB ULCERS**

Important aspects of the treatment of diabetic limb ulcers include:

1. Control of diabetes and co-existing metabolic problems
2. Antimicrobial treatment
3. Pressure reduction
4. Correction of ischaemia (restoration of blood flow)
5. Wound care
6. Lifestlye changes

## **CONTROL OF DIABETES AND CO-EXISTING METABOLIC PROBLEMS**

Having high blood glucose affects the ability of wound to heal<sup>39</sup>. Infection in a diabetic wound causes extra metabolic stress, and release of counter-regulatory hormones that worsen blood glucose control resulting in further impairment of wound healing. A greater

emphasis on achieving tight blood glucose control and overall improved metabolic control in diabetic patients would help reduce the risk of developing diabetic wounds in the first place and likewise would promote healing and reduce morbidity and mortality from wounds once they occur. Intensive control of blood glucose (as shown by DCCT and UKPDS) is therefore crucial in the management of diabetic foot ulcers.

Control of metabolic factors such as cigarette smoking, hypertension, dyslipidaemia, hyperglycaemia, and obesity are particularly important in the management of peripheral arterial disease.

### **ANTIMICROBIAL THERAPY**

The presence of multiple organisms in diabetic limb infection suggests the importance of administering antibiotics that provide coverage for multiple pathogens. Empirical treatment is instituted using previous local or environmental bacteriological studies as a guide. Treatment for some diabetic limb infections can, therefore, include antibiotics that have broad-spectrum activity and that are effective against anaerobes<sup>60,61</sup>.

Based on our study in UPTH that analyzed the antimicrobial susceptibility of bacterial isolates from diabetic foot ulcers, most of the aerobes (74.8% and, 70.2%) were sensitive to ciprofloxacin (fluoroquinolone) and ceftazidime (3<sup>rd</sup> generation cephalosporin) respectively. All the anaerobes were sensitive to clindamycin and metronidazole (nitroimidazole). The outcome of this study forms the basis for empirical antibiotic treatment of diabetic foot ulcers /infection in Port Harcourt and other parts of Nigeria -the choice of combining a 5-fluoroquinolone or cephalosporin and a nitroimidazole in advanced diabetic foot infections<sup>45</sup>.

### **TABLE 12: SUSCEPTIBILITY OF BACTERIAL ISOLATES TO DIFFERENT ANTIMICROBIAL AGENTS<sup>45</sup>**

<b>ANTIMICROBIAL AGENT</b>	<b>NO. (%) OF SENSITIVE ISOLATES n=131</b>
<b>Ciprofloxacin</b>	<b>98(74.8)</b>
<b>Ceftazidime</b>	<b>92(70.2)</b>
<b>Pefloxacin</b>	<b>89(67.9)</b>
<b>Cefuroxime</b>	<b>87(66.4)</b>
<b>Gentamicin</b>	<b>64(48.9)</b>
<b>Clindamycin</b>	<b>60(40.8)</b>
<b>Amoxicillin+clavulanate</b>	<b>36(27.5)</b>
<b>Streptomycin</b>	<b>26(19.8)</b>
<b>Erythromycin</b>	<b>25(19.1)</b>
<b>Chloramphenicol</b>	<b>25(19.1)</b>
<b>Tetracycline</b>	<b>20(15.3)</b>

<b>Ampicillin</b>	<b>14(10.7)</b>
<b>Cloxacillin</b>	<b>14(10.7)</b>
<b>Cotrimoxazole</b>	<b>11(8.4)</b>
<b>Metronidazole (for anaerobes only)</b>	<b>6(100% for anaerobes)</b>

### **CONSIDERATIONS FOR ANTIBIOTIC SELECTION**

The following parameters are considered in the selection of an optimal antimicrobial drug for therapy<sup>60,61</sup>:

1. It should have a high affinity/sensitivity against the suspected causative organism.
2. It should attain effective concentration at the site of infection;
3. It should have very little toxicity.
4. It should not lead to the emergence of resistant microorganism in the patient or in the environment.
5. It can be administered via the desired route.
6. It should be economical.

It is important to note that poor blood flow in people with diabetes may reduce antibiotic delivery to sites of infection thus the need for drugs with extensive tissue penetration. Impaired kidney function, is common in longstanding diabetes. Antibiotics that are toxic to the kidneys, such as aminoglycosides (e.g. gentamicin) are therefore avoided or used with caution if there is no alternative.

### **RESPONSE TO ANTIBIOTIC THERAPY**

The rapidity of response to antibiotics depends on the causative micro-organism, host defense factors, the site of infection, and the therapy chosen.

The possible reasons for insufficient response to antibiotic treatment are:

1. Short duration of treatment for clinical effects.
2. Wrong clinical and microbiological diagnosis.
3. Wrong antibiotic therapy.
4. Substandard drugs.
5. Poor antibiotic penetration to site of infection (due to poor blood flow, pus collection, foreign body or deep-seated infection).

### **EMERGENCE OF ANTIMICROBIAL RESISTANT ORGANISMS -AN OBSTACLE TO SUCCESSFUL TREATMENT OF FOOT INFECTIONS**

Since the beginning of the antibiotic era, bacterial resistance has been seen as the major obstacle to the successful treatment of infections. There is hardly any group of antibiotics introduced into clinical practice, to which some bacteria have not developed resistance. The major cause of antibiotic resistance is the increased and often indiscriminate use of antibiotics in humans and animals<sup>62</sup>. The global increasing antimicrobial resistance has reached crisis proportions, especially with the manufacture of numerous brands of the same antibiotics and global drug trafficking.

The problem of antibiotic resistance is likely to be worse in some countries like Nigeria where drugs are sold over the counter without a doctor's prescription. This results in indiscriminate consumption of antibiotics at sub-optimal doses and shorter duration with the eventual result of resistant organisms and failure of isolation of appropriate pathogens.

### **PRESSURE REDUCTION/ OFFLOADING**

Limb ulcers may not heal in the patient with nerve damage who continues to walk on the affected foot without taking some protective measures. Therefore, patients should keep weight totally off the limb. Offloading simply means taking the pressure off the area. It aims to eliminate abnormal pressure points on the foot to promote healing or prevent the recurrence of foot ulceration. Relief of pressure on the ulcer as well as rest and elevation of the limb



should be started early. This can be done with the use of crutches, a walker (e.g. cam walker or a wheelchair with a foot extension). Complete bed rest may be necessary in recalcitrant cases.

When staying off the limb is not feasible, improper or ill-fitting footwears are replaced with “healing sandals” or special shoes. Total-contact cast is the gold standard for the treatment of ulcers due to nerve damage in ambulatory diabetic patients because they distribute pressure over the total foot surface. Removable walking casts are however as effective as total contact-cast in reducing pressure at ulcer sites. Chiropody to remove calluses and early surgical intervention to correct abnormalities may be prudent for bony prominences.

These special offloading casts are not readily available to us in this environment. Therefore, we use mainly crutches, wheelchairs, and bedrest (with foot elevation) as offloading measures.

## SOME OFFLOADING DEVICES



DIABETIC AIR WALKER



TOTAL CONTACT CAST

Removable cast walker



Scotchcast boot





WHEEL CHAIR



CRUTCHES

Sources: <http://www.ndfclinic.com/foot-biomechanics-offloading-devices/>  
<https://ghss.com.au/product/underarm-crutches/>  
<https://www.themobilityaidscentre.co.uk/drive-medical-silver-sport-wheelchair>

## **CORRECTION OF ISCHAEMIA**

Ischaemia (poor blood flow) is the only factor that, in itself can necessitate foot amputation in a patient with diabetes. Slow healing, despite appropriate care, suggests a vascular compromise and the need for further workup, often including consultation with a vascular surgeon. The addition of hyperbaric oxygen therapy to the conventional treatment (of strict blood sugar control, debridement, and antibiotics) speeds up the healing process and lessens the need for amputation. Systemic hyperbaric oxygen therapy is, however, not used as a substitute for real revascularization (restoration of blood flow) in surgically correctable cases.

