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KNOWLEDGE, ATTITUDE, AND PRACTICES ON DIABETIC RETINOPATHY AND MACULOPATHY AMONG GENERAL PRACTITIONERS IN PUBLIC AND CONFESSIONAL HOSPITALS IN DOUALA.

A Thesis Submitted to the Faculty of Health Sciences of the University of Buea in Partial Fulfilment of the Requirements for the Award of the Doctor of Medicine (M.D) Degree

By

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DEDICATION

This piece of work is dedicated to my mother Berthe Ngo Mong Epse Mongo Mbock and my father Mr. Ruben Mounyemb

CERTIFICATION

This is to certify that the work described in this thesis entitled "**KNOWLEDGE, ATTITUDE, AND PRACTICES ON DIABETIC RETINOPATHY AND MACULOPATHY AMONG GENERAL PRACTITIONERS IN PUBLIC AND CONFESSIONAL HOSPITALS IN DOUALA"** by BIBOUTH BALOG JACQUES (HS14A028) was submitted to the Faculty of Health Sciences of the University of Buea, in Partial Fulfilment of the Requirements for the Award of the Doctor of Medicine (M.D) Degree, under the supervision of:

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HIPPOCRATE OATH

Adopted by the 2nd General Assembly of the World Medical Association(WMA), Geneva, Switzerland, September 1948 and amended by the 22nd World Medical Assembly, Sydney, Australia, August 1968 and the 35th World Medical Assembly, Venice, Italy, October 1983 and the 46th WMA General Assembly, Stockholm, Sweden, September 1994 and editorially revised by the 170th WMA Council Session, Divonne-les-Bains, France, May 2005 and the 173rd WMA Council Session, Divonne-les-Bains, France, May 2006

On admission to the medical profession:

I solemnly pledge to consecrate my life to the service of humanity;

I will give to my teachers the respect and gratitude that is their due;

I will practice my profession with conscience and dignity;

the health of my patient will be my first consideration;

I will respect the secrets that are confided in me, even after the patient has died;

I will maintain by all the means in my power, the honour and the noble traditions of the medical profession;

my colleagues will be my sisters and brothers;

I will not permit considerations of age, disease or disability, creed, ethnic origin, gender, nationality, political affiliation, race, social standing or any other factor to intervene between my duty and my patient;

I will maintain the utmost respect for human life;

I will not use my medical knowledge to violate human rights and civil liberties, even under threat;

I make these promises solemnly, freely and upon my honour.

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ABSTRACT

Background: awareness of diabetic retinopathy and maculopathy among the general practitioners' is a major factor for the prevention of diabetes-related ocular complications. They are most often the first line of contact of diabetic patients and their knowledge, attitude and practice are the principal indicators of their level of awareness.

Objectives: the aim is to assess the knowledge, attitude and practices of general physicians on diabetic retinopathy and maculopathy in public and confessional hospitals in Douala.

Materials and methods: an analytic cross sectional study was conducted from February to May 2021. Data was collected through a well-designed anonymous self-administered questionnaire. The questionnaire was mainly made of close ended questions. It contains questions on demographic and clinical experience data, knowledge, attitude and practices toward DR/DM. At the end of the survey, the entire data coded and entered into Microsoft Excel spreadsheet. Data were analyzed using statistical program for social sciences (SPSS) version 23.0 for windows. Categorical variable was summarized using frequencies and percentages. Continuous variable was summarized using means, percentages, ranges and standard deviation. Where appropriate, dynamic cross tabulation, Chi square and Fischer test statistics were used to assess the relationship between two categorical variables. Significant differences and associations were determined by p-values set at < 0.05.

Results: A total of 196 participants were included in the study, 56.6% were female. The mean age of the study group was 28.57 ± 2.25, with age range of 24-36 years. GPs had an average knowledge on DR/DM at 68.3%. There were gaps noted regarding factors influencing the severity and treatment modality. 100% of GPs were aware that duration of diabetes, poor glycemic control and hypertension were factors that can affect severity of DR/DM. In the study, 74.9% were not aware of any treatment modalities of DR/DM. GPs had an overall poor attitude toward screening of DR/DM at 79.6%. There were gaps noted regarding the checkup of DR/DM, where 50.25% asked for yearly Checkup upon diagnosis of DR and 28% asked for checkup upon diagnosis of DM between 1 to 3 months. In term of practice 100% of GPs never tested the vision of their diabetic patients and no one had access to the ophthalmoscope.

Conclusion: participants had mean gaps in their knowledge but poor attitude that translate poor practice.

Keywords: GPs, Diabetic retinopathy, Diabetic maculopathy, Blindness

RESUME

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LIST OF ABBREVIATION

AAO: American Academy of Ophthalmologist

ADA: American Diabetic Association.

BMI: Body Mass Index

BP: Blood Pressure

BRB: Blood Retinal Barrier.

DM: Diabetic maculopathy

DME: Diabetic macular edema

DMs: Diabetes mellitus.

DR: Diabetic retinopathy.

ETDRS: Early treatment diabetic retinopathy study.

GAD: Glutamic acid decarboxylase.

GPs: General practitioners.

HDL: High density lipoprotein.

IDF: International Diabetes Federation.

IRMAs: Intraretinal microvascular abnormality.

KAP: Knowledge, attitude and practice.

LANA: Latent autoimmune diabetes of adulthood.

MODY: Maturity onset diabetes of the young.

NPDR : Non proliférative diabetic retinopathy.

OCT: Optical coherence tomography.

OCTA: Optical coherence tomography angiography.

OGTT: Oral glucose tolerance test.

PDR: Proliferative diabetic retinopathy.

RCO: Royal college of ophthalmologist.

T1DM : Type 1 diabètes mellites.

T2DM : Type 2 diabetes mellites.

TG: Triglycerides.

UKPDS: United Kingdom Prospective Diabetic

V.A: Visual acuity.

VEGF: Vascular endothelial growth factor.

WESDR: Wisconsin Epidemiology Study of Diabetic Retinopathy.

WHO: World Health Organization.

DEFINITION OF TERMS

Knowledge: refers to awareness and understanding of the existence of a condition or a problem. In this case comprehension of DR/DM. (oxford dictionary)

Good knowledge: refers to knowledge category of score with a score from 5-10 points

Poor knowledge: refers to knowledge category of score with score less than 5.

Attitude: a certain way of thinking, view, perception, reaction, orientation and inclination about something. In this context, it is about DR/DM. (oxford dictionary)

Good attitude: refers to attitude category score of greater or equal to 3 points

Poor attitude: refers to attitude category score of less than 3 points.

Practice: the act of doing something regularly. In this context, it is about DR/DM. (oxford dictionary)

Good practice: refers to practice score of greater or equal to 6 points

Poor practice: refers to score less than 5 points.

Incomplete questionnaire: refers to a questionnaire with less than 60% of answers.

General practitioners: is a doctor who have graduated from medicine school after seven year of school.

CHAPTER ONE:

INTRODUCTION

1.1. BACKGROUND

Diabetes mellitus is defined by International Diabetic Federation (IDF) as a chronic metabolic disease characterized by hyperglycemia that occurs when the pancreas is no longer able to make insulin, or when the body cannot make good use of the insulin it produces [1]. This disease has a high prevalence and is associated with increased morbidity and mortality. It is a global public health problem, constituting a veritable pandemic. The IDF estimated in 2019 that 463 million people were living with diabetes worldwide with the age range of 20 to 79 years old and that one in two people were unaware of their status. These figures are expected to reach 700 million by 2045 [1]. Diabetes caused more than five million deaths worldwide in 2019 and is one of the leading causes of death in adults [1]. In Africa, IDF estimated the number of people living with diabetes at 19.4 million in 2019 [1]. In Cameroon, the prevalence is 5.8% and 52% of diabetic people are unaware of their status, according to a meta-analysis made in 2018 by Bigna et al [2]. Worldwide, the difficulties of management and follow up of diabetic patients increase the complications [2]. Which are generally detected at advanced stages. Microvascular complications are the most frequent and among them, diabetic retinopathy (DR) and diabetic maculopathy (DM) are the most represented and they lead to preventable blindness [2].

Diabetic retinopathy (DR) is defined according to the Royal College of Ophthalmologist (RCO) as a chronic progressive, potentially sight-threatening disease of the retinal microvasculature associated with the prolonged diabetes mellitus [3]. Diabetic maculopathy (DM) according to American Academy of Ophthalmology (AAO) is defined as swelling of the retina in a diabetic patient due to leaking of fluid from the blood vessels within the macula [1]. DR/DM are the common ocular complication of diabetes. They are the fifth cause of blindness affecting 158 million diabetic patients worldwide [2]. They are the first causes of blindness

before the age of 50 in developed countries [3]. The prevalence of DR/DM in the developing countries varies from 25 to 43% for DR and 3 to 10% for DM [3] out of them 4–5% have vision loss [4]. In Africa, DR/DM has a prevalence that varies from 15 to 52% from country to country [5]. A study carried out in Cameroon by Domngang et al in 2020, found a prevalence of 32.10% [6]. Duration of diabetes is an important risk factor in the occurrence of DR/DM. To limit the risk of blindness due to diabetic retinopathy and maculopathy, an early diagnosis is necessary from the discovery of diabetes [2]. This is done through the fundus examination, recommended by WHO during the evaluation of diabetic patients [7].

Diabetic patients are primarily managed by general physicians. Thus if they are knowledgeable about microvascular complications such as DR/DM regarding attitude and practices, this will improve their ability to prevent blindness related [1, 6]. So study done by Mensah et al in Ghana on KAP on DR among GPs shows that participants have good knowledge about DR at 80.2%, good attitude at 67%, and poor practice at 37.4% [8]. However, there is not yet data in our country showing the level of awareness of GPs in this domain. General practitioners being important partners in the diabetic care network, A KAP study assessing their level of awareness is therefore vital in planning strategies for the prevention of DR/DM and blindness related.

1.2. PROBLEM STATEMENT

Patients with diabetes type I and II can develop diabetic eye disease. The longer an individual has diabetes, the more likely it is to develop diabetic retinopathy and maculopathy, which can lead to vision loss. The prevalence of diabetes mellitus and ocular microvascular complications are increasing worldwide. The challenge however, is to reduce the human and financial costs through early diagnosis, effective management and prevention of these complications in newly diagnosed diabetics as far as this is possible. So, in Cameroon, most

diabetic patients are managed by general physicians who are supposed to have skills in the follow-up of these patients reducing them to have vascular complications.

1.3. JUSTIFICATION

Campaigns on diabetes mellitus are carried out to educate healthcare workers but these campaigns do not emphasize microvascular complications like ocular complications of diabetes. So that is why it is important to study the knowledge, attitude, and practices of general practitioners on diabetic retinopathy and maculopathy. This help to determine whether general practitioners recognize the important role they have to play in preventing and managing diabetic retinopathy and maculopathy, as a sight-threatening condition in diabetic patients. This is related to world health organization goal of eliminating avoidable blindness in the vision 2020 initiative.

1.4. RESEARCH HYPOTHESIS

A study done by Abdulsalam et al in Nigeria on knowledge, attitude and practices toward diabetic retinopathy among physicians showed that diabetic retinopathy screening among practicing in Northwestern Nigeria is suboptimal, which prompts a need for improved training of physicians managing people with diabetes on eye examination [9]. Assuming that we have the same level of medical training, we can suppose that General practitioners have same level of the knowledge, attitude, and practices on diabetic retinopathy and maculopathy in our context.

1.5. RESEARCH QUESTION

What is the level of knowledge, attitude, and practice of general practitioners on diabetic retinopathy and maculopathy in public and confessional hospitals in Douala?

1.6. RESEARCH GOAL

This study aims to elaborate strategies to educate and improve the knowledge, attitude, and practices of general practitioners on diabetic retinopathy and maculopathy to prevent blindness due to these complications.

1.7. RESEARCH OBJECTIVES

1.7.1. General objective

To study the knowledge, attitude and practices on diabetic retinopathy and maculopathy among general practitioners.

1.7.2. Specific objectives

1. To assess the current knowledge on diabetic retinopathy and maculopathy
2. To establish the attitudes toward screening of diabetic retinopathy and maculopathy.
3. To evaluate the practices on diabetic retinopathy and maculopathy.
4. To identify factors influencing the knowledge, attitude and practices of general practitioners.

1.8. RESEARCH SCOPE

This study is limited to general practitioners from public and confessional hospitals in Douala.

CHAPTER TWO:
LITERATURE REVIEW

2.1. OVERVIEW OF DIABETES MELLITUS

2.1.1. Definition of diabetic mellitus

Diabetes mellitus is defined by the American Diabetes Association (ADA) as a group of metabolic diseases characterized by chronic hyperglycemia, resulting from a defect in the secretion and/or action of insulin [10]. It is a chronic disease that requires long-term medical attention to limit the development of its complications and to manage them when they occur. The chronic complications of diabetes mainly affect the blood vessels and are divided into microvascular and macro vascular according to the diameter of the affected blood vessels. Excellent glycemic control plays an important role in slowing the progression of microangiopathies [10].

2.1.2. Epidemiology

Diabetes affects approximately 463 million people in the world's population, a prevalence of 9.3%. These figures are expected to reach 700 million by 2045 [1]. It is one of the leading causes of death in adults and is believed to be the cause of more than five million deaths worldwide in 2019 [1]. In Africa, the number of people living with diabetes is estimated at 19.4 million, or a prevalence of 3.9%, with a projection of 47.1 million for 2045 [1]. A meta-analysis carried out in Cameroon in 2018 found a prevalence of 5.8% [2].

2.1.3. Classification

Diabetes is classified into 4 main types according to its pathophysiology;

-Type 1 diabetes, or insulin dependent diabetes mellitus which accounts for 5 to 10% of diabetes cases, is due to autoimmune destruction of the beta cells of the islets of the pancreas, leading to a possible progressive decrease in insulin production and therefore absolute insulinopenia. Diabetes mostly occurs in childhood, but the disease can also develop in adults in their late 30s or early 40s. The resulting insulin deficiency requires daily administration of exogenous insulin [11].

- Type 2 diabetes or non-insulin dependent diabetes mellitus accounts for about 90-95% of diabetes cases. It is characterized by insulin resistance at the level of the target tissue, despite adequate secretion of insulin by the pancreas, which results in a progressive lack of insulin secretion and relative insulinopenia [11]. Most patients with this form of diabetes are obese, and obesity itself causes some degree of insulin resistance. The risk of developing this form of diabetes increases with age, obesity, and lack of physical activity. It is often associated with a strong genetic predisposition [11].

- Gestational diabetes refers to any degree of glucose intolerance with onset or first recognition during pregnancy, regardless of the course in the postpartum period [11].

- Other specific types: tropical diabetes (J-type diabetes mellitus) populated by Hugh Jones 1907. This type is related to malnutrition [12]. Diabetes secondary to pancreatopathy (total pancreatectomy, pancreatic cancer, hemochromatosis), diabetes secondary to endocrinopathy (acromegaly, hypercortisolism, pheochromocytoma, hyperthyroidism), diabetes secondary to certain drugs (glucocorticoids, antihypertensive, oral contraceptives, oral contraceptives). MODY type diabetes (Maturity-Onset Diabetes of the Young) [11].

2.1.4. Risk factors

The onset of type 1 diabetes is determined by genetic predisposition, environmental factors (twins, infections with coxsackies virus, cytomegalovirus, too early introduction of cow's milk proteins), autoimmune processes [7].

The familial nature of type 2 diabetes is well established. People at risk have external factors, especially related to lifestyle: food, overweight/obesity (BMI> 28 Kg / m^2), and lack of physical activity. Other risk factors, in addition to those listed above, include hypertriglyceridemia (TG> 2g / L), decreased HDL-C level (HDL <0.35 g / L), hypertension (> 140/90 mmHg) [7].

2.1.5. Pathophysiology

-TYPE 2 DIABETES (T2DM)

Insulin resistance is a major contributor to the pathogenesis of type 2 diabetes and plays a key role in associated metabolic abnormalities, such as dyslipidemia and hypertension. Insulin resistance is defined as a decrease in the ability of insulin to produce desired effects on target organs and is determined in type 2 diabetes primarily by genetic susceptibility and obesity. Obesity, especially visceral adiposity, is negatively correlated with insulin sensitivity. Physiologically, insulin secretion varies inversely with insulin sensitivity. The diabetic patient presents with insulin resistance or decreased insulin sensitivity, without a compensatory increase in pancreatic insulin secretion, thus leading to insulinopenia [7].

- TYPE 1 DIABETES (T1DM)

It is characterized by an absolute insulin deficiency, due to the destruction of pancreatic beta cells, the most plausible mechanism of which is represented by a cell-mediated autoimmune reaction. According to the American Diabetic Association (ADA), there are two subtypes of T1DM:

- Autoimmune T1DM, the most common (it represents more than 90% of cases in Europe). The main autoantigens targeted by the immune response are insulin and proinsulin, GAD (glutamic acid decarboxylase), IA2 (Islet Antigen number 2, related to a tyrosine phosphatase), ICA (Islet Cell Antibody, which are antibodies directed against island antigens).
- Idiopathic T1DM (characterized by the absence of autoantibodies) [7].

2.1.6. Diagnostic

2.1.6.1. Positive diagnoses

- Clinical diagnosis

The American Diabetes Society and WHO have established 4 diagnostic criteria for diabetes:

- A glycaemia ≥ 1.26 g / l (7.0 mmol / l) after a fast of 8 hours and checked twice;
- or the presence of symptoms of diabetes (polyuria, polydipsia, polyphagia, weight loss) associated with glycaemia (in venous plasma)> 2 g / l (11.1 mmol / l);
- or a glycaemia (in venous plasma) > 2 g / l (11.1 mmol / l), 2 hours after an oral load of 75 g of glucose (OGTT);
- or a level of HbA1c ("glycated hemoglobin") ≥ 6.5% (11.1 mmol / l) quantified according to methods calibrated on international references. This parameter reflects the average blood sugar level for the last three months [7].

2.1.6.2. Differential diagnoses

- type 1 diabetes or latent autoimmune diabetes of adulthood (LANA): it is characterized by the thinness of the patient, the absence of family history, and the presence of positive IA2 and GAD antibody levels.
- Genetic diabetes: MODY diabetes (Maturity Onset Diabetes of the Young) is moderate diabetes in young people [7].

- Secondary diabetes: these are diabetes secondary to pancreatopathies (chronic calcifying pancreatitis), hemochromatosis, cystic fibrosis, drugs (glucocorticoids, overdose of thyroid hormones, neuroleptics, etc.), and endocrinopathies (acromegaly), Cushing's syndrome, pheochromocytoma) [7].

2.1.6.3. Severity diagnoses

- Complications of type 2 diabetes;

Complications of type 2 diabetes mellitus are divided into acute (which usually leads to disease discovery and diagnosis) and chronic (which are largely responsible for the morbidity and mortality of diabetes) [7].

A. Acute complications

The most common acute complications of type 2 diabetes are:

- Diabetic ketoacidosis, which is much more common in type 1 diabetes, but also possible in type 2;
- Non-ketotic hyperosmolar coma, characterized by severe hyperglycemia in the absence of ketosis [7].

B. Chronic complications

Chronic complications can affect either large blood vessels causing macroangiopathy or small blood vessels causing microangiopathy [7].

- **Diabetic macroangiopathy**

Macroangiopathy refers to any pathology affecting medium and large arteries with a diameter greater than 200 µm.

The main form of macroangiopathy in a diabetic patient is atherosclerosis. Another clinically important form is stroke [7].

- **Diabetic microangiopathy**

Diabetic microangiopathies are secondary to the harmful effects of chronic hyperglycemia on the small blood vessels of the retina, nerves, and renal glomerulus, causing diabetic retinopathy, neuropathy, and nephropathy, respectively [7].

2.1.6.4. Treatment

a. Goals

- Eliminate the symptoms;
- Prevent the onset or at least slow down the development of complications;
- Avoid death.

The reduction of microvascular risk (retinopathy, nephropathy) is obtained by controlling blood sugar and blood pressure. Reduction of macro vascular risk (coronary, cerebrovascular, peripheral vascular) by the control of lipids, hypertension, and the cessation of smoking [7].

Aggressive lowering of glucose may not be the best strategy for all patients. As such, individual risk stratification is strongly recommended:

- HbA1c $\leq$ 7% is a reasonable limit in most adult patients
- HbA1c $\leq$ 6.5% in newly diagnosed patients with a life expectancy of more than 15 years and without a history of cardiovascular disease.
- HbA1c $\leq$ 8%, in patients with advanced microvascular complications, a limited life expectancy (<5 years), a long duration of diabetes (> 10 years), and for whom the target of 7% is difficult to achieve because drug intensification causes severe hypoglycemia [7].

However, focusing only on glucose does not provide adequate treatment for patients with diabetes mellitus. Treatment involves several goals (i.e. blood sugar, lipids, blood pressure) [7].

b. Means

- Non-pharmacological:

  Diet modification (low-calorie diet if overweight), physical activity [7].

- Pharmacological:

Properties of hypoglycemic agents available in the United States and Europe that may guide individualized treatment choices in patients with diabetes (Table 1).

Table 1: pharmacologic treatment options in type 2 diabetes [13]

Class	Cellular mechanism(s)	Primary physiological action(s)	Advantages	Disadvantages
Biguanides	-Activates AMP-kinase	-Decreases hepatic glucose production	-Does not cause hypoglycaemia -Does not affect weight -Decreases risk of cardiovascular events	-Gastrointestinal side effects (diarrhoea, abdominal cramping) -Lactic acidosis -Vitamin B_{12} deficiency -Multiple contraindications: CKD,acidosis,hypoxi, dehydration
Sulfonylureas	-Block ATP-K^+ sensitive channels	-Increase pancreatic insulin secretion	-Decreases risk of microvascular complications	-Hypoglycemia -weight gain
Meglitinides	-Block ATP-K^+ sensitive channels	-Increase pancreatic insulin secretion	-Decreases postprandial glycaemia -Easy to adapt doses	-Hypoglycaemia -weight gain -short half-life

TZDs	-Activates the nuclear transcription factor PPAR-γ	-Increases insulin sensitivity	- No hypoglycaemia -Decreases TG levels -Increases HDL-C -Decreases risk of cardiovascular events	- weight gain -Oedema/heart failure - Bone fractures -↑LDL-C (rosiglitazone)
α-Glucosidase inhibitors	-Inhibits intestinal α-glucosidase	-Slows intestinal carbohydrate digestion/absorption	-No hypoglycemia -Decrease postprandial glucose excursions -No systemic effects	-• Gastrointestinal side effects (flatulence, diarrhea)- -Frequent dosing schedule -Generally modest HbA_{1c} efficacy
DPP-4 Inhibitors	-Blocks DPP-4 -Increases postprandial levels of incretins (GLP-1, GIP)	-Increases insulin secretion (glucose dependent) -Decreases glucagon secretion (glucose dependent)	-No hypoglycemia	Angioedema /urticaria –Acute Pancreatitis? -Heart failure?
Bile acid sequestrants	-Binds bile acids in the intestinal tract, increasing hepatic bile acid production;	-↓ Hepatic glucose production? -↑ Incretion levels?	-No hypoglycaemia -Reduces LDL-C	-Gastrointestinal side effects (flatulence, diarrhea)- -↑ Triglycerides -May ↓ absorption of other medications
Dopamine-2 agonists	-Activates dopaminergic receptors	-↑ Insulin sensitivity -Modulates hypothalamic regulation of metabolism	-↓ CVD events - No hypoglycemia	-Fatigue, dizziness -Nausea -Rhinitis
Insulin	-Activates insulin receptors	-increases glucose uptake by cells -Decreases hepatic glucose production	-Nearly universal response - efficacy -↓ Microvascular risk	-Hypoglycemia -Weight gain -Mitogenic effects? -Injectable Training requirement

CVD: cardiovascular disease; GIP: glucose-dependent insulinotropic peptide; PPAR-γ: peroxisome proliferator-activated receptor γ; AMP: adenosine mono-phosphate, TZDs: thiazolidinedione; TG: triglycerides, HDL-C: high-density lipoprotein cholesterol; LDL-C:

Low-density lipoprotein cholesterol, HbA1c: glycated hemoglobin; DPP4: dipeptidyl peptidase IV; GLP: glucagon-like peptide; GIP: glucose-dependent insulinotropic peptide.

c. Monitoring of glucose control

Two main measures are available for healthcare providers and patients to assess the effectiveness of glycemic control: HbA1C and patient self-monitoring of blood glucose (SMBG)

- Blood glucose self-monitoring (BGSM).

All patients treated with insulin should have an BGSM. Providers are encouraged to consider BGSM when needed, such as when drug therapy is initiated or changed, in patients with unstable diabetes control (e.g., a recent history of hypoglycemia).

- Measure the HbA1C

HbA1c results from the non-enzymatic glycation of hemoglobin and makes it possible to estimate the glycemic balance in the 2 to 3 months preceding the sample [7].

2.2. ANATOMICAL OVERVIEW OF THE EYE-BALL AND RETINA

2.2.1. Eye-ball

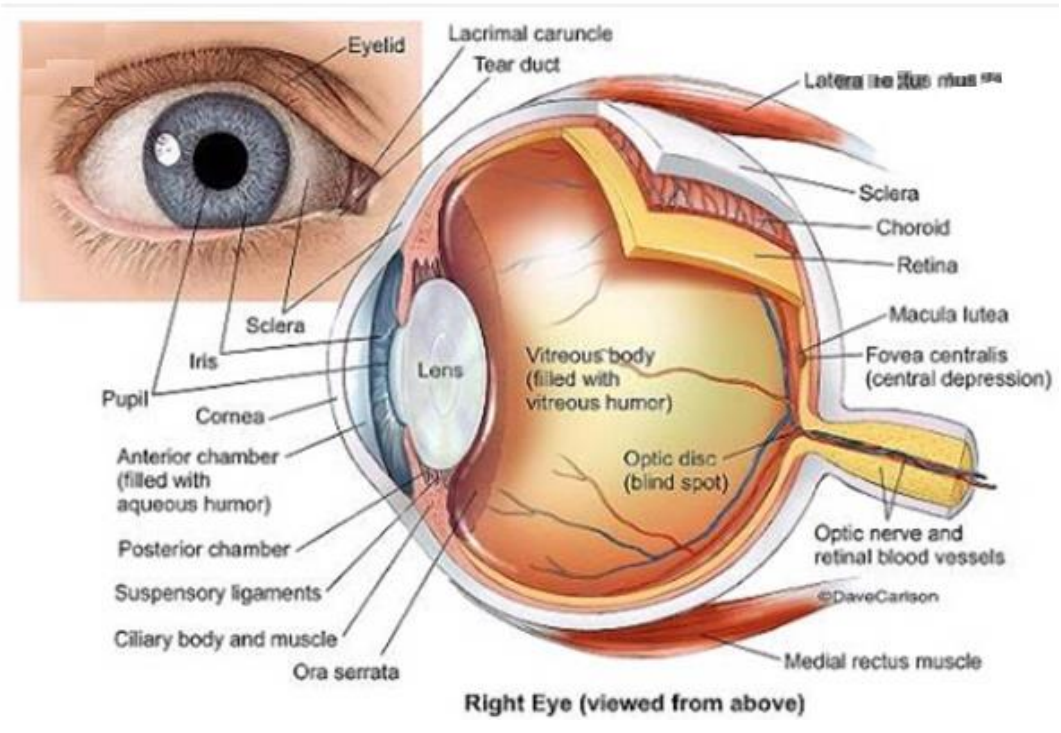

Figure 1: sagittal cut of eye ball
(Sources: Medscape)

Human beings have two eyes, located in the upper part of the facial mass at the level of the junction zone between the face and the bony skull. Each eye is separated from the other by the nasal passages and protected by the bony socket. For a normal or emmetropic eye, the most important diameters are: sagittal (24mm), transverse (24mm) and vertical (23mm). The eyeball weighs 7 g, with a volume of 6.5cm³. It consists of a container and a content [14].

2.2.1.1. Container

- **Outer membrane or corneoscleral shell**

It is made up behind by a supportive fibrous shell, the sclera, extended forward by the transparent cornea; the oculomotor muscles are inserted into the sclera; the junction between sclera and cornea is called the sclerocorneal limbus. The anterior part of the sclera is covered up to the limbus by the conjunctiva. The sclera has an orifice in its posterior part into which the origin of the optic nerve, called the head of the optic nerve or papilla, is inserted [14].

- **Intermediate or uveated membrane**

It is made up from back to front by:

• The choroid, an essentially vascular tissue responsible for the nutrition of the pigment epithelium and the outer layers of the neurosensory retina;

• The ciliary bodies, the anterior portion of which is made up of the ciliary processes responsible for the secretion of aqueous humor and on which is inserted the zonule, suspensory ligament of the lens, and by the ciliary muscle, whose contraction allows accommodation by the changes in the shape of the lens transmitted by the zonule;

• The iris, a circular diaphragm perforated in its center by the pupil, with a small diameter opening in bright light (miosis) and large diameter in darkness (mydriasis). Pupillary play is dependent on two muscles: the pupil sphincter and the iris dilator [14].

-Internal membrane or retina

It extends from the optic nerve behind and lines the entire internal surface of the choroid to end in front, forming a scalloped line, the ora Serrata; the retina is made up of two tissues: the neurosensory retina and the pigment epithelium:

• The neurosensory retina is made up of the first neurons of the optic pathway comprising the photoreceptors (cones and rods), bipolar cells, and ganglion cells whose axons constitute the optical fibers that meet at the level of the papilla to form the optic nerve. The central retinal vessels (central retinal artery and central retinal vein) run along with the optic nerve, which divides into several pedicles just after they emerge from the papilla; the retinal vessels are responsible for the nutrition of the inner layers of the retina;

• The pigment epithelium constitutes a monostratified cell layer placed against the external surface of the neurosensory retina [14]. There are two distinguish part in the retina:

- **The central retina**

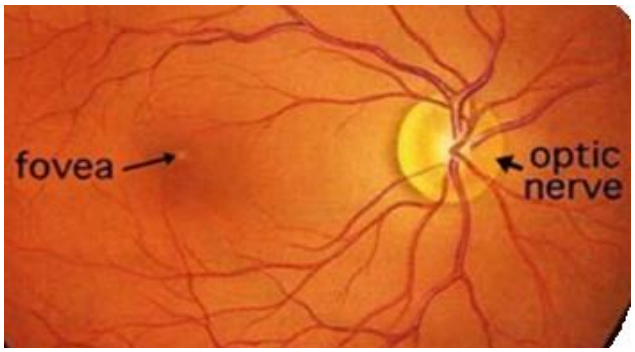

Figure 2: central retina

(SOURCE: college of university of ophthalmologist of France**)**

It is 5 to 6 mm in diameter, located at the posterior pole of the eye, in the space of the superior and inferior temporal arteries. It includes foveola, fovea, macular region.

The foveola is the central depression of the fovea, located two papillary diameters outside the temporal border of the papilla. It has a diameter of 150 µm.

The fovea or macula lutea is an elliptical area 2 mm wide by 1 mm high, includes the foveola in the center, and the clivus which laterally borders the foveolar depression. Its slightly yellowish appearance is due to the presence of a xanthophyll pigment.

Each cone synapses with a single bipolar cell, which in turn synapse with single ganglion cell. It contains no blood vessels [15, 16].

- **The papillary region**

The papilla or head of the optic nerve, the origin of the optic nerve, is formed by the convergence of optical fibers from ganglion cells. It has an oval shape, with a large vertical axis. Its center is located in and slightly above the foveola. It is easily identifiable with the ophthalmoscope by its light yellow colour contrasting with the pink-orange colour of the retina, and its limits are most often clear. It is dug with a more or less important excavation according to the individuals. At this level, the central retinal artery emerges and forms the trunk of the central retinal vein [15,16].

- **The peripheral retina**

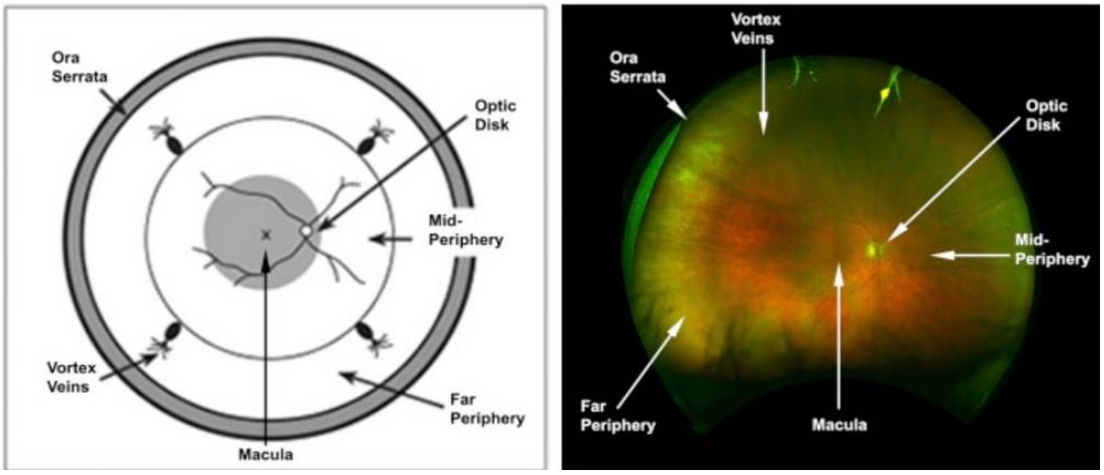

Figure 3: peripheral retina

(Source: Medscape)

It is conventionally divided into four areas by Duke-ELDER,1961

The near periphery, in contact with the posterior pole, extends over 1.5 mm;

The middle periphery measures 3 mm;

The distant periphery extends 9 to 10 mm on the temporal side and 16 mm on the nasal side; the extreme periphery (ora serrata) which measures 2.1 mm temporally and 0.8 mm nasal. The central and peripheral retinas are the regions most affected by DR/DM [15,16].

The human retina histologically presents ten layers. From the outside to the inside, we find:

- The pigmented epithelium; the photoreceptor layer; cones and rod layer; the outer limiting membrane; the outer nuclear layer (formed by the nuclei of photoreceptor cells); the outer plexiform layer; the inner nuclear layer; the internal plexiform layer; the ganglion cell layer; the layer of optical fibers; the internal limiting membrane [16].

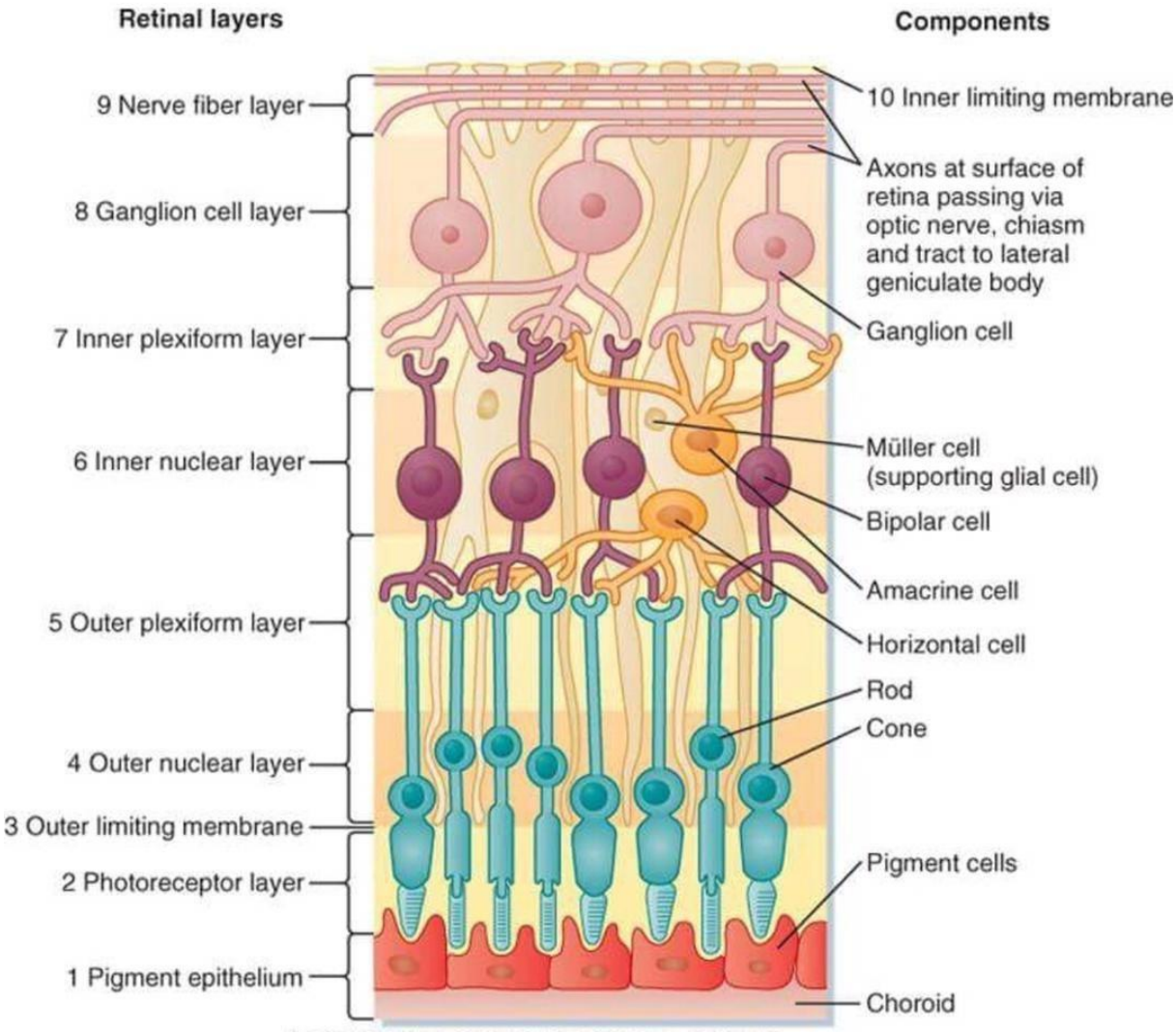

Figure 4: layers of the retina

(Source: college of university ophthalmologist of France)

Vascularization of the retina

Arterial blood supply

The retina has a double vascularization:

-The choriocapillary: it nourishes the photoreceptors through the Bruch membrane and the Pigmentary epithelium (PE). It ensures the vascularization of the outer layers of the retina.

-The Central retinal artery (CRA): responsible for the vascularization of the internal layers. A cilio-retinal artery may incidentally be present. After its emergence from the papilla, the CRA divides into 2 upper and lower branches which redivide very quickly to give 4 branches: 2

temporal arteries, superior and inferior, and 2 nasal arteries, superior and inferior. Retinal arteries and arterioles give rise to the retinal capillaries. Their main characteristic is that they are continuous, non-fenestrated capillaries, which contrasts them with those of the choriocapillary [16,17].

Blood retinal barrier (BRB)

BRB is structurally similar to the blood-brain barrier because it serves as a selective barrier that regulates the local environment of the neural retina. It is made up of 2 parts: the external BRB and the internal BRB. The external BRB at the level of the choroidal vasculature is formed by the tight junctions of the retinal pigment epithelium. Internal BRB is based largely on the tight junctions of endothelial cells and on the non-fenestrated structure of retinal vessels. Tight intercellular junctions (zonula occludens) are the most important components of these barriers. They prevent extracellular substances from diffusing between cells and force them to cross the cytoplasmic membrane by very selective active and passive mechanisms [18].