## **WOUND CARE**

Wound care involves wound dressing and wound debridement. The goal of wound dressing is to provide a warm and moist environment that is free of external contamination. Saline dressing and several other types of commercially available occlusive dressings (hydrocolloids alginates, foams, films) are effective<sup>63</sup>.

## **WOUND DEBRIDEMENT**

Wound debridement is the medical removal of dead, damaged or infected tissue to improve the healing potential of the remaining healthy tissue.

There are five types of wound debridement.

**1. Surgical debridement:** Involves using surgical instruments to remove dead tissue. It is the most aggressive type of debridement and is the only form of debridement proven to be efficacious in clinical trials. This is the form of debridement mostly used in our setting.

**2. Enzymatic debridement:** This involves the topical application of agents that chemically liquefy dead tissue with enzymes. Bacterial collagenase, plant-derived papain/urea, fibrinolysin/DNAse are the ones widely used.

**3. Autolytic debridement:** This method uses the body's own enzymes and moisture beneath a dressing and non-viable tissue becomes liquefied.

**4. Mechanical debridement:** This method uses force to remove dead tissue. This may be by irrigation, hydrotherapy, wet-to-dry dressings, and an abraded technique.

**5. Biological debridement:** This is the use of maggots, *Lucilia sericata* (green bottle fly), that are grown in a sterile environment. These maggots secrete a powerful proteolytic enzyme that digests dead tissue and pathogens<sup>14</sup>.



Figure 27: Biological debridement using maggot

Source:[https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(05\)72870-1/fulltext](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(05)72870-1/fulltext)

### **SUPPLEMENTARY TECHNIQUES OF WOUND CARE**

**Skin grafting:** This involves harvesting skin from a healthy part of the body and transplanting it on the ulcer site to speed up healing.

**Vacuum-assisted closure:** The vacuum-assisted closure (VAC) pump can be used to achieve closure of diabetic wounds by applying negative pressure.

**Hyperbaric oxygen:** This accelerates the healing of ischaemic diabetic foot ulcers by employing oxygen under pressure. It is useful as an adjuvant in severe or life-threatening wounds and has been shown to reduce the number of major amputations in the ischaemic diabetic foot.

**TABLE 13: THERAPEUTIC MODALITIES FOR DIABETES ASSOCIATED LIMB INFECTION**

<b>LESION</b>	<b>METABOLIC REGULATION AND</b>	<b>ANTIBIOTIC TREATMENT</b>	<b>SURGERY</b>
	<b>LOCAL MEASURES</b>		
<b>Uninfected ulcer</b>	++	None	+
<b>Cellulitis</b>	+	++	None
<b>Abscess</b>	+	+	++
<b>Necrotizing fasciitis</b>	+	+	++
<b>Osteomyelitis without gangrene</b>	+	++	+
<b>Ischaemic gangrene</b>	+	None	++



**TABLE 14: CAUSES OF POOR WOUND HEALING**

<b>LOCAL FACTORS</b>	<b>HOST FACTORS</b>	<b>ENVIRONMENTAL FACTORS</b>
Necrosis (tissue death)	Co-morbidities	Poor access to care
Infection	-End-stage kidney disease	Poor access to appropriate offloading devices
Pressure injury on the ulcer area	-Immunosuppression / steroid/ cytotoxic drug use	Poor Family support
Poor blood circulation	-Visual impairment	Health care sector
Foreign body	-Poor glycaemic control	Low socioeconomic status
Local trauma to the ulcer area		
Oedema (swelling)	-Poor nutrition	
Radiation	/Anaemia	
	-Vascular disease	

**Extremes of age**

**Obesity**

**Smoking/ Alcohol  
and substance abuse**

**Poor adherence to  
plan of care**

**Cultural/personal  
beliefs**

**Mental health issues**

## **LENGTH OF HOSPITAL STAY AND OUTCOME OF MANAGEMENT OF PATIENTS WITH DIABETIC LIMB ULCER/GANGRENE**

The average duration of hospital stay for all cases with diabetic foot ulcers in our study in UPTH was  $43.5 \pm 36.57$  days with a range of 2 to 180 days. The average length of hospital stay for patients who had amputation was  $62 \pm 23.19$  days. The average hospital stay for those who received conservative management was  $42.8 \pm 36.92$  days. The longest hospital stay of 180 days was for a patient who had a gangrenous ulcer, refused amputation but persevered on conservative measures.



The outcome of diabetic foot ulcers depends on the severity of the disease at presentation. Ulcer grade, presence of gangrene, presence of co-morbidities, response time to care and more importantly patient compliance to recommended therapy are important determinants. Our studies showed that 81.7% of patients presenting with a foot ulcer achieved wound healing and were discharged.

However, 6.7% of the patients with foot ulceration died. Seventy-five percent (75%) of those that died had gangrenous ulcers. Our studies thus revealed that the outcome is worse in patients with gangrene. The total hospital surgical amputations during the time of the study were 96 (including 12 diabetic amputations). Diabetic limb ulcer/ gangrene, therefore, constituted 12.5% of hospital amputation.

We also encounter a lot of patients who take self-discharge against medical advice for various reasons such as the inability to afford further Medicare and refusal of amputation. This shows the extent of ignorance, poverty, and resistance to amputation in our environment<sup>38</sup>.

**Table 15: OUTCOME OF MANAGEMENT OF DFU IN UPTH<sup>38</sup>**

OUTCOME	NO. OF PATIENTS (%)
Improved and discharged (conservative and surgical management)	49 (81.7)
Refused amputation and had self-discharge	3 (5)
Could not afford further hospital treatment and had self-discharge	4 (6.6)
Died	4(6.7)

## **AMPUTATION IN PATIENTS WITH DIABETES**

Amputation is the removal of a terminal, non-viable portion of a limb. It is the treatment of choice for disease conditions of the limb (such as gangrene, infections, trauma, tumors, or congenital musculoskeletal disorders) for which attempts at salvage and reconstruction may be lengthy, emotionally and financially costly with an unsatisfactory result.<sup>64</sup> In Nigeria, the amputation rates in patients with diabetic foot ulcers are high ranging between 12% to 53%. This is because a lot of patients with diabetic foot present so late that limb salvage becomes impracticable. In these cases, amputation provides a viable treatment option and not a failure of treatment. A multidisciplinary approach to the management of the diabetic patient (with complications warranting amputation) is the standard. The level of amputation is chosen on the basis of tissue viability and residual limb function. Once any form of amputation has occurred, the patient must be considered at risk of foot ulceration.

## **INDICATIONS FOR AMPUTATION**

A surgical decision to amputate is based on an assessment of the extent of the necrotic digit/limb, the extent of the tissue blood flow to sustain healing and the general condition of the patient. The indications for amputation include:

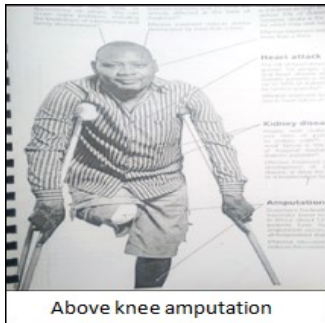
1. Gangrene.
2. Uncontrolled infection.
3. Critical ischaemia (severely impaired blood flow to the limbs)

## **TYPES OF AMPUTATION**

The types of amputation are:

1. Ray amputation
2. Lisfranc and trans metatarsal amputation
3. Chopart amputation
4. Transmalleolar amputation
5. Transtibial or below-knee amputation

- 6.Knee disarticulation
- 7.Hip disarticulation



Sources: Handbook on diabetes foot care for Nigeria

<https://medtube.net/diabetology/medical-pictures/18311-bilateral-trans-metatarsal-amputation>



Bilateral below knee amputation

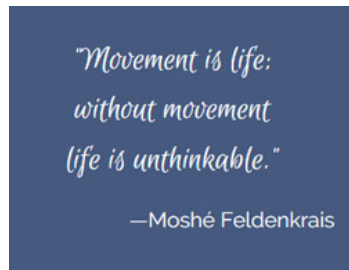


Below knee amputation

Photos with permission of the patients

## Figure 28: Types of amputation

### LIFE AFTER AMPUTATION



Limb loss results in a permanent disability that can impact a patient's self-image, self-care, and mobility. An amputation is thus a life-changing event with a lot of physical, psychological and psychosocial challenges both for the amputee and all those connected to him such as family members, friends, co-workers, etc.

It comes with a lot of negative stigma and psychological trauma as people tend to look down on amputees. The employed amputee may lose their jobs and the unemployed may not get a job with a resultant negative impact on the workforce and in turn increased economic burden. In the USA, for instance, the yearly cost of lower extremity amputation is between \$30,000 and \$60,000 and a lifetime cost of half a million dollars. Amputation is equally expensive in our setting. The average cost of surgery alone in a public hospital is in the neighborhood of N600,000 to N800,000. Post-surgical care such as physical/rehabilitation therapy and prosthetic devices are equally expensive with the cheapest prosthesis costing between N300,000 to N500,000. For this reason, a lot of patients end up moving about on wheelchairs or with crutches after surgery with significantly reduced quality of life. Sadly, amputation reduces life expectancy for various reasons. Generally, those with diabetes with a lower limb amputation are two to three times more likely to die at any given time than those without diabetes.

After amputation, the amputee often grieves for the lost limb and the old body image and usually goes through the various stages of grief viz denial, anger, bargaining, depression, and acceptance. This often resembles the way people respond to the death of a loved one or when being diagnosed with a life-threatening illness. Investigators have noted a high prevalence of depressive and anxiety symptoms as well as suicidal tendencies in amputees<sup>31,49</sup>. Intervention in the amputee's distress addresses the psychological side of injury and healing which is paramount to physical rehabilitation

## **REHABILITATION AFTER AMPUTATION**

Lower limb amputees typically have reduced mobility which affects their ability to perform daily tasks and to successfully reintegrate into the workforce and community life. The goal of rehabilitation after an amputation is to help the patient return to the maximum level of function and independence possible, while improving the overall quality of life—physically, emotionally, and socially.

Rehabilitation is started as soon as possible after surgery and may continue for weeks, months or even years. It is a complex task requiring a multidisciplinary rehabilitation team including, orthopaedic surgeon, physiotherapist, recreational and occupational therapist, psychiatrist/psychologist, social worker, and physician etc<sup>65</sup>.

Effective rehabilitation programs involve the following:

- Treatments to help improve wound healing and stump care.
- Management of post-operative and phantom pain (pain that occurs below the level of amputation).
- Exercises that promote muscle strength, endurance, and control.
- Activities to help improve motor skills, restore activities of daily living and help the patient reach maximum independence.
- Fitting and use of artificial limbs (prostheses).
- Emotional support to help during the grieving period and with readjustment to a new body image.
- Use of assistive devices.
- Nutritional counseling to promote healing and health.
- Vocational rehabilitation (counseling, training and job modification).
- Adapting the home environment for ease of function, safety, accessibility, and mobility.
- Patient and family education.

## **RECOVERING AFTER LIMB LOSS**

It takes a long time for amputees to recover after amputation. The recovery process is different for each person and the rate of recovery varies greatly from one person to another. Attitude and degree of motivation are very important factors in recovery. While younger, active and physically fit patients adapt to a prosthetic device more easily and recover fast, elderly amputees are more likely to use a wheelchair after an amputation rather than learn to walk again on a prosthesis.

Though the recovery process is extremely challenging, it is also entirely possible, especially with patience, acceptance and the right

attitude. Most patients are able to successfully adapt and resume their lives following an amputation. With the invention of many different types of prosthetic devices today, there is now very little amputees can't do<sup>66</sup>.



Oscar Pistorius an Olympic athletic champion by all accounts did not allow his lack of legs slow him down.

## EXAMPLES OF PROSTHESIS DEVICES



Powered prosthetic devices

Sources:<https://rogerwolfsonandassociates.co.za/below-knee-prosthetics>/<https://phys.org/news/2014-11-impact-power-prosthetic-failures-amputees.html>

## **CHALLENGES OF MANAGING DIABETIC FOOT ULCERS IN NIGERIA (KNOWLEDGE BARRIER, CULTURAL BELIEFS, MYTHS, AND MISCONCEPTIONS)**

Managing diabetic foot ulcers in Nigeria is a major challenge both for the patient, family and health care provider. One major challenge is the late presentation to the hospital.

The major reason for the late presentation is the knowledge barrier as regards diabetes and foot care. Since diabetes may be asymptomatic, some patients may not be aware that they have diabetes and may present for the first time with a foot ulcer that has refused to heal. Secondly, for those who are diabetic, there is a lack of education on how to care for the foot to prevent foot ulceration.

Another reason is that patients with diabetic foot ulcers tend to avoid hospitals. They start with self-medication and patronize the chemist shops and alternative medical practitioners first. They only present to the hospital when the ulcer has advanced. This poor health-seeking behavior is especially influenced by misconceptions and unhealthy cultural beliefs.

**THE POISON /SPIRITUAL ATTACK SYNDROME:** The majority of patients presenting with a foot ulcer believe or are made to believe that the non-healing foot ulcer in a diabetic is due to a “poison” that has been stepped on by the individual. Some others believe it is due to a spiritual attack. With these, the usual advice from relatives and friends willing to help is that the individual should seek help in the prayer houses or from a native doctor/spiritualist. In addition, there is the threat that if he/she goes to the hospital, he will end up with an amputation.

For these reasons, patients seek help from alternative medical practitioners who (as part of their treatment), may apply concoctions that would introduce more infections to the wound. Apart from the deterioration of clinical state due to delay in



presenting at the hospital, most patients are already financially drained at the time of presentation in the hospital for proper medical care. At this point, they can no longer pay for Medicare in a society where treatment is out of pocket.

### **REFUSAL OF AMPUTATION AND THE ROLE OF CULTURAL BELIEFS**

A lot of patients presenting very late require amputation. However, amputation is not a well-accepted option of treatment even though it is clear it may be the only option to save a life. In some cultures, those who die with a chronic ulcer or a missing body part are buried in the evil forest. For this reason, patients from those cultural backgrounds do not accept amputation and would prefer to die and be buried whole. However, we should always remember the biblical quotation thus:

***“IF YOUR FOOT WILL LEAD YOU TO HELL, CUT IT OFF! IT IS BETTER TO ENTER HEAVEN WITHOUT A FOOT THAN TO KEEP BOTH FEET AND BE THROWN INTO HELL” MARK 9:45***

### **PREVENTION - THE KEY TO REDUCING THE BURDEN OF DIABETIC FOOT ULCERS**

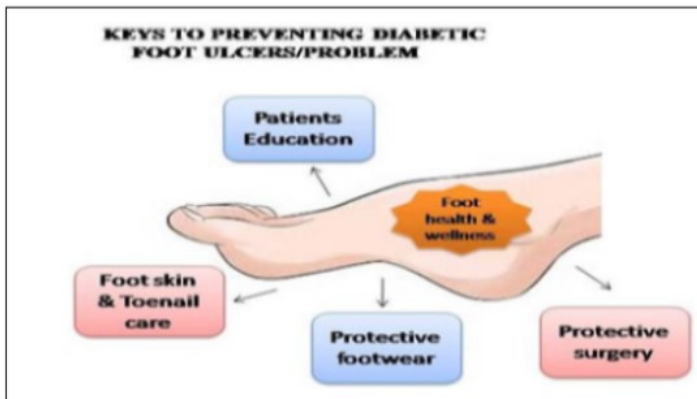


Figure 26: Keys to the prevention of diabetic foot ulcers  
Source: Diabetic foot research India

Approximately eighty-five percent of diabetes-related amputation is preventable. The high cost of treating diabetic foot ulcers argues for the need for better treatment strategies and preventive measures. Nowadays, the aim is to prevent than treat foot ulcers. The prevention of foot ulcers is thus an important component of diabetes management. This demands specialist and teamwork in the setting up of diabetes clinics in order to identify and educate the people living with diabetes at risk and, where possible to use suitable plantar pressure reducing systems (footwears, hosiery among others). Only then would a significant reduction in amputations due to diabetes be achieved in the near future.