Venous vasculature

It is mainly provided by the central retinal vein (CRV). The small caliber venules (1 to 2 µ), meet in a centripetal way, from the ora towards the papilla to provide increasingly important veins which usually drain in 4 trunks: the superior and inferior temporal veins, the upper and lower nasal veins. The junction of the 2 upper branches forms the upper vein and the junction of the 2 lower branches forms the lower vein. These 2 trunks will come together to form the central vein of the retina at the level of the papilla. Thus formed, the central venous trunk is placed on the temporal flank of the trunk of the central artery and travels with it into the optic nerve [16,17].

2.2.1.2. Content

It consists of transparent area allowing the passage of light rays to the retina.

Aqueous humor

Transparent and fluid liquid fills the anterior chamber, delimited by the cornea in front and the iris behind. Permanently secreted by the ciliary processes, the aqueous humor is evacuated at the level of the iridocorneal angle through the trabeculum in the Schlemm canal which joins the general circulation; discomfort in its evacuation causes an increase in intraocular pressure (normal value: less than or equal to 22 mmHg) [14].

Crystalline

It is a biconvex lens, converging, anchored to the ciliary processes by its suspensory ligament, the zonule. It is capable of deforming by tension or relaxation of the zonule under the effect of the contraction of the ciliary muscle, and thus modify its power of convergence: this allows the passage from far vision to the near vision which constitutes the 'accommodation; the loss of the accommodating power of the lens with age is responsible for the presbyopia which requires the wearing of convergent corrective lenses for reading [14].

Vitreous body

It is a transparent gel, surrounded by a thin membrane, the hyaloid membrane, which fills 4 / 5ths of the ocular cavity and lines its posterior face (posterior hyaloid) on the internal face of the retina.

The eyeball is conventionally subdivided into two regions comprising the structures previously described:

- The anterior segment which includes the cornea, iris, anterior chamber, iridocorneal angle, lens and ciliary body;

- The posterior segment which includes the sclera, choroid, retina and vitreous [14].

2.2.2. The appendages of the eye

The eye is moved in different directions via six striated muscles (four rectus muscles and two oblique muscles), under the influence of the innervation of the oculomotor nerves:

• The cranial nerve Ill or common oculo- motor nerve innervates the superior rectus, medial rectus (formerly internal rectus), inferior rectus and inferior oblique (formerly small oblique) muscles; it also ensures the photo motor reflex and accommodation as well as the innervation of the elevator muscle of the upper eyelid;

• The cranial nerve IV or trochlear nerve innervates the superior oblique muscle (former major oblique);

• The cranial nerve VI or abducen nerve innervates the external rectus muscle [14].

Eyeball protection device

He understands:

• The eyelids, formed by a rigid fibrous framework (the tarsus) and a muscle (the orbicularis), which allows eyelid occlusion under the control of the facial nerve; the physiological blink allows the tear film to spread on the surface of the cornea;

• The conjunctiva which covers the inner surface of the eyelids (palpebral or tarsal conjunctiva) and the anterior portion of the eyeball (bulbar conjunctiva) up to the sclerocorneal limbus;

• The tear film, which ensures permanent moisturization of the cornea; it is secreted by the main lacrimal gland located on either side of the superior external part of the orbit and by accessory lacrimal glands located in the eyelids and conjunctiva; it is evacuated by the lacrimal passages which communicate with the nasal cavities by the tear duct [14].

2.2.3 Physiology of the vision

It is a complex phenomenon which have three main mechanisms concerned with vision transduction (rods and cones); transmission of visual sensation and visual perception. Vision begin with light passing through the cornea and the lens, which combine to produce a clear image of the visual world getting to the retina. It passes all the layers of the retina through the ganglion cells then via the plexiform and nuclear layers before it finally reaches the layer of rod and cones located all the way on the outer edge of the retina. At end of these layer, there is last layer of the retina which contain black pigment (melanin) that prevents light reflexion through the globe of the eyeball and stored vitamin A. At this level, the light rays are worm and Impulse generated from retina pass to optic nerve to the optic chiasm and optic tract to the occipital lobe. Cone mediate day vision and rod mediate the night vision [17].

2.3. DIABETES MELLITUS AND THE EYE

2.3.1. DIABETIC RETINOPATHY

2.3.1.1. Definition

Diabetic retinopathy, the most common microvascular complication of diabetes mellitus, is an eye disease resulting from chronic hyperglycemia and causing deterioration of retinal capillaries [19].

2.3.1.2 Epidemiology

Diabetic retinopathy affects 35% of people living with diabetes worldwide [20]. In Africa, DR has a prevalence that varies from 15 to 52% across countries [6]. In 2010, Sayad et al in Morocco, reported a prevalence of DR of 44% [20]. In Nigeria, in 2018, Abdulsalam et al found a prevalence of 36% [9]. A study carried out in Cameroon in 2020 by Domngang et al found a prevalence of 32.1% [6]. DR is common in T1DM as it is in T2DM:

- In T1DM, DR generally does not occur before 7 years of development of disease. After 20 years of evolution, 90 to 95% of type 1 diabetics have DR, of which 40% have proliferative DR [7].

- In T2DM, 20% of type 2 diabetics have DR as soon as their diabetes is discovered [21]. After 15 years of evolution, 60% of them have DR [22].

Risk factors of DR:

The main risk factors for DR: duration of diabetes, poor blood sugar control and high blood pressure [7].

- **Duration of diabetes**

The duration of diabetes is most important risk factor. In patients diagnosed with diabetes before the age of 30 years, the incidence of DR after 10 years is 50% and after 30 years is 90% [23]. DR develops within 5 years of the onset of diabetes or before puberty, but about 5% of type 2 diabetes has DR at presentation [24]. Wisconsin epidemiology study of diabetic retinopathy (WESDR) found that duration of diabetes was directly associated with an increased prevalence of DR in both type 1 and type 2 diabetes [25].

- **Glycaemia control**

Most epidemiological studies have shown a positive association between poor glycemic control and the progression of DR [26]. In the Wisconsin study the incidence and progression of DR were related to the level of glycaemia control at the start of the study, and to the mean level of glycated hemoglobin (HbA1c) throughout the study [25]. Klein calculated that at 1.5% reduction of HbA1c levels, there is reduction of at least 10 years of the evolution symptoms in a study done in four years follow up [25].

- **Blood pressure balance**

The UKPDS (United Kingdom prospective diabetic study) investigated the influence of tight blood pressure control (<150/85mmHg) in type 2 diabetes was highly beneficial in reducing the incidence DR by 37%, the progression of DR, by 34% and 47% decrease in visual acuity at 9 years, mainly by decreasing macular incidence [19].

- **Proteinuria**

In the Wisconsin study, the presence of proteinuria was associated with the severity of DR [25]. It would be an index of the risk of progression to proliferative DR [16, 17].

- **Pregnancy**

Being pregnant worsen retinopathy, especially if glycaemia is poorly controlled. Poor pre-pregnancy control of diabetes, is associated with worsening of diabetic retinopathy [24].

- **Hypercholesterolemia**

Hypercholesterolemia has not been identified as a risk factor for the development of DR or macular edema. However, a direct link has been found between total hypercholesterolemia and the severity of macular lipid exudate [16, 17].

Others risks factors: smoking, obesity and anemia, nephropathy.

2.3.1.3. Pathophysiology

Hyperglycemia plays an important role in the pathogenesis of retinal microvascular lesions. Certain metabolic pathways have been implicated in hyperglycemia-induced vascular damage including polyol pathway, accumulation of advanced glycation end products (AGE), protein kinase C (PKC) pathway, increased activity of the hexosamine pathway [27].

- **The polyol pathway:**

Aldose reductase is an enzyme whose function is to reduce the toxic aldehydes of the cell into inactive alcohols. When the concentration of glucose in the cell becomes too high, aldose reductase reduces this glucose to sorbitol, which is then oxidized to fructose. In the process of reducing intracellular glucose high in sorbitol, aldose reductase consumes the NADPH cofactor. NADPH is also the essential cofactor for regenerating reduced glutathione, an intracellular antioxidant. By reducing the amount of reduced glutathione, the polyol pathway increases sensitivity to intracellular oxidative stress [27].

- **The accumulation of advanced glycation end products (AGE: Advanced Glycation End products):**

They damage cells by three mechanisms. The first mechanism is the modification of intracellular proteins. The second mechanism is the diffusion of AGE precursors out of the cell, followed by modification of nearby extracellular matrix molecules, causing cellular dysfunction. The third mechanism is the diffusion of these precursors out of the cell and the modification of circulating proteins in the blood such as albumin. These modified circulating proteins can then bind to and activate AGE receptors, causing the production of inflammatory cytokines and growth factors, which in turn cause vascular pathology [24, 27].

- **The protein kinase C (PKC) pathway:**

The high concentration of glucose inside the cell increases the synthesis of diacyl-glycerol, which is an activating cofactor for the classic isoforms of protein Kinase-C. Activation of PKC leads to increased vascular permeability [24].

- **Increased activity of the hexosamine pathway:**

When there is a high concentration of glucose inside the cell, the majority is metabolized by glycolysis to glucose-6 phosphate, then to fructose-6 phosphate. However, fructose-6 phosphate is diverted into a signaling pathway in which an enzyme called GFAT (Glutamine fructose-6 phosphate aminotransferase) converts fructose-6 phosphate into glucosamine-6 phosphate and ultimately into UDP (Uridine diphosphate) N-acetyl glucosamine [24].

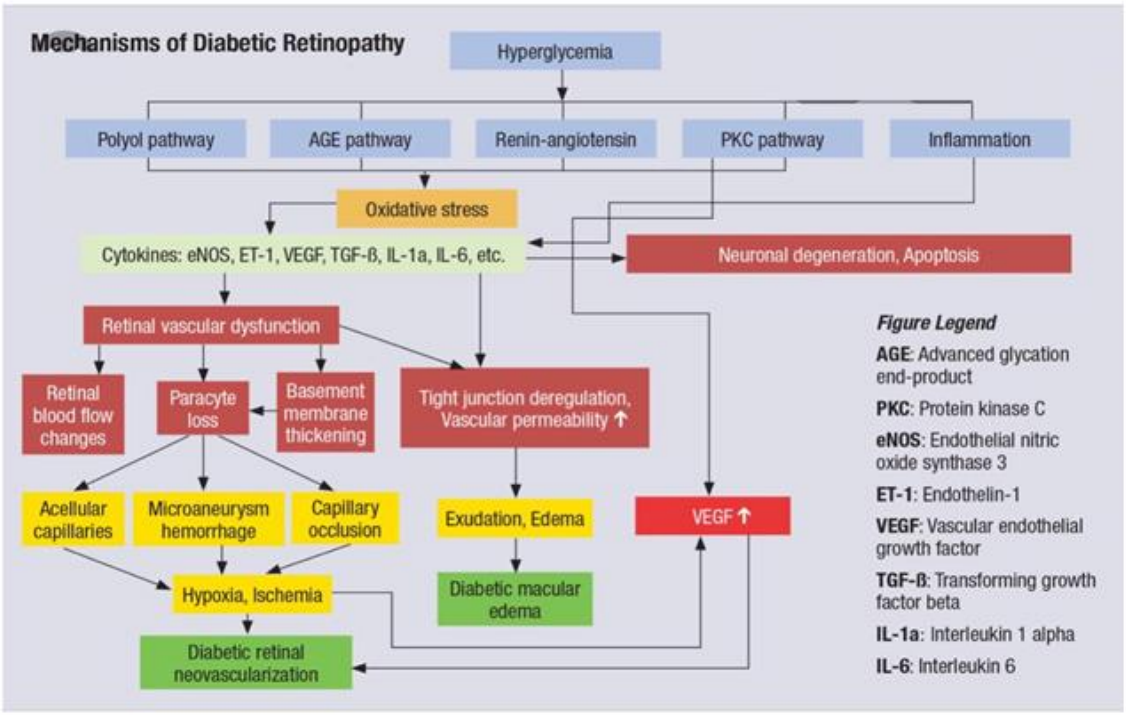

Figure 5: **metabolic pathway of DR**

(Source: Medscape)

Oxidative stress, activation of the renin-angiotensin system and inflammation lead to altered retinal blood flow and relative hypoxia, leading to the local secretion of angiogenic growth factors such as VEGF [24].

The first histological lesions of diabetic retinopathy are the thickening of the basement membrane, the dysfunction of the pericytes, then that of the endothelial cells of the retinal capillaries, resulting in their obstruction [28]. The role of pericytes is to provide structural

support to the capillaries. Their loss leads to a localized overflow of the capillary walls. This process is associated with the formation of micro aneurysms, which is the first clinical sign of DR. In addition to pericyte loss, endothelial cell apoptosis and basement membrane thickening are also detected during the pathogenesis of DR, which collectively contributes to the deterioration of the Blood Retinal Barrier (BRB). In addition, a pronounced loss of pericytes and endothelial cells results in capillary occlusion and ischemia. When the capillary occlusion is extensive, there is a reactive proliferation of new vessels by the production of growth factors, including VEGF: this is proliferative diabetic retinopathy [24].

2.3.1.4. Diagnostic

2.3.1.4.1. Circumstances of discovery

DR can be revealed by a decrease in visual acuity. This usually appears after a long period of DR development. Screening for DR should be done by systematic ophthalmologic examination when diabetes is discovered or during the annual monitoring of any diabetic patient. DR could also be discovered via normal routine eye examination on a diabetic patient, vision loss and complication such as HIV [29].

2.3.1.4.2. Diagnosis of diabetic retinopathy

The diagnosis is based on a biomicroscopic examination of the fundus after dilation of the pupils, supplemented by photographs of the fundus. This examination identifies:

- Retinal micro aneurysms which are the first ophthalmoscopic signs of DR. They appear as small red punctate lesions, predominantly at the posterior pole of the fundus. Some micro aneurysms can occlude and disappear spontaneously during the course of DR. But the increase in the number of micro aneurysms is a good indication of the progression of DR [28].

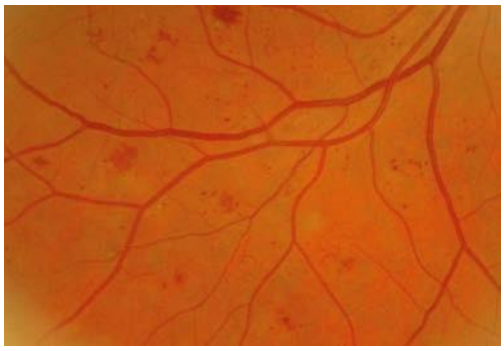

Figure 6: micro aneurysm and punctiform hemorrhage

(Source: college of university of ophthalmologists of France)

- Punctiform retinal hemorrhages which may be associated with micro aneurysms;

- Cottony nodules which are small white areas, localized infarction of the internal retina. They are mainly located at the posterior pole of the fundus. If their location is peripapillary, one must suspect associated arterial hypertension attacks (70% of type 2 diabetics are hypertensive and can therefore present to the fundus with mixed lesions of DR and hypertensive retinopathy) [28].

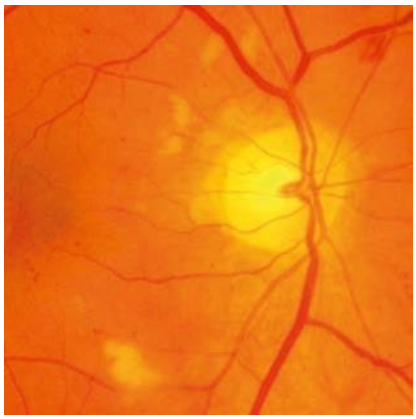

Figure 7: cottony wool nodules

(Source: College of University Ophthalmologists of France)

Other signs suggestive of severe retinal ischemia complicating DR:

- The intraretinal hemorrhages "in spots" are the witness of a recent capillary occlusion in the retinal periphery;

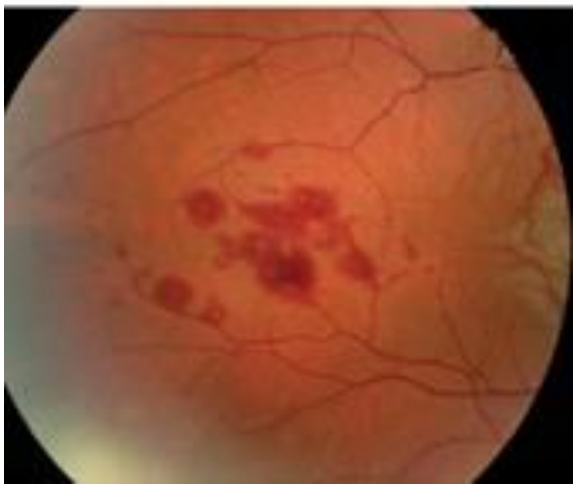

Figure 8: hemorrhage in spots
(Source: College of University Ophthalmologists of France)

- Flame hemorrhages suggest associated hypertensive retinopathy;

- Irregular "string" venous dilations or venous loops are observed at the edge of large areas of capillary occlusion (ischemia);

- Intraretinal microvascular anomalies (AMIR) are dilations and intraretinal capillaries developed around the capillary occlusion territories [28].

Pre-retinal and prepapillary neovessels characterize proliferating DR. They proliferate at the posterior limit of ischemic territories, or on the optic nerve when the surface of the unperfused retina is very extensive [28].

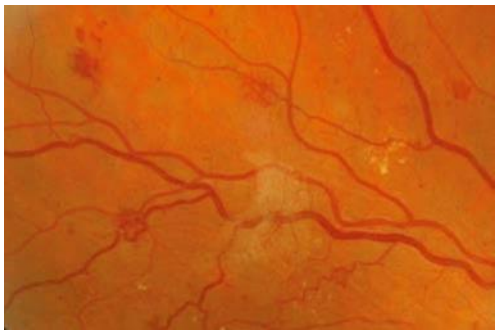

Figure 9: Pre-retinal neovessels

(Source: College of University Ophthalmologists of France)

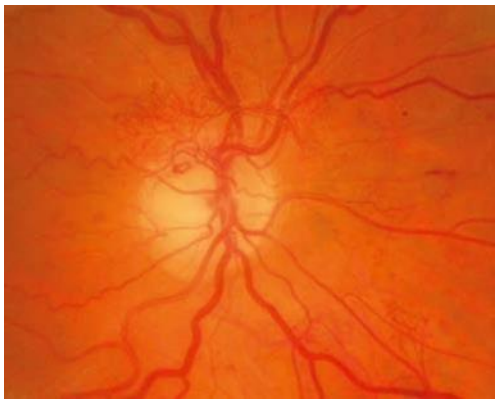

Figure 10: prepapillary neovessels

(Source: College of University Ophthalmologists of France)

- Pre-retinal or intravitreal hemorrhages occurring from new vessels.

Other signs are suggestive of capillary hyper permeability in the macula:

- Cystoid macular edema (CMO) which results in microcystic thickening of the macular retina;

- Lipid exudates which are accumulations of lipoproteins in the thickness of the edematous retina. They form yellowish deposits, often arranged in a ring around the microvascular abnormalities from which they originate (circinate exudates) [28].

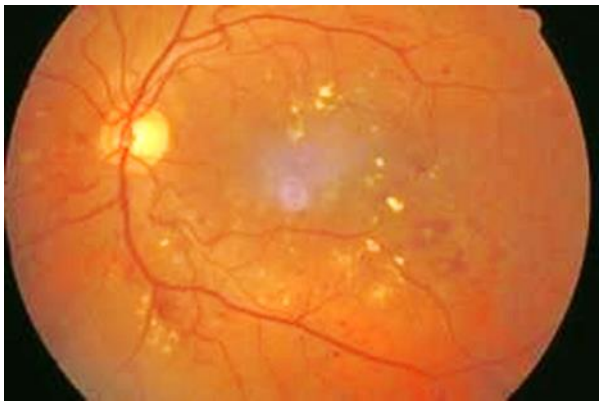

Figure 11: lipid exudates

(Source: College of University Ophthalmologists of France)

2.3.1.5. Complications of DR

They are:

- Intra-vitreous hemorrhage by bleeding from the preretinal or prepapillary neovessels

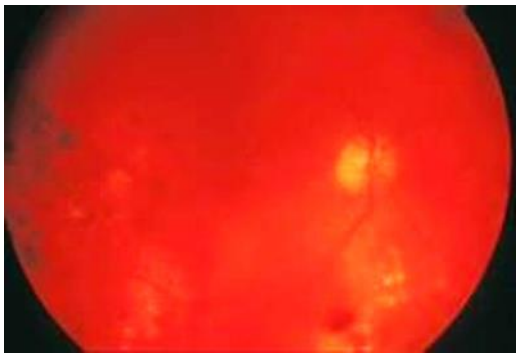

Figure 12: intra-vitreous hemorrhage

(Source: College of University Ophthalmologists of France)

- Detachment of the retina due to traction exerted on the retina by fibrous tissue supporting the new vessels.