The first building block for effective care is the establishment of a multidisciplinary team- chiropodist, shoe fitter, physicians, surgeons, nurses, dieticians amongst others. The ultimate goal is prevention and the therapeutic approach must be through education of the patient on foot care.

Patients who develop foot lesions have significantly less knowledge of diabetes and foot care. Health education, early elimination of areas of peak pressures and surgical intervention can help patients maintain an active lifestyle and lessen the probability of ulceration/amputation later in life.

## **LEVELS OF PREVENTION OF DIABETIC FOOT ULCERATION**

In view of the burden of diabetic foot ulcers, prevention is the key. Preventive strategies can be at 3 levels – primary, secondary and tertiary.

**PRIMARY PREVENTION-** Primary prevention includes all measures involved in preventing diabetic foot in the first instance. The target of primary prevention is to prevent the risk factors for diabetic foot ulceration. This is the main focus of preventive strategies.

**SECONDARY PREVENTION-** This is aimed at early detection and proper management of an established foot ulcer and prevention of a second ulcer. Apart from the provision of appropriate footwear for people with (in particular) plantar ulceration, targeted education is believed to be an essential part of secondary prevention.

## **TERTIARY PREVENTION**

This is aimed at improving the quality of life and reducing the impact of diabetic foot ulcers. Tertiary prevention includes ulcer treatment, prevention of amputation and physical and occupational rehabilitation as well as psychotherapy for patients with foot ulcer and amputation.

Secondary and tertiary levels of prevention are very costly in a resource-poor setting like ours, hence the emphasis should be on primary prevention.

## **PRIMARY PREVENTION**

Foot ulceration can be the first presentation of diabetes. Therefore, primary prevention involves education geared towards the prevention of diabetes in the general public and includes education on a healthy diet, exercise, and lifestyle as well as blood pressure control. If there is no diabetes, then there will be no diabetic foot ulceration. Prevention is always better than cure!!

## **MEASURES TO PREVENT AND CONTROL DIABETES**

Those who have risk factors for diabetes (such as having a sibling or parent with diabetes, gestational diabetes, obesity or prediabetes) are particularly at risk of having diabetes. In these categories of persons, lifestyle changes have been proven to prevent or delay diabetes<sup>70</sup>.

Tips for preventing diabetes include

**1. Maintaining a healthy weight:** This is essential in preventing or delaying diabetes especially in people who are obese. Obese or overweight individuals are encouraged to lose weight. The ideal weight should be one that would maintain the body mass index of between 18.5 - 24.5kg/m<sup>2</sup>. The key to maintaining a healthy weight is by balancing the number of calories consumed with the number of calories used by the body. This is achieved by eating the right diet and being physically active.

**2. Eating a healthy (balanced) diet:** A healthy diet is a low salt, low-calorie diet that consists mainly of fruits, vegetables, protein, good fat, whole grains, and fibre. Refined carbohydrates, sugar, honey, sweetened beverages, and fatty foods contain a lot of calories and encourage weight gain and increase the risk of diabetes. These should be avoided as much as possible. Artificially sweetened drinks, as well as processed fruit juice, are equally unhealthy. Water

is the best beverage. It is advised to drink water instead of sweetened beverages. With respect to diet, emphasis is particularly made on portion control in other words, large portions of food should be avoided as these increase the risk of diabetes.

**3. Physical activity /Exercise:** Physical activity is beneficial in reducing body weight, blood pressure, blood glucose, high cholesterol and improves overall physical and psychological wellbeing. At least 30 minutes of physical activity a day, five days a week is recommended. Aerobic exercises (e.g. cycling, brisk walk, gardening, jogging, dancing, swimming), vigorous-intensity training and resistance training are all recommended. All adults are advised to decrease the amount of time spent on daily sedentary behavior and prolonged sitting should be interrupted every 30 minutes.

**4. Blood pressure and cholesterol management:** Blood pressure and cholesterol are closely associated with diabetes. These can be managed with regular exercise, a balanced diet and keeping a healthy weight. Medications may also be needed in some cases.

**5: Smoking cessation:** Cigarette smoking damages the small and large vessels and nerves. This may lead to disease of the artery leading to strokes, heart attacks, etc. Smoking has been linked to diabetes and other health conditions like cancers, and lung diseases amongst others. Both first hand and second-hand smoking are considered dangerous. Smoking cessation has been found to reduce the risk of developing diabetes and its complications.

**6: Cutting down on alcohol intake:** Alcohol intake encourages weight gain, damages the liver and pancreas and increases the risk of diabetes. Excessive alcohol intake can seriously affect diabetes treatment and control. It can also aggravate diabetes nerve damage (neuropathy). Reducing the intake of alcohol (for those who drink) will significantly reduce the risk of developing diabetes. The recommended amount of alcohol allowed is not more than two drinks per day in males, and not more than a drink per day in females. Those who do not drink alcohol should not start.

**7. Regular medical checkup:** As one gets older the risk of developing diabetes, hypertension and cholesterol problems increases. It is therefore wise to undergo regular screening/medical checks for blood glucose, blood pressure, and blood

cholesterol levels. This is important for the early detection of diabetes and other cardiovascular risk factors.

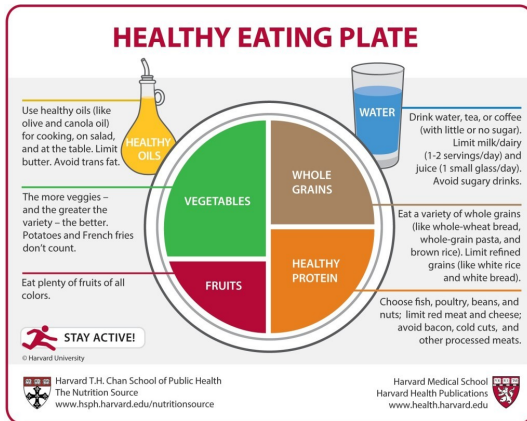


Figure 25: Strategies to prevent diabetes

Source: <https://medicowiki.com/endocrinology/>

## PRIMARY PREVENTION OF FOOT ULCERS IN PERSONS WITH DIABETES

In those with diabetes, primary preventive strategies aim to identify those at high risk of developing diabetic foot (in particular those with vascular disease and nerve damage.) This high-risk population is identified during regular examination and appropriate education is given. Emphasis is placed on foot care, lifestyle changes, appropriate diet, regular exercise (including frequent breaks for short exercise during sedentary work), self-control of body weight,

quitting cigarette smoking, ensuring good blood sugar control, treating lipid disorders, hypertension and hyperuricemia. It also includes the use of orthotics and preventive surgeries (including vascular surgeries) in patients with nerve damage, and or vessel disease as the case may be.

### **SCREENING FOR THE FOOT AT RISK:**

Diabetic foot problems have the capacity to deteriorate rapidly. It is important therefore to detect them early so that rapid and aggressive treatment is instituted. It is also important to identify the foot at risk so that prompt preventive measures can be instituted. Diabetes foot screening is strongly supported by evidence-based best practice recommendation as a key component of the systematic and multidisciplinary care required by people with diabetes.

According to the International Working Group on Diabetic Foot (IWGDF), all individuals living with diabetes should have a comprehensive foot examination once a year to identify the foot at high risk of ulceration. Those identified with one or more high-risk foot conditions should be examined at least twice a year while those with nerve damage should have their feet examined at every contact with a healthcare provider. The multidisciplinary diabetic clinic plays a major role in diabetic foot screening and consists of all health care providers involved in diabetic foot management.

### **COMPONENTS OF DIABETIC FOOT SCREENING**

Diabetic foot screening is a simple but comprehensive process that includes history, an examination of the feet and investigation for nerve damage and peripheral artery disease as well as inspection of the shoes.

**HISTORY-** This is a pivotal component of risk assessment. Key components of the history include a previous history of foot ulceration, amputation, Charcot foot, or vascular surgery, symptoms of nerve damage (pain, burning sensation, numbness) or poor blood circulation (leg fatigue, claudication) impaired vision, or kidney disease. Lastly, tobacco use should be recorded, since cigarette smoking is a risk factor not only for vascular disease but also for neuropathy.

### **EXAMINATION OF THE FEET**

The feet are examined for swelling, colour, temperature, dryness, thickness, cracks of the skin and ulceration, callus formation and other foot deformities (claw toe, prominent metatarsal head, Charcot foot, etc.). They also examined for the presence of fungal infection of the webspace.

The nails are examined for thickening, ingrown corners, length and presence of fungal infections. Nail polish has to be removed for proper nail inspection.

Footwears are examined for torn linings, foreign objects, abnormal wear patterns, and proper fit or appropriateness. Examples of inappropriate shoes include those that are excessively worn or are too small for the person's feet, resulting in rubbing, redness, blister, or callus.

Socks and hose are inspected for the presence of blood and other discharges.

### **OBJECTIVE ASSESSMENT FOR NERVE DAMAGE**

The clinical examination recommended for screening for the presence of nerve damage is designed to identify loss of protective sensation (LOPS) rather than early neuropathy. The clinical examination to identify LOPS is simple and requires no expensive equipment. Five simple clinical tests, (each with evidence from well-conducted prospective clinical cohort studies), are considered useful in the diagnosis of LOPS in the diabetic foot. Any of the five tests listed could be used by clinicians to identify LOPS:

1. 10g monofilament
2. Vibration using a 128-Hz tuning fork
3. Pinprick sensation
4. Ankle reflex
5. Vibration Perception Threshold Testing (VPT)

Ideally, two of these should be regularly performed during the screening exam—normally the 10-g monofilament and one other test. One or more abnormal tests would suggest LOPS. The last test listed, (vibration assessment using a biothesiometer or similar instrument), is widely used in the USA.; however, identification of the patient with LOPS can easily be carried out without this or other expensive equipment.



Figure 26a: Testing for neuropathy using the 10g monofilament

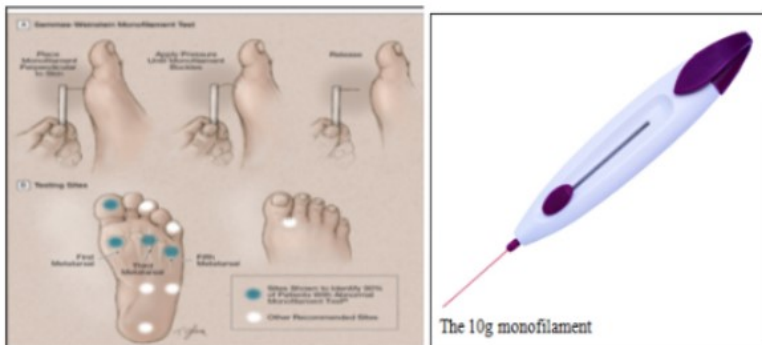


Figure 26b: Anatomical sites for testing for neuropathy using the 10g monofilament

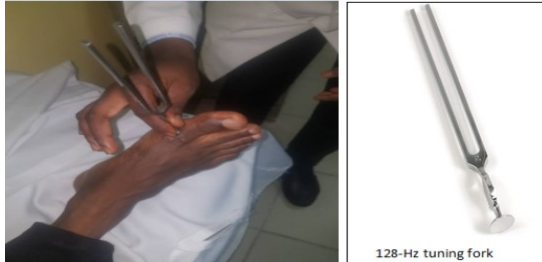
Sources: <https://www.grepmcd.com/images/1802/monofilament-primarycare-neuropathy-diagnosis-locations-diabetic-testing>,  
<https://www.rainiermeded.com/monofilament-5-07-to-10-gram-p/monofilament.htm>

Loss of the ability to detect the pressure of the 10g monofilament at one or more anatomic sites on the plantar surface of the foot indicates loss of protective sensation.

## TESTING FOR VIBRATION USING A 128-HZ TUNING FORK



The tuning fork provides a very cheap and easy way to test for vibratory sensation and is widely used clinically. The vibratory sensation is tested over the tip of the great toe bilaterally. An abnormal response can be defined as when the patient loses vibratory sensation and the examiner still perceives it while holding the fork on the tip of the toe.



Testing for vibration using a tuning fork

### **VIBRATION PERCEPTION THRESHOLD TESTING (VPT)**

The degree of nerve damage can be further quantified using the biothesiometer (or neurothesiometer). This is a simple handheld device that assesses the threshold of perception of vibration. When applied to the pulp of the big toe of the foot, the device delivers a vibratory stimulus, which increases as the voltage is increased. The amplitude is increased until the patient can detect the vibration. Any patient unable to feel a vibratory stimulus of 25 volts is considered at risk of ulceration.



Testing for vibratory perception threshold

### **OTHER TESTS FOR PERIPHERAL NEUROPATHY**

#### **PINPRICK SENSATION**

The inability of a subject to perceive pinprick sensation has been associated with an increased risk of ulceration. A disposable pin is applied just proximal to the toenail on the undersurface of the big toe, with just enough pressure to deform the skin. The inability to perceive pinprick over the big toe would be regarded as an abnormal test result.

### **ANKLE REFLEXES.**

The absence of ankle reflexes has also been associated with an increased risk of foot ulceration. Ankle reflexes can be tested with the patient either kneeling or resting on a couch/table. The Achilles tendon is stretched until the ankle is in a neutral position before striking it with the tendon hammer. If a response is initially absent, the patient can be asked to hook fingers together and pull, with the ankle reflexes then retested with reinforcement. A total absence of ankle reflex either at rest or upon reinforcement is regarded as an abnormal result.

**NEUROPAD:** This is a visual indicator test to evaluate sympathetic autonomic neuropathy (sweating in the feet). When the pad is applied to the feet, it changes from blue to pink in patients with intact autonomic system but in patients with neuropathy, the pad remains blue or partially turns to pink over a given period.



Testing for pin prick sensation



Testing for ankle reflex



Testing for autonomic neuropathy using a neuropad

### **VASCULAR ASSESSMENT**

Peripheral arterial disease (PAD) is a component cause in approximately one-third of foot ulcers and is often a significant risk factor associated with

recurrent wounds. Therefore, the assessment of PAD is important in defining overall lower-extremity risk status. Vascular examination includes palpation of the posterior tibial and dorsalis pedis pulses, which is characterized as either “present” or “absent”.

Patients with diabetes who have signs or symptoms of vascular disease (or absent pulses on screening foot examination) should undergo ankle brachial pressure index (ABI) testing and be considered for a possible referral to a vascular specialist. The ABI is a simple and easily reproducible method of diagnosing vascular insufficiency in the lower limbs. Blood pressure at the ankle (dorsalis pedis or posterior tibial arteries) is measured using a standard Doppler ultrasonic probe. The ABI is obtained by dividing the ankle systolic pressure by the higher of the two brachial systolic pressures. An ABI  $>0.9$  is normal,  $<0.8$  is associated with claudication, and  $<0.4$  is commonly associated with ischemic rest pain and tissue necrosis.