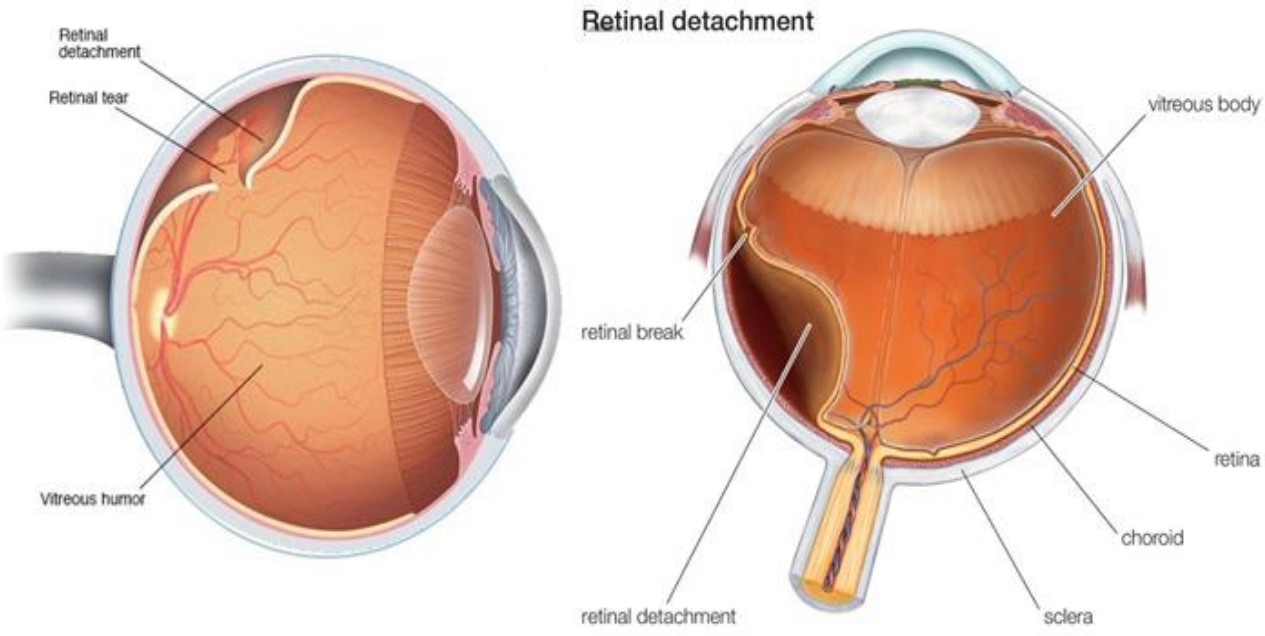

Figure 13: retinal detachment

(Source: college of university of ophthalmologists of France)

- Proliferation of new vessels on the iris and in the iridocorneal angle (iris neovascularization), causing neovascular glaucoma by blocking the flow of aqueous humor [28].

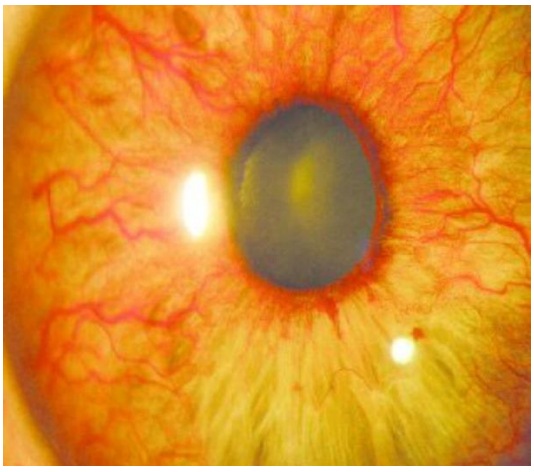

Figure 14: iris neovascularization

2.3.1.6. Classification of diabetic retinopathy

Table 2: classification of diabetic retinopathy and diabetic maculopathy [17]

Classification of diabetic retinopathy and diabetic macular edema (According to international clinical diabetic retinopathy

Measure	Score	Observable Findings
ICDR severity level		
No apparent retinopathy	0	No abnormalities (Level 10 ETDRS)
Mild non-proliferative diabetic retinopathy	1	Microaneurysm(s) only (Level 20 ETDRS)
Moderate non-proliferative diabetic retinopathy	2	More than just microaneurysm(s) but less than severe non-proliferative diabetic retinopathy (Level 35, 43, 47 ETDRS)
Severe non-proliferative diabetic retinopathy	3	Any of the following: > 20 intra-retinal haemorrhages in each of 4 quadrants, definite venous beading in ≥2 quadrants, prominent intra-retinal microvascular abnormalities in ≥1 quadrant, or no signs of proliferative retinopathy. (Level 53 ETDRS: 4-2-1 rule)
Proliferative diabetic retinopathy	4	One or more of the following: neovascularization and/or vitreous or preretinal haemorrhages. (Levels 61, 65, 71, 75, 81, 85 ETDRS)
Macular oedema severity level		
No macular oedema	0	No exudates and no apparent thickening within 1 disc diameter from fovea
Macular oedema	1	Exudates or apparent thickening within 1 disc diameter from fovea

Abbreviations: ETDRS, Early Treatment Diabetic Retinopathy study; ICDR, International Clinical Diabetic Retinopathy

2.3.1.7. Additional tests

Fundus photography

Fundus photography is the basis tool of the DR classifications [29]. Photographs of the posterior pole and the periphery are taken [30]. They make it possible to visualize the various signs of DR, and to indirectly assess peripheral retinal ischemia [31]. Indeed, the severity of the latter is estimated by the number and severity of certain clinical signs (micro aneurysm, intraretinal microaneurysm anomalies(IRMA), retinal hemorrhage) [29]. Fundus photography is also used for screening for DR which targets patients without known DR [32]. Photographs can be taken

without pupillary dilation by non-medical technicians, using retinographs. This method has a greater sensitivity than that of the ophthalmoscopic examination to detect DR [29].

Fluorescein angiography

It should not be requested systematically. These main indications are DR, retinal degeneration and occlusions of retinal vessels [33]. It helps in laser photocoagulation treatment of macular edema, diabetic retinopathy and assesses the degree of macular ischemia [34]. It makes it possible to detect capillary hyper permeability (diffusion of dye) and to assess the retinal capillary perfusion [35].

Optical coherence tomography (OCT)

OCT is essential for the diagnosis and monitoring of macular edema by showing lateral sections of the macula and allowing measurement of the thickness of the macular edema [36]. It is a widely utilized option for imaging the diabetic neural retina that uses light interferometry to create cross-sectional image of the retina in which individual retinal layers can be distinguished [37]. OCT allows quantitative measurements of retinal thickness as well as evaluation of morphological changes in eyes with DR and DME [38,39].

Ophthalmic B-scan ultrasonography

Is a modality useful in patients with massive vitreous hemorrhage that prevents fundus examination, to detect possible underlying retinal tractional detachment [40]. It can also be useful in proliferative diabetic retinopathy (PDR) [41]. B-scan ultrasonography creates an image of the eye by using sound waves transmitted at a high frequency from a transducer to the target tissue, which then return to the transducer at varying times and amplitude [42]. B-scan can also demonstrate if a DR is present and others pathology as posterior vitreous detachment [42,43].

2.3.1.8. Methods of screening and surveillance

DR screening should involve all diabetics because patients with type 1 or type 2 diabetes are at risk of developing neurovascular complications that can lead to DR/DM and then to blindness [45]. Researchers have found that NPDR was present in 25% of patients 5 years after they were diagnosed with diabetes, 60% at 10 years, and 80% at 15 years [45,46]. These study found that the incidence of proliferative DR varied from 2% in those who had diabetes for less than 5 years to 15.5% in those who had diabetes for 15 or more years [47]. Consensus of the American Optometric Association practice guidelines and the American Diabetes Association stated that patients with type 1 diabetes should have dilated fundus examination within 5 years of disease onset [46, 48]. Patients with type 2 diabetes should receive a dilated fundus examination at the time of the diagnosis and yearly thereafter [46,48]. Women diagnosed with type 1 or 2 diabetes should have fundosccopy exams before pregnancy or within the first trimester [46,48].

Monitoring:

- In the absence of DR: annual monitoring of the fundus by photographs [49].

- In the event of mild non-proliferating DR: annual monitoring of the fundus by photographs [49]. There is a 5% risk that mild NPDR will progress to PDR within 1 years [46].

- In the event of moderate nonproliferative DR: monitoring of the fundus by photographs every 6 to 8 months [46,49]. There is a 12% to 27% risk that they will develop PDR within 1 year [46].

-In the event of severe NPDR (intraretinal hemorrhage (> 20 in each quadrant), venous bending (in 2 or more quadrant) and IRMA [46, 49-50]. Known as 4:2:1 rule is monitored by OCT or fluorescein angiography at every 3 to 4 months [46,49]. Here, severe NPDR have a 52% risk of developing PDR within 1 year [46,50].

- In the event of macular edema: monitoring every 4 months [50].

American Diabetes association (ADA) has developed screening guideline based on studies that demonstrated that blindness secondary to DR could be prevented [49].

Table 3: screening Guideline ADA (American diabetes association)

DMs type	Recommended time of first eye Examination	Routine minimum follow up Interval
T1DM	Within 3-5 years after diagnosis	Yearly
T2DM	At time of diagnosis of DM	Yearly
TYPE1 or 2 Pregnancy in preexisting diabetes mellitus	Prior to conception and during1st Semester	No retinopathy to mild or moderate NPDR every3-12 months. Severe NPDR or worse every 1-3months

Evolutions

The development of DR is usually slow, and occurs gradually throughout the life of the diabetic. The visual loss associated with macular oedema is slow, but can end up being very disabling. Neovascular proliferation, if not treated effectively, could lead to blindness through its complications: tractional retinal detachment, intravitreal haemorrhage and neovascular glaucoma [51].

2.3.1.9. Treatment

- Goals

• Maintain the best possible visual acuity.

• Prevent the onset and aggravation of DR.

• Stabilize the progression of existing retinal lesions.

• Treat complications.

- **Means and Indications**
- **Medical treatment:** is the mainstay of treatment. It forms the basis of the treatment of diabetes mellitus. It consists of correcting metabolic and hemodynamic disturbances. The correction of lipid and carbohydrate disorders, the normalization of blood pressure and the reduction of hyperaggregability constitute the three essential objectives of the medical treatment of diabetic retinopathy [52].
- **Treatment of proliferative DR**

Laser photocoagulation

Laser pan retinal photocoagulation (PPR) is the specific treatment for proliferative DR. It consists of delivering laser impacts in a scattered manner over the entire peripheral retina. It does not act directly on the neovessels but indirectly by the extensive destruction of retinal ischemia territories [53]. This makes it possible to obtain regression of preretinal and / or prepapillary neovascularization in nearly 90% of cases and to considerably reduce the risk of blindness linked to proliferative DR. It is performed on an outpatient basis under contact anaesthesia, in several sessions [52].

Intraocular steroid

Through its plasmin-suppressing effect, the steroid inhibits the activation of collagenases which are responsible for the deterioration of the basement membrane at the start of the neovascular cascade [54]. steroid inhibits cell proliferation; it can therefore have a direct stabilizing effect on intraocular neovascularization [54]. Example of intraocular steroids: ranibizumab, dexamethasone and triamcinolone acetonide which is still used in low and middle income countries. However, intravitreous steroid use is limited by more frequent ocular side effects, such as cataract, glaucoma [55].

Intravitreal injections of anti-VEGF

Intravitreal injections of anti-VEGF, bevacizumab or ranibizumab among others, can by their antiangiogenic power, have an interest in certain indications of proliferative DR. They are also used in severe macular oedema affecting the central region and associated with reduced visual acuity (VA), particularly in the treatment of neovascular glaucoma [56].

Surgical treatment (retinovitreal surgery)

This treatment is indicated in cases of proliferative DR complicated by persistent intravitreal bleeding or tractional retinal detachment [57].

Combination therapy

Combination therapy involving laser and anti-VEGF can provide effective results. The combination of steroids and anti-VEGF therapies together has also shown a favorable response. focal/grid laser photocoagulation [58].

2.3.2. DIABETIC MACULOPATHY (DM)

2.3.2.1 DEFINITION AND PATHOPHYSIOLOGY

DM: Is a potential complication of DR, in people with type 2 diabetes, DM causes most vision loss [59]. It is stereoscopically visible as a retinal thickening from the accumulation of fluid and hard exudate at the posterior pole of the eye [58]. DM can be developed in both setting of nonproliferative diabetic retinopathy (NPDR) and proliferative diabetic retinopathy (PDR) [59].

DR is a significant complication of diabetes that generally refers to microvascular anomalies in the fundus of the eyes in persons with diabetes [60]. DM involves the deterioration of the blood retina barrier (BRB) in the eye; and a resulting pooling of fluid within the retina central area [46]. This capillary leakage causes diffuse oedema, whereas focal or multifocal

leakage from grouped micro aneurysm leads to localized oedema. Vascular endothelial growth factor(VEGF) contribute to the pathogenesis of DM, and to a significant increase vascular permeability. Vitreous VEGF levels are markedly elevated in patients with DME [58].

The oedema is intracellular at the beginning, with Müller cells (component of the external limiting membrane layer) swelling as the first affected cells [59]. Its progression induces its apoptosis [58]. Other cells such as bipolar cells, ganglion cells, and photoreceptors undergo presynaptic elongation and a reduction of its prolongation until the oedema is reversible if metabolic status ameliorates [59]. After this phase, the liquid passes through the cell membrane and accumulates in the interstitial space, forming cysts. In DM, cyst formation appears in the inner layers with little cyst that progress to the external layers forming much larger cysts, which will become visible under retinal bio microscopy and fluorescein angiography [59]. At the eternal plexiform layer, the oedema allows lipid deposition hard exudate. The rupture of retinal pigment epithelium allows liquid accumulation under the neurosensory retina and its detachment, which is a form of oedema [60].

Diabetic maculopathy can be divided into three types:

-Diabetic macular oedema(exudative)

-Diabetic macular ischemia

-Mixed maculopathy

Diabetic macular oedema (DME): it is more common in type 2 diabetes. The incidence increase with the severity of diabetes in both young and adult. It is more common and the vision loss generally is not irreversible [61]. It is clinically significant if one of the following conditions is present: retinal thickening (500mm) of the macula; hard exudates; and zone of retinal thickening 1 disk area in size. Clinically, is further divided into focal and diffuse depending on the leaking pattern. Can also be associated with cystoid macula oedema if

breakdown of blood retinal barrier is general with fluid that accumulate in the outer plexiform layer [46].

Diabetic macular ischemia (DMI): most severe form, detected by fluorescein angiography as lack of filling of capillaries. The fovea avascular zone (FAZ) become enlarged and irregular due to capillary closure. DR increase the risk of DME, which increase the risk of DMI [62].

2.3.2.2. EPIDEMIOLOGY

The DM is a further important complication of diabetes which is present in the eyes levels of DR. The prevalence of DM among those with type 1 diabetes and type 2 diabetes varies by region. DM affect more than 21 million people worldwide [39]. Approximately one in 14 people with diabetes have some degree of DM [44]. The prevalence rate range from 11% in Europe to 7.5% in some African countries [49]. An estimation of 20% of people living T1DM and 25% of those with T2DM, can expect to develop DM [44]. Those diagnosed with proliferative diabetic retinopathy are at a particular risk for DM [10].

2.3.2.3 RISK FACTORS OF DM

The risk factors for DM can be divided into modifiable and non-modifiable factors associated with the onset of DM [44].

Modifiable: hyperglycaemia especially in the presence of hypertension, dyslipidaemia, obesity, smoking [51].

Non modifiable: duration of diabetes, pregnancy, gender (more frequent in male)

Additional pre-existing condition which increase the risk of DM: DR, previous cataract surgery; nephropathy, microalbuminuria; sleep apnoea [49].

- **Hyperglycaemia:** is a noted of DM, and intensive glycaemic control can cut the risk by 50%. Through a legacy effect in DR, vascular may persist despite glucose normalization.
- **Hypertension:** elevated blood pressure predisposes a person to develop DM.
- **Dyslipidaemia:** the precise role dyslipidaemia plays in DM is unclear.
- **Duration of diabetes:** while everyone with diabetes is at risk of developing DM. Elevated HbA1c >7% and longer disease duration confer the most risk. [10]
- **Diabetic retinopathy:** the presence and the severity of DR are both major risk associated with DM [40].
- **Cataract surgery:** people with diabetes, especially those with DR, may develop DM after cataract surgery. The risk is highest in the first 3 to 6 months' post-surgery [46].
- **Obesity:** a relationship may exist between DM and the person overweight and obesity status.
- **Sleep apnoea:** patient with sleep apnoea have a higher risk of developing DM.
- **Pregnancy:** pre-existing diabetes, especially in the presence of hypertension, may increase the risk of developing to DM [49]. The precise causes are not well understood and various placental hormones may be implicated. It is important that pregnant women with diabetes undergo regular screening to prevent retinopathies such as DM. Women who are diagnosed with gestational diabetes mellitus have the same risk of developing DR as the general population with diabetes [11].

2.3.2.4. Diagnosis of DM

Bio microscopic examination of the retina and vitreous confirms the presence of DM and specified its severity [50]. All the clinical signs of DM should be studied, at the posterior pole, then at the level of each quadrant of the periphery of the retina [5–7].

CLINICAL LESIONS OF DM

- **Micro aneurysm and punctiform haemorrhages**

Retinal micro aneurysms and punctuated retinal haemorrhage are the first ophthalmoscopic signs of DR. They appear as small red punctate lesions, micro aneurysms, ectasia of the capillary wall, being more superficial than retinal haemorrhage. Micro aneurysms can thrombose and disappear spontaneously [1, 7].

- **Cotton wool nodules**

Cotton nodules are small, white lesions with an axis perpendicular to the axis of the optical fibres. They reflect an occlusion of the arterioles pre retinal capillary when they are numerous on average peripheral retinal, they reflect an evolutionary surge of DR. Their pre papillary location should raise suspicion of hypertensive retinopathy [9].

- **Signs of maculopathy ischemia**

a. Intraretinal haemorrhages in spots

They are larger in size and deeper than punctuates haemorrhages when they are numerous, they reflect ischemic suffering of the retinal tissues. The presence of numerous spotted haemorrhages. Spots in the periphery of the retina is one of the three criteria for severe non proliferative DR [7, 10].

b. Venous anomalies

This is an irregularity of localized venous calibre, dilation followed by an area of narrowing (rosary appearance), venous loops or venous duplication. The presence of numerous venous abnormalities is the characteristic [5, 7].

- **Pre retinal haemorrhage, intravitreal haemorrhage**

It is the bleeding from the neo vessels in the retro hyaloid space. Intravitreal haemorrhage area collection of blood in the vitreous. These are complications of proliferative diabetic retinopathy [5, 7]. Intravitreal bleeding obscures the intravitreal cavity making retinal examination difficult. In this case, a B-model sound is essential to determine the state of the retina. Intravitreal bleeding usually revolves within a few weeks or may rupture into the vitreous cavity [10]. However, they can be accompanied by significant fibro vascular proliferations which rapidly lead to severe macular retraction or retinal detachment by fraction which is an indication of vitrectomy [7,8].

- **Retinal detachment**

Is a separation of the neurosensory retina from the retinal pigment epithelium due to traction caused by proliferative membrane over the retinal surface or vitreous [3,4].

Retinal detachment is a complication of proliferating DR. Two type of detachment can be observed:

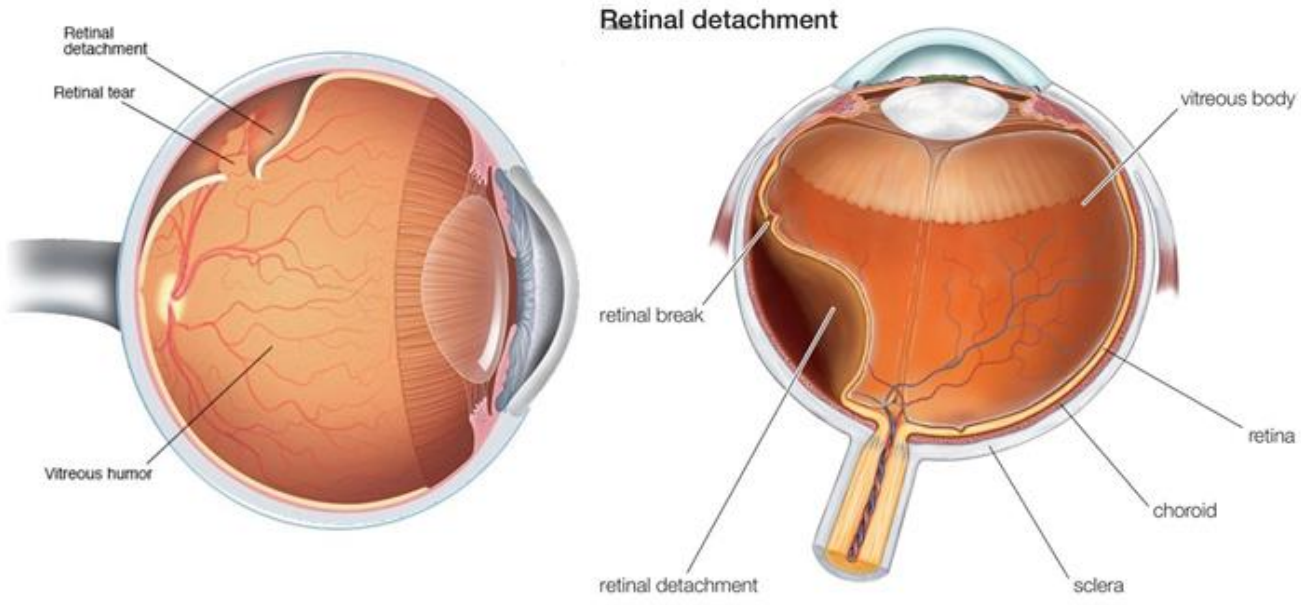

Figure 15: retinal detachment

(Source: college of university of ophthalmologist of France)

Retinal detachment by traction is the separation of the neurosensory retina from the underlying retinal pigment epithelium due to the traction resulting from membrane in the vitreous or over the retinal surface in diabetics [3, 9].

- **Neovascular glaucoma, Iris rubeosis**

Iris rubeosis is the neovascularization of the iris, a consequence of severe retinal ischemia. Neovascular glaucoma is a glaucoma secondary to proliferation of neovessels and fibrous tissue in the iridocorneal angle and on the iris [5]. This is the terminal complication of rubeosis iris can progress for months without becoming complicated by neovascular glaucoma. The time period separating the onset of rubeolla iris and neovascular glaucoma is variable [5, 7]. It is at the stage of iris rubeosis that the retinal pan photocoagulation must be undertaken urgently in order to avoid the progression to neovascular glaucoma [8, 10].

- **Exudates**

These are accumulation of lipoproteins in the thickness of the retina, they appear as yellow deposits and are usually arranged in a crown around the micro aneurysm or IRMAs (intraretinal microvascular anomalies) from which they originate [11]. When they are numerous, the exudates tend to accumulate in the macula and create a Centro macular exudate patch with visual prognosis. Their presence in the macula region is a sign in favor of macula edema [3, 5].

- **Macula edema**

It is a thickening of the macula-retina. Observed on microscopic examination. The edema can be localized (focal edema) or generalized (no cystoid edema and cystoid macula edema). Angiography makes it possible to visualize a diffusion of the edema in the macula or late retina [5, 7].

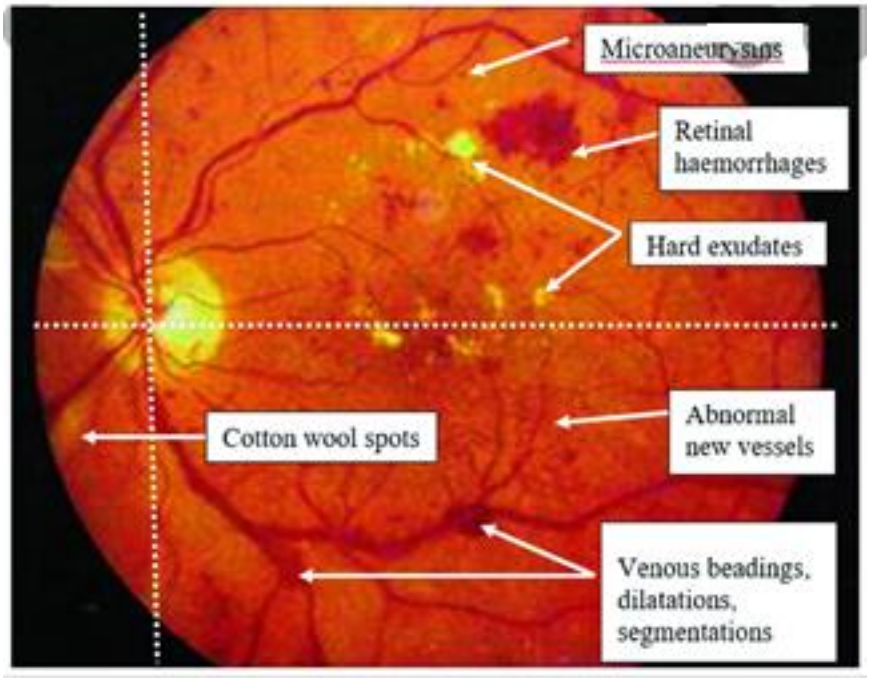

Figure 16: summarizing clinical lesion caused by DM [6]

(Source: college of university of ophthalmologist of France)

2.3.2.5. Complementary laboratory examination for DM

1) Ophthalmoscopy: with the pupil dilated

It is the standard comprehensive procedure in the screening of DM

This test helps to look:

- Abnormal blood vessel
- Swelling, blood or fatty deposits in the retina
- Growth of the new blood vessels and scars tissue.
- Bleeding in the clear, jelly like substance that fills the center of the eye vitreous
- Retinal detachment
- Abnormalities in the optic nerve [5, 11].

2) **Fluorescein angiography**

It is an invasive medical procedure in which a fluorescent dye is injected into the bloodstream. The dye highlights the bloods vessels in the back of the eye so they can be photographed. It is a costly and time consuming technique but is a sensitive method to detect vascular changes due to rupture of the inner and outer blood retinal barrier then the doctor inject a special dye into the vein and take more picture as the dye circulate through the eyes blood vessels (see if vessels of eye is closed, broken down or leaking fluid) [3].

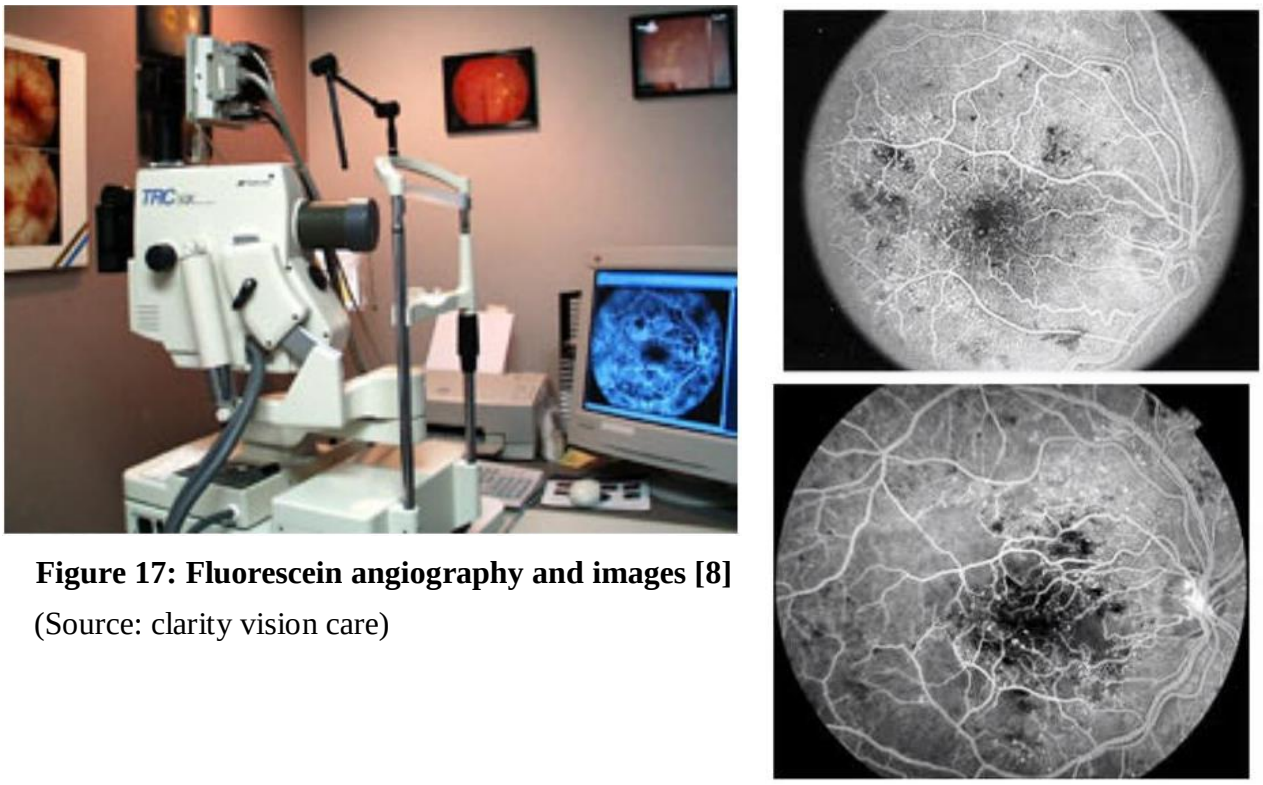

Figure 17: Fluorescein angiography and images [8]
(Source: clarity vision care)

3) Optical coherence tomography (OCT)

It is an imaging examination test that provides a high-resolution cross sectional image of the retina, choroid, vitreous gel, and the vitreoretinal interface. This help to determine whether fluid has leaked into retinal tissue. The test has become the golds standard for the diagnosis, treatment approach prognosis, assessment of treatment response, and control of patients with diabetic macular edema [3, 8].

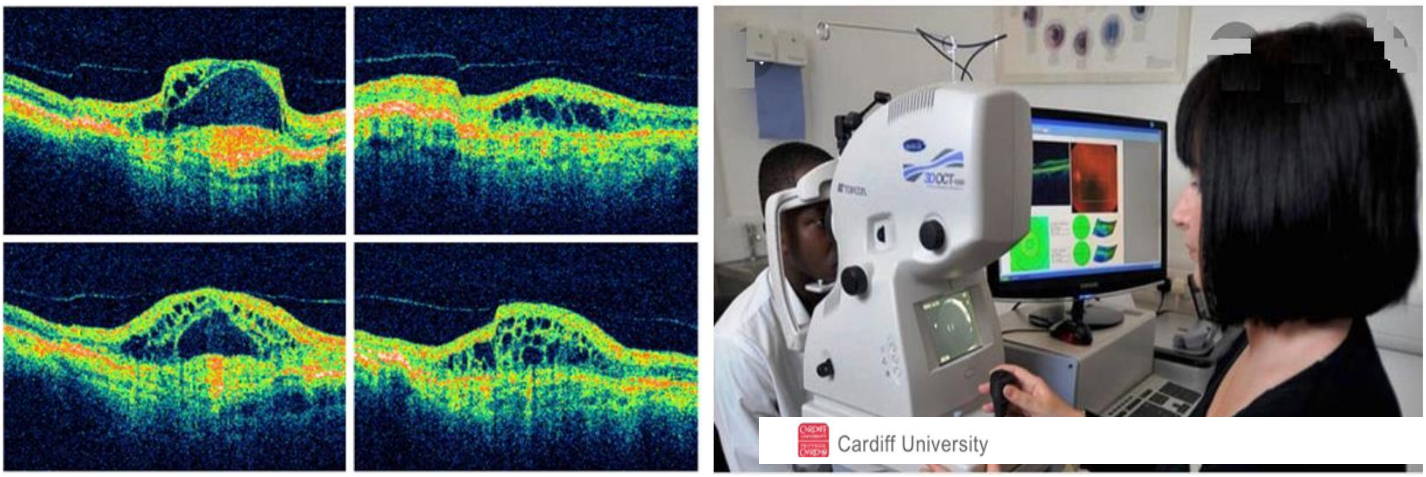

Figure 18: optical coherence tomography / images [8]

(Source: clarity vision care)

4) Optical coherence tomography angiography (OCTA)

Is a new noninvasive imaging technique that employs motion contract imaging. To high-resolution volumetric blood flow information generating image in a matter of seconds [9, 10] . It provides a highly detailed view of the retinal vasculature, which allows for accurate delimitation of the fovea avascular Zone (FAZ) and deletion of subtle microvascular abnormalities; including FAZ. Enlargement areas of capillary without perfusion, and intraretinal cystic spaces [3,5]. The possibility of detecting microvascular changes in diabetes eyes before the presence of visible micro aneurysms may have important implications in the future. As OCTA is fast and noninvasive, it can provide sensitive method for detecting early

changes in DR/DM, constituting a very promising technique for early diagnosis and control of treatment in patients with DR/DM [1–3]. In this sense, OCTA could be able to quickly identify diabetic individuals at risk for developing DR/DM.

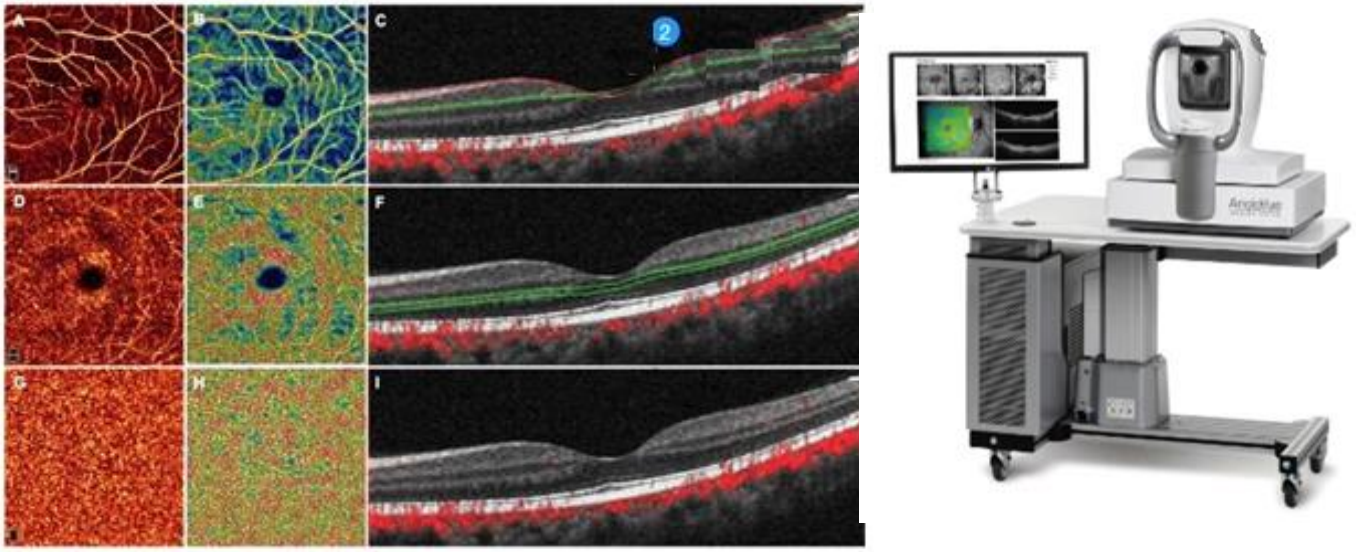

Figure 19: optical coherence tomography angiography and images [13]

(Source: clarity care vision)

2.3.2.6. Classification of DME

The aim of classifying DR/DM is to establish stages of severity and therefore different signs of progress in the development of these pathologies, to which correspond different monitoring times and therapeutic indications [2].

Table 4: classification of DME by clinically significant macular edema (CSME)

DME	Finding Observable upon dilated Ophthalmoscopy
DME Absent	No retinal thickening or hard exudate in fundus of eye
DME Present (non- central involved DME) Mild	Retinal thickening in the macula that does not involve the central subfield zone, and is> 1mm around fovea -Focal DME: from microanerysm due internal blood retinal barrier damage -Diffuse: from external blood retinal barrier damage.
Central-involved DME(severe)	Retinal thickening in the macula involving the central subfield zone that is >1mm

(Source: international diabetic Federation (IDF))

Hard exudate indicates either current or previous macular edema. DME is defined as a retinal thickening and requires a three-dimensional assessment that is best performed during dilated examination using slit-lamp bio microscopy and or stereoscopic fundus photography [45].

2.3.2.7. Screening for prevention of DM

Early detection and treatment can prevent nearly all associated risk factors leading to blindness in a diabetic patient. Qualities screening procedures are crucial to ensure timely detection of DM and intervention to prevent or minimize visual loss [3, 5]. American Diabetes Association (ADA) has developed screening guidelines based on studies that demonstrated

that blindness secondary to DR could be prevented [3, 5]. The finding at this first examination will determine the frequency of subsequent exams.

Table 5: screening Guideline ADA (American diabetes association)

DMs type	Recommended time of first eye Examination	Routine minimum follow up Interval
T1DM	Within 3-5 years after diagnosis	Yearly
T2DM	At time of diagnosis of DM	Yearly
TYPE 1 or 2 Pregnancy in preexisting DMs	Prior to conception and during1st Semester	No retinopathy to mild or moderate NPDR every3-12 months. Severe NPDR or worse every 1-3months

(Source: international diabetic federation (IDF))

Time of referral to ophthalmologist: The recommendations in the international council of ophthalmology (ICO) guideline for eye care are: visual acuity is worse than 6/12 (20/40); visual acuity or retinal examination cannot be obtained at the screening examination; women withT1DM or T2DM who desire to get pregnant [10].

Table 6: re-examination and referral recommendations (based on international classification of DM)

Classification	Re-examination	Referral to ophthalmologist
Non-central-involved DME	3 months	Referral required
Central-involved DME	1 month	Referral required

(Source: international diabetes federation)

2.3.2.8. Treatment of DM

- Goals

• Improve the best possible visual acuity.

• Prevent blindness, prevent further vision loss

• Restore impaired vision where possible.

- **Means and Indications**
- **Medical treatment:** is the mainstay of treatment. It forms the basis of the treatment of diabetes mellitus. It consists of correcting metabolic and hemodynamic disturbances. The correction of lipid and carbohydrate disorders, the normalization of blood pressure and the reduction of hyperaggregability constitute the three essential objectives of the medical treatment of diabetic retinopathy [52].
- **Treatment of proliferative DR**

Laser photocoagulation

Local and grid laser photocoagulation is effective for stabilizing and protecting remaining sight, however its ability to reverse vision loss is poor. The photocoagulation stops micro aneurysm from leaking into the macula. This makes it possible to obtain regression of preretinal and / or prepapillary neovascularization in nearly 90% of cases and to considerably reduce the risk of blindness linked to proliferative DR. It is performed on an outpatient basis under local anesthesia, in several sessions [53].