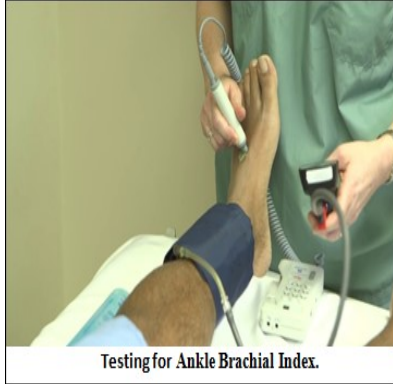
The American Diabetic Association Consensus Panel on peripheral artery disease (PAD) recommends measurement of ABI in diabetic patients over 50 years of age and consideration of ABI measurement in younger patients with multiple PAD risk factors, repeating normal tests every 5 years. ABI may, therefore, be part of the annual comprehensive foot exam in these patient subgroups. ABI measurements may be misleading in diabetics with calcified vessels that render the arteries incompressible resulting in falsely elevated ankle pressures. In the presence of incompressible calf or ankle arteries (ABI  $>1.3$ ), measurement of the digital arterial systolic pressure (toe pressure) or transcutaneous oxygen tension is recommended.



Palpation of the Dorsalis pedis artery



Palpation of the Tibialis posterior artery



Testing for Ankle Brachial Index.

## RISK STRATIFICATION AND RECOMMENDATIONS FOR DIABETIC FOOT ULCERS<sup>54</sup>

RISK CATEGORY	RISK LEVEL	DEFINITION	RECOMMENDED TREATMENT	RECOMMENDED FOLLOW UP
0	LOW RISK	<p>No loss of protective sensation (LOPS)</p> <p>No Peripheral artery disease (PAD)</p> <p>No deformity.</p>	<p>Patient education including advice on appropriate footwear</p>	<p>Annually by a general physician and/or specialist</p>
1	<p>MODERATE RISK</p>	<p>LOPS ±</p>	<ul style="list-style-type: none"> <li>Consider prescription or</li> </ul>	<p>3-6monthly by a general physician or a specialist</p>

				<p>accommodative footwear</p> <p>deformity</p> <ul style="list-style-type: none"> <li>Consider prophylactic surgery if the deformity is not safely accommodate in shoes.</li> <li>Continue patient education</li> </ul>	
2	HIGH RISK	PAD LOPS	±	<ul style="list-style-type: none"> <li>Consider prescriptive or accommodative footwear.</li> <li>Consider vascular consultation for</li> </ul>	<p>2-3 monthly by a specialist</p>

			<b>combined follow up</b>	
<b>3</b>	<b>VERY HIGH RISK</b>	<b>History of</b>	<ul style="list-style-type: none"> <li>• Same as</li> </ul>	<b>1-2 monthly by a specialist</b>
		<b>ulceration or</b>	<b>category 1</b>	
		<b>amputation</b>	<ul style="list-style-type: none"> <li>• Consider vascular</li> </ul>	
			<b>consultation for</b>	
			<b>combined follow up if PAD present</b>	

## **EDUCATION ON FOOT CARE**

Intensive and comprehensive foot care education decreases the number of foot problems requiring treatment<sup>67</sup>. One hour of patient education can result in a threefold reduction in the rate of subsequent foot ulceration and amputation<sup>68</sup>. A daily self-foot examination is worth stressing. Including family members in the educational program and instructing them on diabetic foot care is beneficial especially when the patient's visual impairment limits the adequacy of foot inspection.

Reinforcement of the importance of this aspect of care can be accomplished at each clinic visit. The knowledge, beliefs, and abilities of each patient are assessed prior to diabetes educational efforts, and the educational plan should be tailored to the abilities and risk level of the patient. If a patient is indigent, homeless or has

no family, the educational strategy will differ radically from that implemented for patients who have comfortable homes and social support<sup>69, 70</sup>.

Elderly patients with diabetes may present a particular challenge. A study done to determine whether patients of various ages have the visual acuity, manual dexterity, and joint mobility needed to perform routine foot care showed that most people older than 65 years are unable to reach their toes and respond to the simulated plantar lesion. The education of family members is particularly important in this situation.

Basic elements of foot care of people living with diabetes mellitus include<sup>24, 36, 70</sup>:

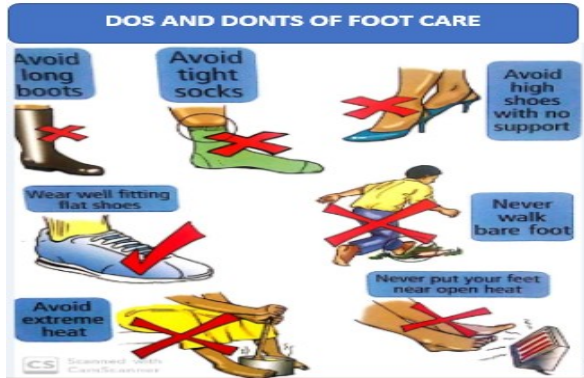
1. Daily foot inspection. Inspect underfoot with mirrors as much as the face is inspected.
2. Wash the feet daily in tepid water, drying between toes.
3. Be careful never to burn your feet. Always check the temperature of the shower water with your elbow or a bath thermometer.
4. Prevent dryness by applying moisturizing lotion over the tops and bottom of the feet but not between the toes.
5. Never walk barefoot.
6. Don't cross your legs for long periods
7. Wearing well-fitting shoes and clean socks
8. 'Breaking in' new shoes gradually
9. Inspecting shoes for foreign objects before wearing
10. Keeping toenails properly cut; cut nails after a bath or shower when they are softer
11. Never use a razor blade to cut nails. Use a nail clipper
12. Do not cut nails too short or leave them poking beyond the end of the toe
13. Never cut out the corner of the nail or dig down the sides.
14. Do not try to cut the whole nail in one piece
15. Buffing calluses after bathing to smoothen them
16. Visiting podiatrist for the care of corns, calluses, and ingrown toenails
17. Having a foot examination by a physician at least 4 times a year.



18. If problems develop (red spots, cuts, blisters, scaly skin, warts, athletes' foot) seek help immediately from a doctor. Never try to treat the problem yourself.



Source: Novo Nordisk foot care guide



Source: Novo Nordisk foot care guide



Inspecting the foot with mirrors



Cutting nails with clippers

Source: Diabetes and foot care. Put the foot first and prevent amputation. An initiative of the IDF and WHO world diabetes day 2005

**ORTHOTICS:** Elevated plantar pressures can be reduced by wearing therapeutic shoes with increased depth, soft insoles, and rocker bottoms. Given the fact that many patients in the developing world walk without any footwear whatsoever or with only sandals, (exposing their insensate feet to unrecognized trauma), or use poorly fitting footwear, (which actually causes ulcerations) use of appropriate footwear is highly recommended in all persons living with diabetes.

**PROPER FOOTWEAR FOR PEOPLE WITH DIABETES**

Choosing the right footwear can drastically reduce injuries to the feet of those living with diabetes such as cuts and bruises, skin irritations from friction, or sores from squashed toes. High heels (taller than 2 inches) and sandals that have thongs between the toes should be avoided. It is also advisable to buy shoes in the evening

when the foot is most swollen. The following are the features of a proper shoe for those living with diabetes:



**1. SPACIOUS TOE BOX:** The toe box (the area around the toe) should be wide and spacious to prevent overcrowding and constriction of the toes. The toe box should be preferably square or rounded but not pointed.

**2. BREATHABLE UPPER:** The upper of the shoe should be made of breathable material such as leather. This will help reduce moisture and hence infections.

**3. HARD OUTSOLE:** The sole of the shoe should be made of hard rubber to protect the feet from sharp objects.

**4. WIDE FOOTBED AND DEEP INTERIOR:** The footbed of the shoe should be wide to allow for swelling that occurs during the day. The interior should also be deep and spacious. This will provide room for cushioning shoe inserts.

**5. INSOLE CUSHIONING:** This provides proper padding of the footwear and reduces pressure on the foot.

**6. ADJUSTABLE CLOSURE:** This accommodates any foot swelling that occurs throughout the day.

**7. LOW ARCHES:** It is advised that those with flat feet should avoid shoes with arched insole as these can cause uncomfortable pressures.

**8. SEAMLESS INTERIOR:** Shoes should have smooth seamless linings. Raised seams can cause friction and irritation of the foot.

**9. CLOSED DESIGN:** A completely covered foot is protected from pebbles and other debris, which can be tough to detect in the presence of nerve damage.