Intravitreal injections

Intravitreal injections of anti-VEGF, bevacizumab, or ranibizumab among others, first-line therapy for central involved DME. Administered via intravitreal injection under topical anesthesia. Aflibercept offers most vision improvement in patients with baseline visual acuity of 20/50 or worse. Anti VEGF is superior to laser treatment patients should be educated that any intraocular injection carries the potential risk of endophthalmitis, vitreous hemorrhage, and retinal detachment. [54].

Intraocular or intravitreal steroids

Second-line treatment for patients for whom Anti-VEGF therapy is ineffective. Corticosteroids have powerful anti-inflammatory and anti-edematous effects. Corticosteroid agents are commercially available for intravitreal use as dexamethasone implant. Corticosteroid inhibits cell proliferation; it can therefore have a direct stabilizing effect on intraocular neovascularization. Through its plasmin-suppressing effect, the steroid inhibits the activation of collagenases which are responsible for the deterioration of the basement membrane at the start of the neovascular cascade [58].

Combination therapy

Combination therapy involving laser and anti-VEGF can provide effective results. The combination of steroids and anti-VEGF therapies together has also shown a favorable response. On-central involved DME shows positive results from focal/grid laser photocoagulation [58].

Surgical treatment (retinovitreal surgery):

Vitrectomy may help to remove advanced glycated end products (AGEs) from the vitreoretinal interface or remove abnormally adherent vitreous that could induce DME. AGEs are caused by primary hyperglycemia and fractional retinal detachment [59].

2.4. RELATED STUDIES

Table 7: Related studies

Author, years, country	Title	Study design, sample size	Relevant finding
Abdul Salam et al. 2018, Nigeria	KAP on DR among physicians in North-Western Nigeria	Cross-sectional 105	63,8% were aware of the knowledge of DR and effective method of delaying the meet 81,9% disagree that eyes examination is not their Job 36,2% perform routine eyes exam
Rajiv Raman et al. 2016 India	KAP on DR among Gps in south India	Cross-sectional 450	31,3% have good knowledge of DR 54% have a good attitude. 84% Good practices fundus examination.
Niyonsaye et al 2015 Burundi	KAP on DR among Gps in the district and regional hospital in North region of Burundi	Cross-sectional 81	Poor knowledge on DR with 43% very poor attitude on screening 6,2% - 22,2% Good practice in referral 99,5%
Mensah et al. 2013 Ghana	KAP of DR among Medical officers in the Regional hospitals of Ghana	Cross-sectional 120	80,2% of participants have good knowledge about DR 67% did not have access to ophthalmoscope, 11% could appreciate practice with a poor test for vision within a year and 17,6% do fundoscopy

CHAPTER THREE:
METHODOLOGY

3.1. Study design

The study was an analytic cross-sectional survey.

3.2. Study period

This study was carried from 1st February to 31 May 2021.

3.3. Study duration

The study duration was 4 months.

3.4. Study site

This study was carried out in public and confessional hospitals in Douala. Douala is the metropolitan city, the largest and most populated city in Cameroon. It is the commercial and economic capital of Cameroon located in the littoral region. It has a heterogeneous population (ethnics and religion). It is made up of people from all walks of life. The town of Douala is located in the wouri department into the littoral region. The regional delegation of public health for the littoral region is located at Bonanjo quarter in Douala. The regional delegation is an administrative place representing the ministry of public health in the littoral region. Health centers in the department of wouri (town of Douala) are distributed into public, confessional and private hospitals. For our study, hospitals concerned were public (reference and district hospitals) and confessional hospitals listed in the table and the map below.

Table 8: lists of public and confessional hospitals in Douala

Public hospitals	Confessional hospitals
DGH	Presbyterian hospital Atcha Bependa
DLH	Presbyterian hospital Bicec
DMH	Presbyterian hospital Emilisaker
DH Bangue	Adlucem hospital Bali
DH Nylon	Adlucem hospital bonamoussadi
DH Boko	Hospital des soeurs logpom
DH Logbaba	Padre Pio hospital
DH Japoma	
DH New bell	
DH Cite des palmiers	
DH Deido	
DH Bonassama	

DGH: Douala general hospital, **DLH:** Douala laquintinie hospital, **DMH:** Douala military hospital; **DH:** District hospital.

Figure 20: map showing health facilities in Douala

3.5. STUDY POPULATION AND SAMPLING

The study targeted general practitioners in public and confessional hospitals in Douala.

A non-probabilistic consecutive sampling was used.

3.5.1. Inclusion criteria

All general practitioners who agreed to participate to the study working in public and confessional hospitals were included.

3.5.2. Exclusion criteria

Exclusion criteria were:

- Incomplete questionnaires
- Doctors from private clinics
- Refusal consent

3.6 STUDY FLOW CHART

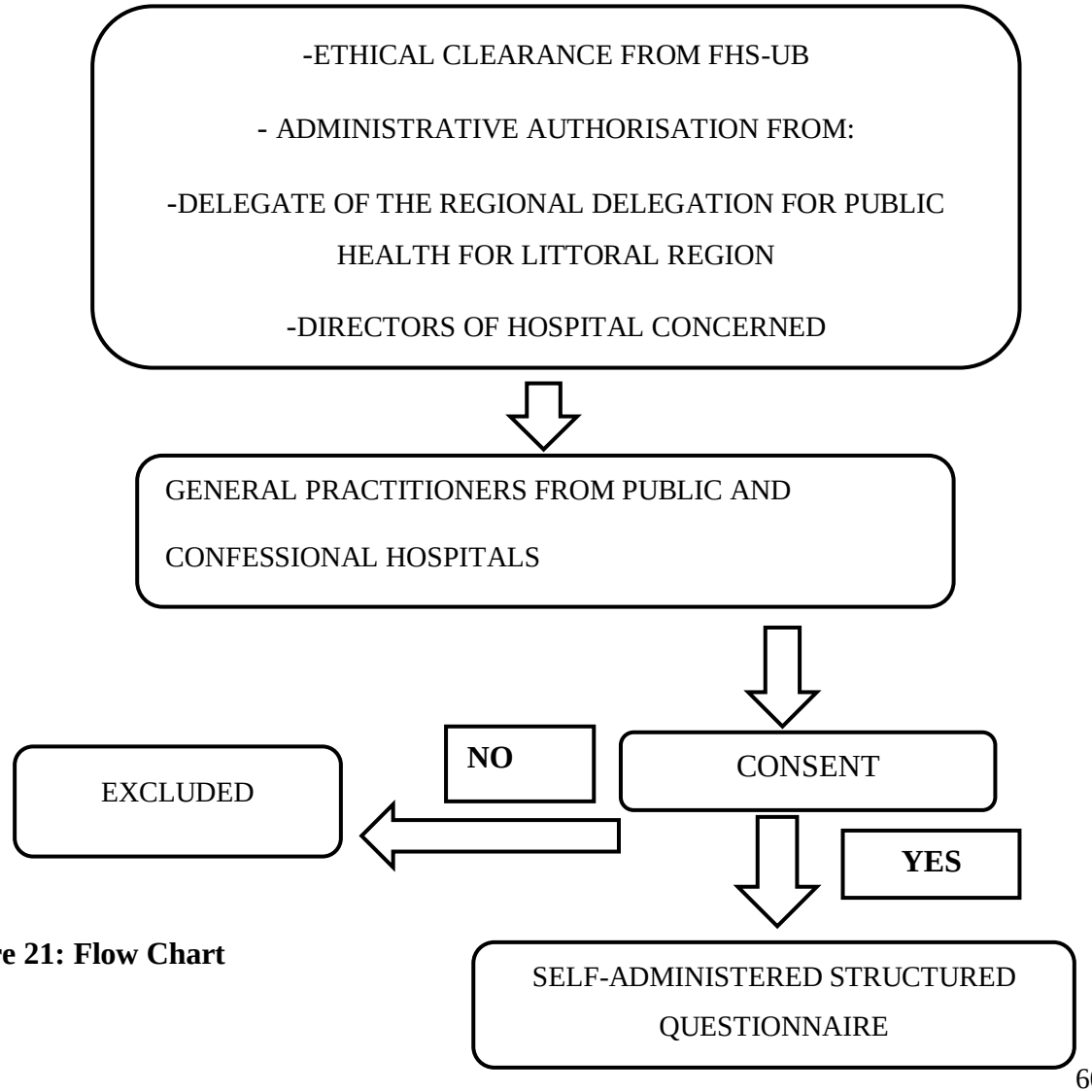

Figure 21: Flow Chart

3.7. STUDY PROCEDURE

3.7.1 Administrative procedure

Ethical approval was obtained from the institutional review board of the faculty of health sciences university of Buea (IRB-FHS UB). An authorization to carry out the research was obtained from the Dean of FHS-UB; from the Delegate of the Regional delegation of public health for the littoral region. Assessment and localization of the different hospitals' concerns were done. Authorization was obtained from the directors in the respective hospitals concerned.

3.7.2. Data collection

The structured self-administered KAP questionnaire was developed using information from published literature on DR/DM, including publication on guideline by international society of ophthalmology. Made in both English and French sections and it was mainly composed of closed ended questions. It contained four sections. After obtaining consent from the general practitioners. All GPs were instructed to answer without consulting any document or internet or colleagues. The questionnaire was distributed personally by the researcher to the GPs. They were asked to provide demographic and socio professional information's including sex, age, professional experience, service sectors, and the average number of diabetic patients seen yearly. By choosing the letter corresponding to the correct response, the level of knowledge on risk factors, signs, diagnosis, and treatment of DR/DM were provided by the general physicians. They were also asked to provide their level of attitudes toward screening of DR/DM by choosing the correct response or by choosing (yes or No) on the questions. Their practice and the factors affecting the KAP on DR/DM were provided by the questions toward screening of the signs of DR/DM on ophthalmoscope using a categorical scale (Yes or NO and had identified or never identified). The questionnaire was pretested with four GPs who are not working in the study area and adjustments were made.

3.8. ETHICAL CONSIDERATION

This study was commenced after ethical approval and administrative clearance were issued. The study was described to all eligible participants. Participants were given opportunities to ask questions. Participants who consent to this study were just given the anonymous self-administered questionnaire to be filled. The questionnaire was filled in the presence of the researcher. Participants were not informed on how the questionnaires were corrected. They were notified of their right to quit the study at any time and also that no compensation was to be given or received from the participants' Information obtained were used only for scientific purpose.

3.9. DATA MANAGEMENT

Confidentiality was ensured by coding all participants' information by not putting their names on the questionnaire. Questionnaires were kept in a safe place accessible only to the principal investigator.

3.10. DATA ANALYSIS

Data generated from the questionnaires were entered into an excel spreadsheet and analyzed with IBM SPSS (statistical package for social sciences) version 23.0 for windows. The predictor variables considered were: gender, age, professional experience, the service sectors, and the number of diabetics seen yearly. Categorical variables were analyzed using frequencies and percentages. The outcome variables were: knowledge (good and poor), attitude (good or poor), practice (good or bad), and factors affecting the KAP on DR/DM. Continuous variables were summarized using means, percentages, ranges and standard deviation. Where appropriate, dynamic cross tabulation, chi square and Fischer test statistics were used to assess the relationship between two categorical variables. Significant difference and association were determined by p-values set at <0.05.

Objective 1: it entailed assessing the current knowledge of the general practitioners (GPs) with a total of 10 questions which correspond to 10 points. Some questions may have multiple options containing multiple correct answers so, more than 50% of correct answer in a question was assigned to 1 point. Less than 50% of correct answer or wrong response was assigned to 0 point. And some questions have multiple answers with only one correct answer; a correct answer was assigned to 1 point and incorrect answer to 0 point. The total score was converted into a percentile, superior or equal to 50% correspond to good and less than 50% correspond poor level of knowledge. This is shown in the table below.

Table 9: global knowledge on DR/DM

Global knowledge	Scoring	Percentile score
Good	≥ 5 points	>50%
poor	<5 points	< 50%

Objective 2: it entailed assessing attitude and comprise 5 questions for 5 points. Each question had between 2 to 5 possible options while accepting only one answer. Correct response assigned to 1 point; wrong response or No assigned 0 points. So superior or equal to 3 points correspond to a good attitude and less than 3 points correspond to poor attitude.

Objective 3: it entailed assessing the practice of the GPs regarding DR/DM with a total of 11 questions which were equal to 11 points. Each question had between 2 to 6 possible options and only one answer was accepted. Each correct response corresponds to 1 point; wrong response or No or never identified assigned to 0 points. A score of superior or equal to 5 points assigned good practice and less than 5 points correspond to bad practice.

Objective 4: it entailed identifying factors influencing KAP of GPs on DR/DM. These factors were deductible from the question of the questionnaire.

CHAPTER FOUR:
RESULTS

4.1. SOCIO DEMOGRAPHIC CHARACTERISTICS OF STUDY PARTICIPANTS

4.1.1. Participation rate

Two hundred and twenty questionnaires were distributed, out of which 196 were received completely answers. Representing a response rate of 89.0%. Consequently, these included 159(81.1%) in public hospitals and 37(18.9%) in confessional hospitals.

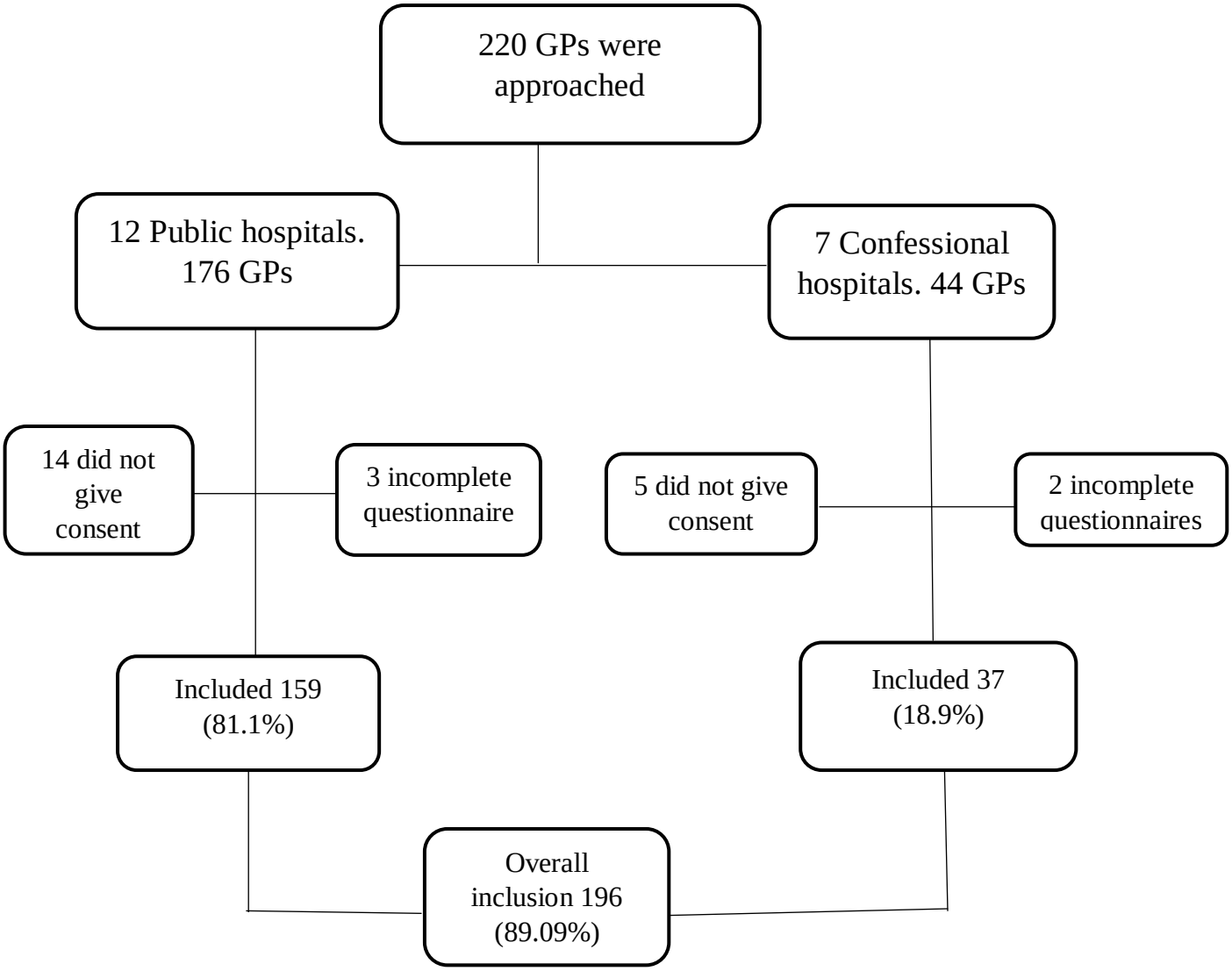

Figure 22: flow chart demonstrating derivation of GPs for the study

4.1.2 Age and sex ratio

The average age of the GPs was 28.57(SD±2.25) with age range of 24-36 years. We had 111 (56.6%) females, with a male to female ratio of 0.8:1.

4.1.3. Geographical distribution of GPs in Douala

Distribution of participants per sector services was as follows:

Reference hospitals 57(29.1%)

District hospitals 102(52.83%)

Confessional hospitals 37(18.9%)

Table 11: distribution of participants according to health facilities

Public hospitals	Frequency	Percent (%)
DGH	13	6.6
LDH	30	15.3
DMH	14	7.1
DH. BONASSAMA	15	7.6
DH. DEIDO	18	9.2
DH. JAPOMA	1	0.5
DH. LOGBABA	9	4.6
DH. NEWBELL	10	5.1
DH. NYLON	23	11.8
DH. CITE DES PALMIERS	11	5.6
Total	159	81.1
Confessional hospitals		

Protestant Hospital ATCHA Bepanda	4	2.04
Ad Lucem Hospital BALI	6	3.06
Ad Lucem Hospital Bonamoussadi	9	4.59
Protestant Hospital Becec	4	2.04
Protestant Hospital EMILISAKER	4	2.04
Hôpital des sœurs de Logpom	4	2.04
Padre pio hospital	6	3.09
TOTAL	37	18.9

4.1.4. Professional experience

Of the respondents, 189(96.4%) had less or equal to 5 years of experience as a GPs. 6(3.6%) had between 5 to 10 years' experience and 1(0.5%) had more than 10 years of experience as GPs.

4.1.5. Average diabetic patients yearly seen

172(87.2%) participants consulted more than 50 diabetic patients per year; 13(6.6%) respondents consulted 21-50 diabetic patients per year and 11(5.6%) consulted less than 20 diabetic patients per year.

The socio-demographic variables are summarized in the tables below.

Table 10: socio-demographic characteristics of the study population

	Frequency (%)	Percent (%)
Gender		
F	111	56.6
M	85	43.4
Total	196	100.0
Age group		
< 28 years	69	35.2
28 – 32 years	116	59.2
> 32 years	11	5.6
Total	196	100.0
Sector services		

Confessional hospital	37	18.9
Public hospital	159	81.1
Total	196	100.0
Professional experience		
< 05 years	189	96.4
05 - 10 years	6	3.1
> 10 years	1	0.5
Total	196	100.0
Type of hospitals		
Reference hospitals	57	29.1
Confessional hospitals	37	18.9
District hospitals	102	52.0
Total	196	100
Average number of diabetic consultation per year		
≤ 20	11	5.8
21-50	13	6.8
>50	172	87.4
Total	196	100

4.2 Knowledge of general practitioners on diabetic retinopathy and maculopathy

4.2.1 Global knowledge of GPs on DR/DM

The overall knowledge level of GPs on DR/DM was good 141(71.9). The mean knowledge was 7.44 with SD±1.5.

Table 11: knowledge on DR/DM

Question	Answer	Score	Frequency	Percent (%)
7- Knowledge of signs of Diabetic retinopathy	< 50%	0 point	70	35.7
	≥ 50%	1 point	126	64.3
	TOTAL		196	100.0
8- Knowledge of signs of Diabetic Macular edema	< 50%	0 point	129	65.8
	≥ 50%	1 point	67	34.2

	TOTAL		196	100.0
9-Knowledge on time needed to refer a type 1 diabetic patient to an ophthalmologist.	Wrong answer	0 point	194	99.0
	Right answer(s)	1 point	2	1.0
	TOTAL		196	100.0
10- Knowledge of time needed to refer a type 2 diabetic patient to an ophthalmologist.	Wrong answer	0 point	36	18.4
	Right answer	1 point	160	81.6
	TOTAL		196	100.0
11- Knowledge on monitoring of diabetic patient.	< 50%	0 point	0	0
	≥ 50%	1 point	196	100.0
	TOTAL		196	100.0
12- Knowledge on early diagnosis test of Diabetic retinopathy.	Wrong answer	0 point	31	15.8
	Right answer	1 point	165	84.2
	TOTAL		196	100.0
13- Knowledge on early diagnosis test of Diabetic macular Edema.	Wrong answer	0 point	56	28.6
	Right answer	1 point	140	71.4
	TOTAL		196	100.0
14-Knowledge on management of diabetic retinopathy	< 50%	0 point	146	74.5
	≥ 50%	1 point	50	25.5
	TOTAL		196	100.0
15- Knowledge of management of diabetic maculopathy	< 50%	0 point	166	84.7
	≥ 50%	1 point	30	15.3
	TOTAL		196	100.0
16-Knowledge of complication of proliferative diabetic retinopathy	< 50%	0 point	60	30.6
	≥ 50%	1 point	136	69.4
	TOTAL		196	100.0

Table 12: global knowledge

		Frequency	Percent (%)
Good	**>5**	141	71.9
poor	**<5**	55	28.1
	Total	196	100.0

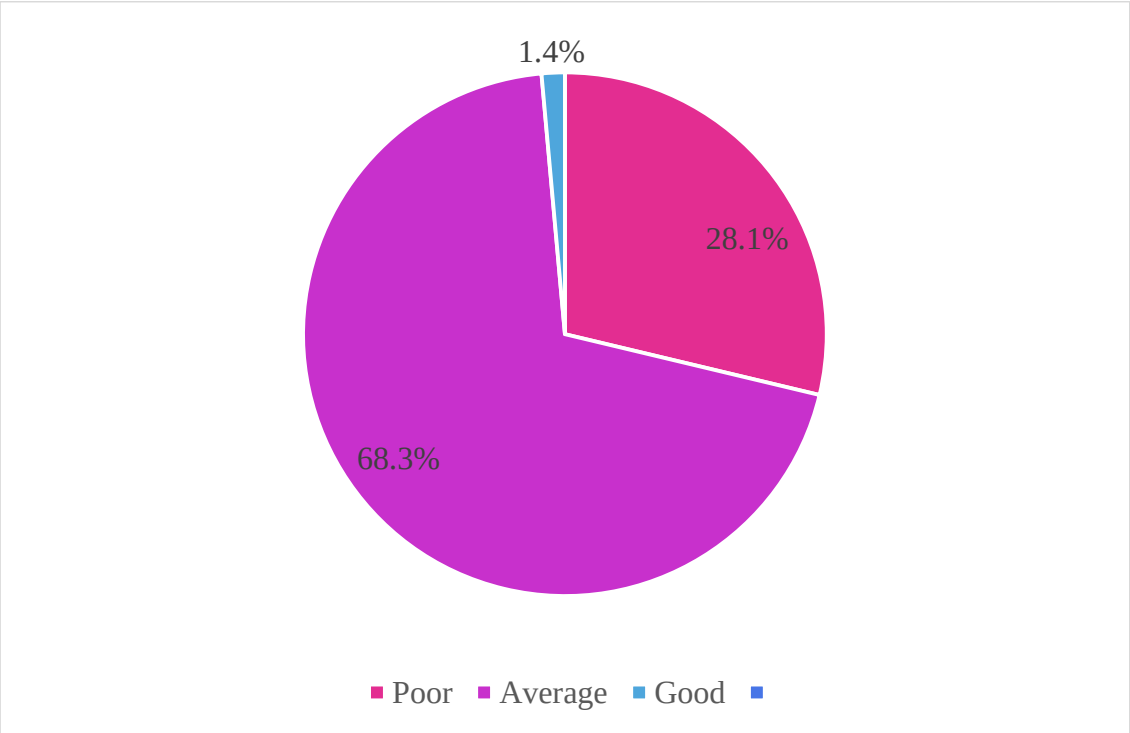

Figure 23: distribution of Global Knowledge on DR/DM

Sources of updating knowledge

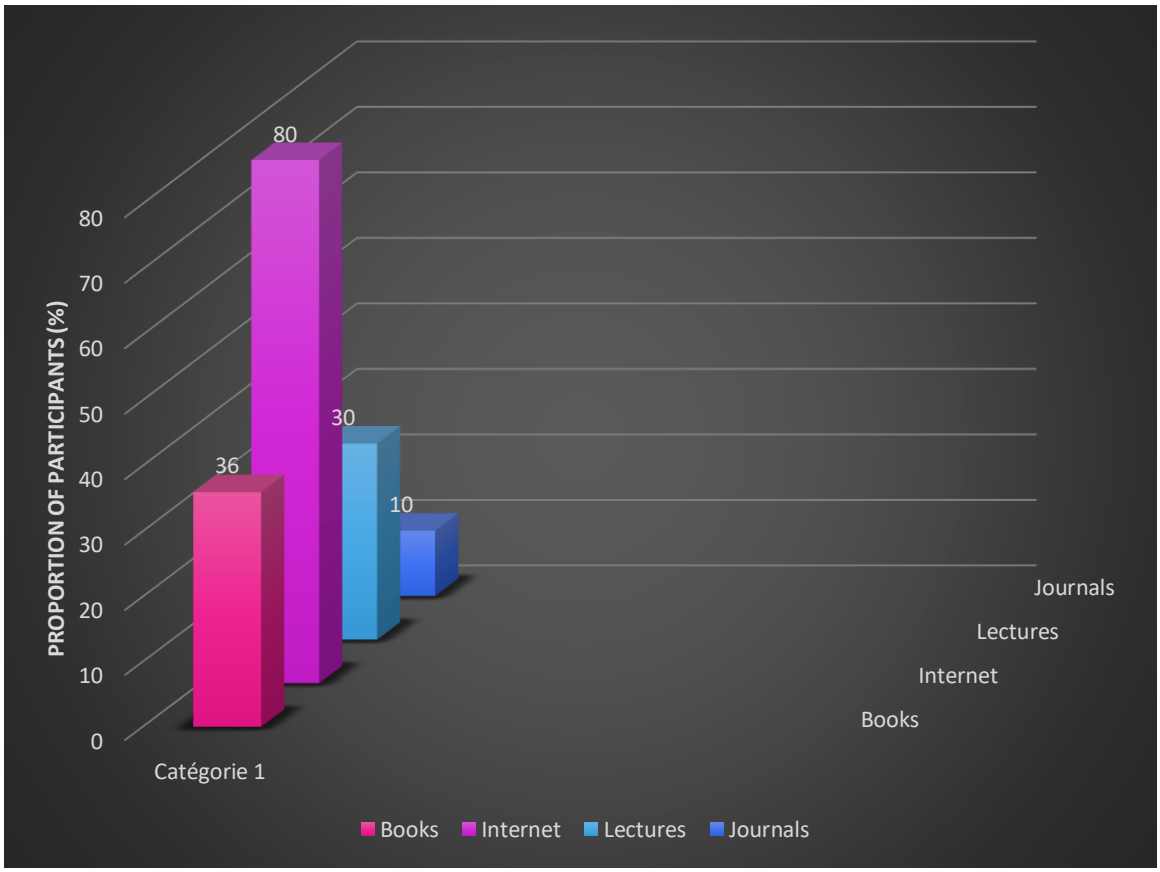

Figure 24: source of knowledge of GP on DR/DM

4.2.2 Determinant of good knowledge on DR/DM

Good knowledge of DR/DM has no significantly association with sociodemographic characteristics. This is shown in the table below.

Table 13: Association between knowledge and sociodemographic characteristics

		Poor Knowledge	OR [95% CI]	P-value
Gender	**Female**	31(27.9)	1.125 [0.601 – 2.106]	0.713
	Male	25(29.4)		
Age group	**< 28 year**	22(31.9)	1.333 [0.701 – 2.537]	0.380
	28 – 32 year	30(25.9)	0.692 [0.369 – 1.298]	0.251
	> 32 year	4(36.4)	1.501 [0.422 – 5.347]	0.528
Service sector	**Public**	44(30.3)	1.370 [0.655 – 2.868]	0.402
	Confessional	12(23.5)		
Professional	**< 05 year**	54(28.6)	0.974 [0.183 – 5.177]	1.000
experience	**5 – 10 year**	2(33.3)	1.292 [0.230 – 7.267]	0.674
	> 10 year	0(0)	0.718 [0.675 – 0.784]	0.945
Type of	**Reference**	20(37.1)	1.431 [0.733 – 2.792]	0.293
hospitals	**hospitals**			
	Confessional	6(16.2)	0.434 [0.170 – 1.109]	0.075
	hospitals			
	District hospitals	30(29.4)	1.150 [0.615 – 2.149]	0.661
Average number of diabetic patients consulted per year	**≤ 20**	3(27.3)	0.959 [0.245 – 3.756]	0.952
	21-50	2(15.4)	0.446 [0.096 – 2.081]	0.359
	> 50	51(29.7)	1.557 [0.551 – 4.400]	0.475

4.3 ATTITUDE OF GPs ON DR/DM

4.3.1 Global attitude toward DR/DM

In this study 156 (79.6%) GPs had a poor attitude towards DR/DM. These are shown in the table and figures below.

Table 14: Global attitude towards DR/DM

	Score	Frequency	Percent
Poor attitude	< 3 points	156	79.6
Good attitude	≥ 3 points	40	20.4
Total		196	100.0

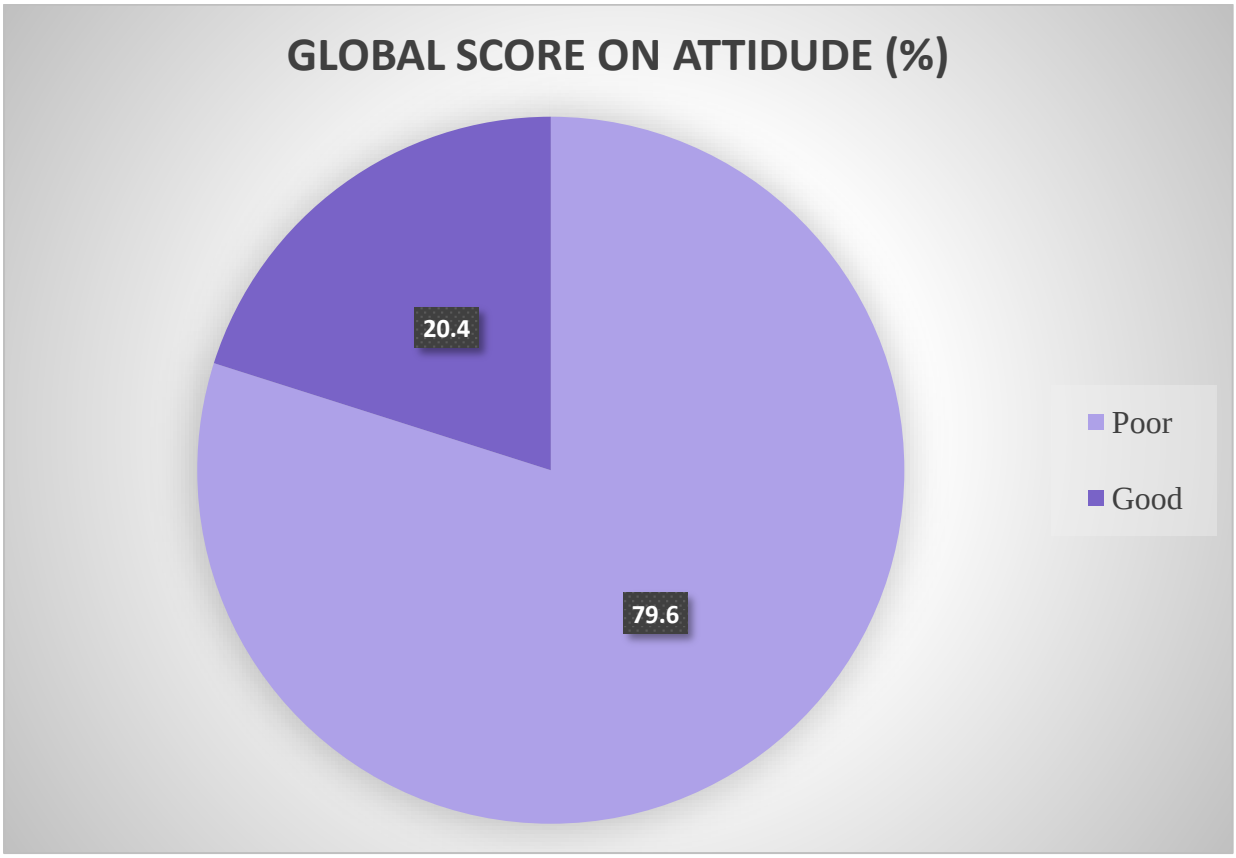

Figure 25: distribution of the attitude level

Table 15: Attitudes concerning DR/DM

			Frequency (%)	Percent (%)
19-Do you perform Fundoscopy on all diabetic patients.		**Score**		
	No	0 point	196	100.0
	Yes	1 point	0	0.0
	Total		196	100.0
20-Do you systematically ask for fundoscopy on any patient with diabetes				
	No	0 point	191	97.4
	Yes	1 point	5	2.6
	Total		196	100.0
21- Once the diagnosis of DR/DM is made, what's next?				
	Wrong answer	0 point	159	81.1
	Good answer	1 point	37	18.9
	Total		196	100.0
22- Once the diagnosis of DR is made, when do you do the control?				
	Wrong answer	0 point	156	79.6
	Good answer	1 point	40	20.4
	Total		196	100.0
23- Once the diagnosis of DM is made, when do you do the control?				
	Wrong answer	0 point	87	44.4
	Good answer	1 point	109	55.6
	Total		196	100.0

- **All the participants agreed that the ophthalmologic training in the medical school was not enough to detect patients with retinopathy and maculopathy**

4.3.2 Association between attitude and socio demographic characteristics

There was a statistically significant association between attitude and age group **[p=0.004]** and professional experience **[p=0.000].** This is shown in the table below.

Table 16: Association between attitude and socio demographic characteristics

		Attitude			
		Good	**Poor**	**OR [95% CI]**	**P-value**
Gender	**Female**	23(20.7)	88(79.3)	0.957 [0.474 - 1.931]	0.901
	Male	17(20.0)	68(80.0)		
Age group	**< 28 years**	18(26.1)	51(73.9)	1.684 [0.831 – 3.416]	0.146
	28 – 32 years	16(13.8)	100(86.2)	0.373 [0.183 – 0.761]	**0.006**
	> 32 years	6(54.5)	5(45.5)	5.329 [1.536 – 18.486]	**0.004**
Service sector	**Public**	27(18.6)	118(81.4)	0.669 [0.314 – 1.424]	0.295
	Confessional	13(25.5)	38(74.5)		
Professional experience	**< 05 year**	34(18.0)	155(82.0)	0.037 [0.004 - 0.314]	**0.000**
	5– 10 year	1(16.7)	5(83.3)	22.143 [2.508-195.518]	**0.000**
	> 10 year	1(100.0)	0(0.0)	Not applicable	0.048
Type of hospitals	**Reference hospital**	1(2)	54(98)	1.226 [0.580 – 2.589]	0.594
	Confessional hospital	0(0)	37(100)	2.248 [1.200 – 5.845]	**0.016**
	District hospital	1(1)	102(99)	0.416 [0.202 – 0.857]	**0.014**
Average number of diabetic patients consulted per year	**≤ 20**	5(45.5)	6(54.5)	3.571 [1.031 – 12.373]	**0.034**
	21-50	5(38.5)	8(61.5)	2.643 [0.815 – 8.571]	0.095
	< 50	30 (17.4)	142(82.6)	0.296 [0.120 – 0.729]	**0.006**

4.3.3 Association between knowledge, attitude

There was no statistically significant association between knowledge and attitudes. This is show in the table below

Table 17: association between knowledge and attitude

		Score on attitude		Total	Chi ^{2}	P-value
		Poor (%)	**Good (%)**			
Score on knowledge	**Poor**	46(82.1)	10(17.9)	56		
	Average	104(78.2)	29(21.8)	133	0.546	0.761
	Good	6 (85.7)	1 (14.3)	7		
	Total	156	40	196		

4.4.PRACTICES OF GENERAL PRACTITIONERS ON DR/DM

The global score on practices of GPs was 100% poor about DR/DM. It is show in the table below.

Table 18: Global score of Practice on DR/DM

	Frequency	**Percent (%)**
Good Practice	00	00
Bad Practice	195	100
Total	195	100,0

Table 19: Practices concerning DR/DM

		Frequency	Percent (%)
25- Do you have an ophthalmoscope?	**Score**		
Yes	**1**	0	0.0
No	**0**	196	100.0
Total		196	100.0
26- Do you realize fundoscopy of diabetic patient with pupil dilation?			
Yes	**1 point**	0	0.0
No	**0 point**	196	100.0
Total		196	100.0
28- Which drugs do you use for pupil dilatation?			
Wrong answer	**0 point**	196	100.0
Right answer	**1 point**	0	0.0
Total		196	100.0
29- Have you ever diagnosed DR using an ophthalmoscope?			
Yes	**1 point**	0	0.0
No	**0 point**	196	100.0
Total		196	100.0
30-Have you ever diagnosed DME using an ophthalmoscope?			
Yes	**1 point**	0	0.0
No	**0 point**	196	100.0
Total		196	100.0

31- About micro-aneurysm of DR, have you ever diagnosed it?				
	Yes	**1 point**	0	0.0
	Never	**0 point**	196	100.0
	Total		196	100.0
32- About retinal hemorrhage of DR, have you ever diagnosed it				
	Yes	**1 point**	0	0.0
	Never	**0 point**	196	100.0
	Total		196	100.0
33- About dry exudates of DR, have you ever diagnosed it				
	Yes	**1 point**	0	0.0
	Never	**0 point**	196	100.0
	Total		196	100.0
34-Regarding cotton wool nodules of DR, have you ever diagnosed it				
	Yes	**1 point**	0	0.0
	Never	**0 point**	196	100.0
	Total		196	100.0
35- Regarding pre-retinal neo vascularization of DR, have you ever diagnosed it				
	Yes	**1 point**	0	0.0
	Never	**0 point**	196	100.0
	Total		196	100.0
How many fundoscopy, have you ever done a year?				

	None	**0 point**	196	100.0
	≥ 1	**1 point**	0	0.0
	Total		196	100.0

CHAPTER FIVE: DISCUSSION, CONCLUSION, AND RECOMMENDATIONS

5.1 DISCUSSION

The participant in this study were recruited from 12 publics and 9 confessional hospitals in Douala. Our study was to: assess the knowledge level of general practitioners on DR/DM. To establish their attitude toward DR/DM. To evaluate their practices and to identify factors affecting their knowledge, attitude and practices towards DR/DM. The sample size was exhaustive.