**10. LOW HEEL:** High heels create pressure points on the balls and heels of the feet that can lead to calluses and ulcers. Wide, square heels less than 1-2 inches in height, are best.

The choice of socks is also very important to proper foot care. Socks provide padding for the soles. They should not have a tight cuff which would restrict the blood circulation to the feet, or have any holes, which could also reduce blood flow to a toe sticking out through. They should be seamless to prevent skin irritation. Breathable fabrics such as cotton or a cotton-wool blend are preferred as they can help absorb moisture. White or light coloured socks are recommended; as it allows easy detection of bleeding or weeping from injuries or infections.

### GOOD SHOES FOR PEOPLE WITH DIABETES



### INAPPROPRIATE FOOTWEARS FOR PEOPLE LIVING WITH DIABETES





Sources: Handbook on diabetes foot care for Nigeria

### CONSEQUENCES OF BAD FOOTWEAR



A thorn penetrating a soft outer sole of the footwear caused an injury in a person with a neuropathic foot



A plantar ulcer (common site) because of gripping the footwear's toe-grip strap tightly for a long time

Source:

The National Medical Journal of India 2017

## **MY CONTRIBUTION TO THE PREVENTION OF DIABETIC FOOT ULCERS**

- I have attended many trainings, workshops/conferences both locally and internationally (Republic of Cameroun, South Africa, USA, Germany, Spain, Portugal, etc.) aimed at prevention of DFU and foot salvage and have shared my experiences with my students (undergraduate and postgraduate) and my colleagues.
- I have also published many papers and educational materials to increase awareness of diabetes and foot care.
- I am a foundation member of the recently inaugurated Nigerian diabetes foot study group as well as the Pan -African Diabetes foot Study group (PADFSG).
- I have carried out series of group/individual diabetes education/training programs locally (especially in Port Harcourt) and internationally, for patients as well as healthcare providers, communities and media.
- I coordinated the setting up of a diabetes foot clinic in UPTH in January 2019. We have also put together a handbook on diabetes education.
- In collaboration with the Beaumont Health/Global Health Committee, a Diabetes Self-Management and Education (DSME) project was carried out in UPTH/UNIPOINT under my supervision.

Through these efforts and programs, foot care in people living with diabetes has improved significantly.

## **STRUCTURED TRAINING PROGRAMS ON DIABETES FOOT CARE FOR HEALTH CARE PROFESSIONALS IN PORT HARCOURT**





**DIABETES SELF MANAGEMENT & EDUCATION PROJECT (Beaumont  
Health/UNIPOINT/UPTH Collaboration)**



**PROGRAM FACILITATORS**

**GROUP DIABETES EDUCATION SESSIONS**

**THE COURSE COMPONENTS:**

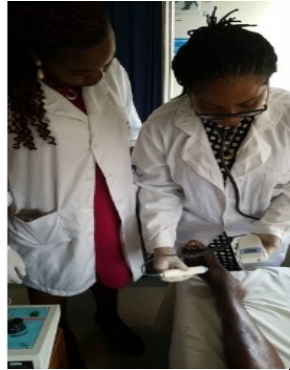
- Group Session 1 (General Diabetes Overview)
- Group Session 2 (Nutrition for Diabetes)
- Group Session 3 (Your Diabetes Self-Care Plan)
- Individual Session (s):
  - General diabetes assessment
  - Nutrition history
  - Diabetes knowledge
  - Medication review
  - Hypoglycemic reactions
  - Blood glucose monitoring
  - Exercise and health habits

→ Disease-related psychosocial status

**VARIOUS ACTIVITIES AT THE DIABETES FOOT CLINIC IN UPTH (DIABETES EDUCATION, FOOT INSPECTION, TESTING FOR SENSATION AND PERIPHERAL VESSELS )**









Some members of the Diabetes foot team of the EDM Unit of UPTH

**CHALLENGES IN THE PREVENTION AND MANAGEMENT OF DIABETIC FOOT ULCERS IN A RESOURCE POOR SETTING**

The reasons for poor outcomes of diabetic foot complications are numerous and include:

1. Lack of awareness of the need for foot care among patients, their relatives and healthcare providers due to gaps in diabetes education.
2. There is a lack of training programs for healthcare professionals on DFU and little or no emphasis is placed on DFUs in basic training and continuing education of doctors and nurses.
3. Shortage of trained healthcare workers for general diabetes care and relatively few professionals with an interest in the diabetic foot and with the training to provide specialist treatment.
4. Lack of trained diabetes educators.
5. There is non-availability of diabetic foot clinics, podiatry, chiropody and orthotic service in most of our health care institutions.
6. Gaps in primary healthcare management
7. There is a lack of a standard pathway of referral between general primary healthcare and specialist care and between different specialist groups leading to delay among healthcare providers in referring patients with serious complications for a specialist opinion.
8. Lack of the concept of a multidisciplinary team approach to diabetes foot management.
9. Poverty
10. Delays among patients in seeking timely medical care.
11. Long-distance for patients to travel to the clinic.
12. Lack of physical and occupational rehabilitative services
13. Non-availability and affordability of prosthesis for amputees.
14. The high cost of care.
15. Minimal or non-existence of insurance coverage.
16. Poor funding of the healthcare sector.
17. Lack of surveillance activities.

**WE CAN PREVENT DIABETIC FOOT ULCERS!!! YES, WE CAN!!!  
THIS IS THE WAY FORWARD**

1. An educational program should be put in place for foot ulcer prevention targeted at health care workers/diabetes educators whose responsibility it will be to pass on appropriate advice to the patients and their families.
2. Implementation of sustainable training programs for healthcare professionals focusing on the management of the diabetic foot.
3. Health system strengthening and capacity building in the healthcare sector for the prevention and management of diabetes and diabetic foot syndrome.
4. Setting up of diabetic foot clinics in every hospital both at the primary health care level and every level of referral.
5. Empowerment of people with diabetes to care for their feet better, detect problems earlier, and seek timely help when problems arise.
6. The involvement of policymakers and other stakeholders in the care of people living with diabetes
7. Community and grass-root involvement.
8. Education and training of faith healers and traditional healers on the recognition of diabetic foot ulcers and need for referral to the hospital.
9. Establishment of a strong social security system and functional health insurance system to provide financial relief for people with diabetes.
10. Improvement in healthcare financing by the government and all relevant stakeholders.

## **A CALL ON GOVERNMENT TO HELP SAVE THE FOOT IN PEOPLE WITH DIABETES**



At the IDF call to action on the road to the UN High-level Meeting on Non-Communicable diseases in 2018, the IDF on behalf of people living with and affected by diabetes called on governments all over the world to:

1. Heighten focus on prevention to achieve a 0% increase in diabetes prevalence by 2025.
2. Educate to achieve a 30% reduction in diabetes-related premature mortality by 2030.
3. Boost investment to ensure 80% access to essential medicines and devices by 2025 and Universal Health Coverage by 2030.
4. Listen to the priorities of people with diabetes and defend their rights.

### **CONCLUSION:**

In view of the double burden of communicable and non-communicable diseases in a resource-limited setting like ours, there is an urgent need to curb the scourge of diabetes and its complications. The burden and agony of DFU are very high in Nigeria and the identified gaps include poverty, ignorance and low level of foot care knowledge, high patronage of unorthodox medicine, late hospital presentations and various myths and misconceptions amongst others. This is a call for action in terms of advocacy, promotion of awareness and public health policies that will empower people with diabetes to prevent the agony of DFU. A structured and extensive foot care education within the framework of a multi-disciplinary footcare team is highly desirable.

**EDUCATION IS THE KEY; FOR MY PEOPLE DIE FOR LACK OF KNOWLEDGE. (HOSEA 4:6)**



**LET US EMPOWER PEOPLE TO PREVENT AGONY:**

- IN PERSONS LIVING WITH DIABETES AND DIABETES FOOT DISEASE.
- IN THE FAMILIES
- IN THE SOCIETY
- LET US REDUCE THE BURDEN ON THE HEALTHCARE SYSTEM

### **MY DREAM**

- To see the prevalence of diabetes, reduce to less than one percent in our society in the nearest future.
- To see the prevalence of DFU reduce to less than one percent in the nearest future.
- To see all amputees (from DFU) fully rehabilitated with appropriate prostheses.
- To see all of us move to make a positive change in diabetes care.

**THE DIABETIC FOOT CONCERNS ME. IT CONCERNS YOU. IT CONCERNS EVERYBODY.**

**LET US ALL JOIN HANDS TO SAVE THE FOOT.**

**WE CAN!!!YES, WE CAN!!!**



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Professor Chioma Unachukwu was born on the 30<sup>th</sup> of November 1962 in Itu, Ezinihitte-Mbaise, Imo state to the family of late Isaac Ezekwesiri Okwandu and Dame Golden-Rose Okwandu. She is the 6<sup>th</sup> of nine children. Being born to the God-fearing family was a great privilege. She had a solid Christian foundation and grew up to be humble and disciplined.

### **EDUCATION:**

Chioma received her primary and secondary education at Town school, Itu and Girls' Secondary School, Amumara, Mbaise respectively. She was popular among her mates for her academic excellence as she was second to none.

She successfully completed her secondary education with Division 1 in the WASCE in 1977. Her father being an astute educationist, insisted on her obtaining a Bachelor's degree before pursuing her dream course – Medicine. This, he stressed, was to empower her physically and emotionally for the great task ahead. Chioma, therefore, proceeded to the University of Lagos in 1978, won the Federal Merit Award (Federal Scholarship) for academic excellence in 1981, and graduated as the best student in

Microbiology with Second Class Honour, Upper Division in 1982. After one year of NYSC at NNPC (Research and Development Division), Port Harcourt, she proceeded to the University of Benin in 1984 to actualize her life's dream of becoming a Medical doctor.

She exhibited great academic excellence during her medical training and this earned her many awards and prizes which include:

- The Dean's prize for the best student in Part II MBBS (Pharmacology) in the School of Medicine, University of Benin 1986/19887 academic session.
- Professor Hill's Memorial Prize, University of Benin scholarship as well as Dr. Aghaghowa's Memorial prizes for the best student in Part III MBBS (Pathology) in 1987/1988 session.
- She graduated as the best student from the School of Medicine, University of Benin with MBBS (with Distinction in Pathology) in 1989, which earned her the Professor T. Bello-Osagie's, Dean's as well as the Provost's prizes.

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### **PROFESSIONAL CAREER:**

Chioma did her housemanship at the University of Port Harcourt Teaching Hospital in 1992. Thereafter, she commenced her residency training in Internal Medicine and obtained the Fellowship of the West African College of Physicians (FWACP) in October 2001.

Professor Chioma Unachukwu was employed as a Lecturer 1 by the University of Port Harcourt in December 2003 as well as an Honorary Consultant Physician at the University of Port Harcourt Teaching Hospital. She draws a lot of inspiration from the motto of her Alma-mater (Girls' Secondary School, Amumara) "Still achieving, still pursuing". This continually propelled her academic journey as she was determined not to "perish" but to research and "publish". Her commitment to research saw her rise to the rank of Senior lecturer in 2006, Reader in 2010 and Professor in December 2013, which was no easy feat within nine years.

### **ADMINISTRATIVE SERVICES:**

Professor Unachukwu has served the University and humanity at various levels. She is a member of the Committee for the review of the General Regulations and Academic Policies of the University of Port Harcourt. She also serves in panels of interviews for the promotion of academic staff of the university to the professorial cadre. She was a member of the Faculty Research and Collaboration committee from 2006-2009, as well as Co-ordinator of the Introduction to Clinical Medicine (ICM) from 2010-2012. She was the Acting Head, Department of Medicine from February 2012 to 2014.

She has served in various committees in the College of Health Sciences and is currently a member of the Business Committee (for Promotion and Appraisal of the academic staff). Professor Unachukwu has rendered selfless services to the University of Port Harcourt Teaching Hospital. She has served in many committees and panels of investigations because of her commitments to equity and justice. She was the Project Manager, Department of Internal Medicine, Revolving fund (UPTH) from May 2012-2014.

### **RESEARCH AND PUBLICATION:**

Professor Chioma Unachukwu is an astute researcher and has authored more than 60 publications in national and international peer-reviewed journals. She has co-authored two books and contributed chapters in four books. She has attended many workshops, courses, conferences and fellowship programmes (locally and internationally) in internal medicine and endocrinology where she presented many papers and posters and served as a resource person. Her main areas of research and publication include – the burden of diabetes (with greater emphasis on diabetes foot syndrome), the endocrine and metabolic consequences of HIV/AIDS and thyroid disorders amongst others.

Professor Unachukwu has a passion for diabetes education which she considers as the main tool for the prevention and management of the disease.



She has a great passion for tutelage and mentorship of younger colleagues and is known amongst her students for her popular mantras: “winners don’t quit” and “ It is not over until you win”. It is no wonder that her mentees have emerged as pacesetters in the Medical field globally.

Professor Unachukwu has supervised Part II dissertations of 24 postgraduate medical doctors; many of who are now Consultants/Lecturers including an Associate Professor. She is a renowned Examiner in the Endocrine, Diabetes, and Metabolism (EDM) subspecialty of the faculty of Internal Medicine of the West African College of Physicians (WACP). She has been involved in WACP Accreditation visits to many tertiary health facilities in Nigeria and Ghana. She also acts as an external examiner for the Final MBBS in many Nigerian universities.

She is an editor and reviewer to many journals including the Port Harcourt Medical Journal, the Africa Journal of Endocrinology and Metabolism, the Nigerian Health Journal to mention but a few.

#### **PROFESSIONAL ACTIVITIES:**

As a result of her outstanding contribution to the field of Endocrinology locally and internationally, she was endorsed, a Fellow of the famous American College of Endocrinologists (FACE) in 2009 (in Houston, Texas). She is also a member of the Pan-African Diabetes Foot Study Group (PADFSG). She is a renowned member of the Endocrine and Metabolism Society of Nigeria (EMSON) as well as the Diabetes Association of Nigeria (DAN). Her passion for Diabetology drove her to become a pioneer member of the Nigeria Diabetes Foot Study Group in 2019.

She is a member of the Medical and Dental Consultants Association of Nigeria (MDCAN) and was the Secretary of the Welfare Committee of the UPTH chapter from 2010 – 2014. Prof. Unachukwu is a resource person for the Continuous Medical Education (CME) Programme of the Nigerian Medical Association (NMA), Rivers State Branch. Her passion for medical education takes her to churches, communities, media houses and companies where she gives talks to improve public awareness of a healthier lifestyle.

### **FAMILY AND CHRISTIAN LIFE:**

Professor Unachukwu is a devoted Christian of the Anglican denomination. She is a member of the Women's Guild, Mothers' Union and the Parish Church Council of her current church. (Chapel of Grace and knowledge, Elelewo in Evo Diocese)

Her pilgrimage to Jerusalem in January 2006 strengthened her faith in Jesus Christ as the Risen Lord. She is endowed with the ministry of prayer and counseling.

Chioma is the widow of her soul mate, Pharm. Eddy Unachukwu and blessed with 4 lovely children (a medical doctor, a first class Chemical Engineer, a lawyer and a medical student). She is a virtuous woman and a role model to her children who like their mother have determined to never settle for less. She is an adorable sister to her siblings; a source of inspiration to her friends and a vessel of inestimable value to her communities.

Distinguished ladies and gentlemen, I present to you, an epitome of beauty with brains, humility, excellence and integrity; a great achiever and an academic giant, Professor Chioma Unachukwu to deliver the 167th Inaugural lecture of the University of Port Harcourt titled **“THE BURDEN OF THE FOOT IN DIABETES: A PREVENTABLE AGONY”**.

**Prof Ndowa E.S Lale**

Vice Chancellor