5.1.1. Socio demographic characteristics

They were 220 general practitioners that were approached and 196 responded with a response rate of 89.09%. This was similar with study by Fatima et al in Sudan had response rate at 85.3% [54]. This is higher than study done by Mensah et al in Ghana with response rate of 70% [53]. And this was lower than study done by Niyonsavye et al Burundi had response rate at 94.2% [55]; and Abdulsalam et al Nigeria at 95.4% [56].

In our study ,there were more female (56.6%) than male (43.3%), with sex ratio of 1.23 male to one female. Several studies revealed similar results: by Oenga et al in Kenya had Sex ratio of 1:1 [57] . Niyonsavye et al Burundi had a sex ratio of 4.8: 1 [55] . Mensah et al had a sex ratio of 2.1:1 [53] A possible explanation is that most female doctor are married and are living their husband and also there are more female than men in medicine school.

The mean age of the present study group was 28.57 years ±2.25(range of 24 to 36 years) which was in line with Oenga et al in Kenya, where the mean was reported to 27.8 years with a wider age range(22-48 years) [57]. And Fatima et al, Sudan , where the mean age was 27.7 ±8.0 years (range :20-36 years) [54].

The mean duration of practice for the study participants was less than 5 years with 96.4%; Therefore, the population was relatively young doctors. This could be due to the fact that general practitioners in public and confessional health facilities tend to be younger doctors who have recently graduated from medical school. So this result is similar with study by Abdulsalam et al , Nigeria where 76.2% have less 5 years[56]. Fatima et al ,Sudan, had the duration of practice more than 2 years at 62% [54]. In Burundi by Niyonsavye et al , where the mean duration was 2.4 years at 86% [55]. Oenga et al ,Kenya had mean duration of practice at 1 year in 96.7% [57].

5.1.2 Knowledge on DR/DM

We observed an overall moderate knowledge on DR/DM at 68.3% of general practitionners.

When asked about signs of diabetic retinopathy and maculopathy on fundus , 58% of the participants responded cotton wood, 68% mentioned spot hemorrhage and 37.2% mentioned preretinal new vessels and microaneurysm. This is higher compared to study done in Ghana, by Mensah et al where 63.7% , 42.9% and 36.3% participants responded respectively cotton woods, spot hemorrhage and new vessels [53]. And the study by Fatima et al ,Sudan found that 27% mentioned cotton woods, 42.2% said retinal hemorrhage , 34.7% mentioned new vessels an 2.2% said microaneurysm [54] .

Concerning the ideal method for the evaluation of diabetic retinopathy and maculopathy, 71.8 % mentioned direct fundoscopy after dilation , 3.1% mentioned fluorescein angiography and 12.8% have no idear of any method of evaluation in our study . This is in contrast with the study by Mahesh et al ,India where 75.86% said fluorescein angiography [58]. A possible explanantion is that fluorescein angiography is done in a diabetic centre directly which is not the same procedure in cameroon. The study by Khandekar et al in Oman(Saoudi Arabia) in regard to the evaluaton method for DR/DME ,only few 23% gave a positive reply

by choosing dilated fundoscopy which is now considered as the best mehod for the diagnosis of DR/DM and this is suggested by AAO guideline [59,63,64,65].

This results show that participants have good knowledge regarding the factors affecting the presence or severity of the DR/DM 196(100%) mentioned poor glycemic control, hypertension, lipide profile and renal disease as factors influencing the presence or severity of DR/DM this results are similar to others study. A study done by Oenga et al, in Kenya found that participants were aware that glycemia control (95.6%),hypertension (84.6%) ,duration of diabetes(89.0%),and renal disease 4.4% [57]. In the study done by Mensah et al in Ghana found that glycemic control (86.8%),hypertension (46.2%), duration of diabetes 28.6% [53]. In another study by Mahesh et al ,in india,100% of physicians recruited in the study agreed that hypertension and renal disease can influence DR , 93.1% and 68.97% were of the opinion that the duration of diabetes and pregnancy respectively can affect DR, 93.1% agree that serum lipid profile is related to the severity of diabetic maculopathy [58].

The American Academy of ophthalmology recommends that severe vision loss from DR/DM is preventable if the disease is detected early and treated timely.they recommend that type 1 diabetes be screened within the first 5 years of diagnosis and type 2 diabetics screening for DR/DM be done immediately upon diagnosis [59] In our study 60,5% refer to ophthalmologist for fundoscopy immediately after diagnosis of type 1 diabetes,when patient complain of eye problems 15.4%, after 1 year 10.8% , after 5 years 1%, and 26% don't know when to refer a type 1 diabetes. For type 2 diabetes 82.1% refer immediately and 13.8% if complain eye problems.This is similar to study by Oenga et al.kenya,where GPs were aware that diabetes patients require eye examination upon diagnosis but could differenciate where this is applies in regard to types of diabetes [57]. However majority of participants in our study refer immediately after diagnosis of type 1 diabetes ; this finding give hope in reducing the prevalence of sight loss due DR because duration of diabetes mellitus is is usually

uncertain.Futhermore education have to emphasize on those who refer when patients complain of eye problem because it may be late to catch up the vision.

Knowledge about the treatment of DR/DM, 74.9% participants were not aware of any treatment modalities, which is in line with Oenga et al ,in Kenya where 67% were not aware of treatment modalities [57]. This may influence the general the general practitionners because they may not see the need to screen or refer diabetic patients. Regarding the treatment modalities in our study found that ,16.9% said laser photocogulation,4.6% intravitreal injection of corticoid,0.5% for intravitreal anti VEGF and vitrectomy and 15.4 said all the above modalities are useful in the treatment of DR/DM . This results is similar and lower than Study by Oenga et al which found out that 47.3% laser photocoagulopathy and 11% surgery [57]. Other study by Mensah et al found out that 78% said DR is treatable ,55% laser photocoagulation,while 12.1% and 27.5% mentioned surgical and medical modality respectively as the forms of treatment of DR [53].Yet another study Mahesh et al. found that 75.86% participants believed that laser treatment is curative for DR and 62.07% said surgical treatment was available for advanced DR [58].

In regard to complication of DR/DM ,52% said intravitreal hemorrhage, 58.2% said retinal detachment and 14% neovascular glaucoma.In the study by Oenga et al 65.9% said vitreous hemorrhage and retinal detachment 52.7% [57]. In other study by Muecke et al in Burma(Birmania) also found lack of awareness among Yangon physicians on the serious ophthalmic complications of DR such as vitreous hemorrhage (43%) and retinal detachment (44%)[60].

The knowledge gap thus established in our study may need to be addressed through educational programs to educated GPs on DR/DM and its blinding complications. Emphasis on blinding complications of diabetes complications of diabetes mellitus ; need for screening and referral for DR/DM. In the medical school there is need to emphases on education and training on eye examination that may also bridge this gap and prevent this cause of avoidable blindness.

5.1.3 Attitude toward DR/DM

Generally, participants in our study have poor attitude at 80%.This is in contract with study by oenga et al where GPs had a good attitude.The American Academy of ophthalmology recommend that check up screening of DR/DM after DR diagnosis is made is respectively each year for DR and 1 to 3 months for DM depending if it is central or peripheric. In our study 50.25% mentioned check up yearly for DR and 47.74% don't knows. 28% mentioned that check up is done every 1 to 3 months and the rest don't know. In study by Oenga et al found that less than half ,37.4% of the general practitioners assessed vision of their diabetes yearly. Majority of GPs never assessed vision at 26.4%[53]. Study by Mensah et al found 18.7% tested their patients after 6 months[58] .This demonstrate that there is a need for a GPs to update their knowledge toward recommendation.

In this study ,most participants 100% agreed that ophthalmology training in medical school was not enough to detect patients with DR/DM. In study by Mensah et al found out that 52.8% disagree with the statement that ophthalmology training in medical school was enough to detect patients with diabetic retinopathy and maculopathy[53] . This indicate that there is a need to emphasize on ophthalmology course in our medical school.All the participants of the study agreed that there is doing fundoscopy to their diabetic patient themselses and majority agreed that they do not ask for systematically fundoscopy to all their diabetic patients.The poor attitude in our study may also be explain by the average knowledge in regard to DR/DM..

There is a statistically significant association between age and professional experience p=0.004 ; p=0.000 respectively .A possible explanation could be that concerning attitude more you are old and have old professional experience ,the more the ability to deal with DR/DM as complication .

5.1.4 Practices toward DR/DM

In term of practice of testing the vision ,100% of participants don't have ophalmoscope .This is similar to the others study where majority of GPs had poor practices. Study by Oenga et al found that GPs had poor practice of fundus examination , 51.6% never did a fundus examination of their diabetic patients [57]. Study by Mensah et al found that 17.6% of participants practice do test vision of their diabetic patients, an out of them 11% could appreciate the retina on details. 50% participants performe fundoscopy without dilating the eye . only 33% don't have access to ophthalmoscope [53] . All the participants of our study agreed that there is not aphthalmoscope in their workplace.

Study by Rajiv et al in Oman(Saoudi arabia) found that fundoscopy performed with opthalmoscope was done by 2 (2/159) of general practitionners [64] . Of the two, one GPs performed with dilatation while the other performed it without dilation ,the raison stated for not dilating is lack of time [64]. This result may be explain by lack of ophthalmoscope at workplace ,even if at 5^{th} years in some of medical school ,teacher always recommend to have an ophthalmoscope in our context.

This study revealed that despite the effort of some teacher, the ophthalmology is still a highly specialized area in our perception.

5.1.5. Factors affecting the practices of GPs

This study also sought to establish the factors that hinder the practice of GPs in screening of DR/DM.

Limited knowledge toward DR/DM, lack of equipment such as ophthalmoscopes and vision charts were the most common factors that the GPs felt hindered them from performing

eyes examination.This was indicated at 100% of the study participant which is different from study by Oenga et al. found out 73.6% [53].

100% GPs think they lack the skill to perform fundoscopy appropriately to detect sign of DR/DM. 20% have the same impression in the study by Oenga et al [53].

Others factors include inadequate training in the medical school, limited financials mean of patients to pay for specialist consultation.this is compared with the study by Muecke et al in Myanmar did not assess for factor affecting practice but postulated that lack of equipment, lack of time, patient not cooperating etc [60].

5.2 STUDY LIMITATIONS AND STRENGTHS

5.2.1 Study limitations

Our study has some limitations and strengths that need to be taken into accounts when interpreting these results.

1- This study was conducted in public and confessional hospitals in Douala, so the GPs in other towns and from private clinics could not participate in the study due to the method procedure used.

2- Non-response bias. To reduce non-response bias we remind to the respondents, informing them that the questionnaire was completely anonymous and they were filling the questionnaire in presence of the investigators.

3- Some hospitals were asking for payment of ethical clearance, so there were excluded from our study due to limited financial means.

4-This study is the first study assessing knowledge, attitude and practice of general practitioners towards diabetic retinopathy and maculopathy in Cameroon. Hence there will be limited local data for comparisons.

5.2.2 Strength

This is the first study on knowledge, attitude, and practices on diabetic retinopathy and maculopathy among general practitioners in Cameroon. It was a multicenter study including public and confessional hospitals.

5.3 CONCLUSION

In summary, our study does not constitute a representative sample size in Cameroon. However, it gives a general picture of the awareness, attitude and practices of GPs in regard to DR/DM. The study establishes that majority of GPs had good knowledge, despite some gaps such as lack of knowledge on time for the first eye examination to be done, complications, and treatment options for DR/DM.

The attitude of general practitioners in the study toward DR/DM was poor. So the moderate knowledge and poor attitude level imply their poor practice of DR/DM. As factors affecting their knowledge, attitude, and practices of DR/DM are; inadequate Ophthalmologic training (100% agreed). Lack of an ophthalmoscope at their workplace (100% agreed). There is a need to carry out a large-scale awareness program, national guideline and training of GPs who are susceptible to manage diabetic patients.

5.4 RECOMMENDATION

To the minister of public health of Cameroon

To establish continuous medical training programs of GPs on DR/DM at health facilities, regular skills update workshops and provision of basic equipment such as vision chart and ophthalmoscope at their workplace.

To create awareness among people via mass media, mail education regarding DR/DM in order to reduce the blindness impact of diabetes.

To the minister of higher education of Cameroon

The minister should ensure that there is an ophthalmologist lecturer in every medical school in Cameroon and communicate on the training of medical students in getting more hands-on training of eye examination during clinical rotation.

To the general practitioners of Cameroon.

The general practitioners must systematically ask for eye checkup of all their diabetic patients regardless the time of diagnosis of diabetes mellitus and to counsel all diabetic patients on blindness related to diabetes mellitus.

To update continuously their knowledge about DR/DM by using books, journals, seminars and internet

To the medical students

Effective attendance to ophthalmologic courses during training in school and Get more hand-on training of eye examination (fundoscopy) during clinical rotation.

To researchers

Further studies need to be conducted in the future to determine if the level of the knowledge, attitude, and practice of GPs has increased after applying the aforementioned recommendations.

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APPENDICES

APPENDIX I: PARTICIPANT INFORMATION SHEET

Title of the study: KNOWLEDGE, ATTITUDE, AND PRACTICES OF GENERAL PRACTITIONERS ABOUT DIABETICS RETINOPATHY AND MACULOPATHY IN PUBLIC AND CONFESSIONAL HOSPITALS IN DOUALA.

Introduction

My name is **Bibouth Balog Jacques**, I am a 7th (final) year medical student at the Faculty of Health Sciences of the University of Buea and I am the main investigator of this study. My contact address is **+237697597014**, Email:**aimezbibajak45@gmail.com**

Supervisor: Assoc. prof Koki Godefroy

Co-supervisor: Dr Teuwafeu Denis

Purpose of the study

The study is designed to assess knowledge, attitude and practices of general practitioners on diabetic retinopathy and maculopathy in public and confessional hospitals in Douala.

Selection of participants

Individuals invited to participate in the study are those who meet the inclusion criteria. Those who are ask to participate in the study are under no obligation to do so.

Procedure

If you are volunteer to participate in the study, you will be asked to fill a questionnaire.

Potential risk and discomforts

We acknowledge the fact that the time spent in filling and gathering this information could be a bother to the general practitioners. However, there are no associated health risk related to the study.

Potential benefit to participants or society

The results obtained would help in the identification of knowledge gaps in DR/DM as well as improve care of diabetic patients and limited preventable blindness related to these diabetic complications

Payment of participants

The study would be conducted at no cost to you and no payment shall be made to participant.

Confidentiality

Absolute confidentiality shall be ensured at every cost. Questionnaires shall be anonymous and coded so that only members of the research team can interpret any data. Data will be used or scientific purposes.

Participation and withdrawal

You can choose to be a part of this study or not. You are free to withdraw from the study at any point in time with no consequences of any sort.

Rights of the research participant

You may withdraw your consent and discontinue participation at any time without penalty.

You have the right to participate in another research simultaneously.

Consent form

Declaration.

I……accept that I have read and understood the above explanation given to me by ……. I have had all my question concerning this study answered satisfactorily and I am aware I can withdraw from the study at any time. I am willing to participate in this study voluntarily.

Sign…….

Date……

(Participant)

Sign……

Date…….

(investigator)

APPENDIX II: DATA COLLECTION SHEET

Study objective:

Knowledge, attitude and practices of general practitioners on diabetics' retinopathy and maculopathy in public and confessional hospitals in Douala.

Information to the respondent:

Diabetic retinopathy and maculopathy are microvascular complication of diabetes mellitus. According to WHO, it is responsible for 4.8% of the 37 million cases of blindness worldwide.

Diabetic patients are primarily managed by general physicians. It is thus imperative they are knowledgeable about microvascular complications of diabetes mellitus affecting the eyes. This will improve their ability to detect DR/DM early for an early management in order to prevent blindness related . They should also have examination skills to be able to detect abnormalities in the eyes as consequence of diabetes mellitus.

DR/DM are diagnosed by performing a retinal examination and early treatment would depend on an early referral to eye care personnel. There is however no data on knowledge, attitude and practices of general practitioners; who are important part of the primary care givers of diabetics, in Cameroon, concerning DR/DM.

This cross sectional and analytic study seeks to assess the knowledge, attitude and practices of GPs on DR/DM. This study is conducted in public and confessional hospitals in Douala. This is an anonymous survey to assess the knowledge, attitude and practices of general practitioners on diabetic's retinopathy and maculopathy in public and confessional hospitals in Douala

<u>SECTION I</u>: DEMOGRAPHIC AND SOCIO-PROFESSIONAL ASPECTS

1) Gender:

a) Male [ ]

b) Female [ ]

2) Your age ……

3) Your experience as a Doctor:

a) <5 years

b) 5-10 years

c) > 10 years

4) You are in:

a) the public sector

b) the denominational private sector | _ |

5) If You work in the public sector, in what type of health facility:

a) a referral hospital

d) a district hospital

6) How many diabetic patients do you see per year on average?

a) ≤ 20
b) 21-50
c) > 50

<u>SECTION II</u>: KNOWLEDGE ABOUT THE DIAGNOSIS OF RETINOPATHY DIABETIC AND DIABETIC MACULOPATHY

7) What are the signs for you of diabetic retinopathy?

a) micro aneurysm
b) flame-shaped hemorrhage
c) spot hemorrhage
d) cottony nodules intraretinal microvascular anomaly
e) dry exudates
f) pre-retinal neo vessels
g) all
h) None
i) I don't know

8) What are the signs for you of diabetic maculopathy?

a) micro aneurysm
b) flaming hemorrhages spot hemorrhage
c) cottony nodules intra-retinal

d) microvascular anomaly
e) dry exudates
f) Pre-retinal neo vessels
g) All
h) none
i) I don't know

9) After how long of suffering from diabetes, do you find it useful to refer the Type I diabetic patient to the ophthalmologist?

a) Immediately after diagnosis of diabetes
b) 1 year after diagnosis
c) 5 years after diagnosis
d) if he complains of eye problems
e) never refers
f) I don't know

10) After how long of suffering from diabetes do you find it useful to refer the Type II diabetic patient to the ophthalmologist?

a) Immediately after diagnosis of diabetes
b) 1 year after diagnosis
c) 3 years after diagnosis
d) 5 years after diagnosis
e) 10 years after diagnosis
f) 15 years after diagnosis
g) In the event of visual disturbance
h) I never refer
i) I don't know

11) What assessment do you ask for when monitoring the diabetic patient that can aggravate the severity of DR/DM?

a) Fasting glycaemia
b) Glycated hemoglobin
c) Lipid balance
d) Measurement of arterial pressure
e) Renal function
f) Background

12) According to you, what is the first eye exam to order for the diagnosis of diabetic retinopathy?

a) Fundoscopy after eyes dilation
b) Fundus retinophotography
c) Fluorescein L retinal angiography
d) Optic coherence tomography

e) Automated visual field
f) I don't know

13) In your opinion, what is the first ophthalmologic examination to order for the diagnosis of diabetic maculpathy?

a) Fundoscopy after eyes dilation

b) Fundus retinophotography

c) Retinal fluorescein angiography

d) Optical coherence tomography

e) The visual field automates

f) I don't know

14) In your opinion, what treatments can be used for the management of diabetic retinopathy?

a) Retinal laser photocoagulation

b) Intra-vitreous injections of anti-vascular Endothelial Growth Factor

c) Vitrectomy

d) All

e) None

15) In your opinion, what treatments can be used for the management of diabetic maculopathy ?

a) Retinal laser photocoagulation

b) Intra-vitreous injection of corticosteroids

c) Intra-vitreous injection of anti-VEGF

d) Vitrectomy

e) All

f) None

16) The complications of proliferative diabetic retinopathy are:(several possible answers)

a) Intravitreal hemorrhage L

b) Retinal detachment

c) Neovascular glaucoma

d) Others Specify…….

17) Regarding your knowledge and your practice for the ophthalmologic in the follow-up of the diabetic patient:

a) I think I know enough and my practice is adequate

b) I think I should improve my knowledge and not my practice

c) I think I have to improve my practice and not my knowledge

d) I think I have to improve my practice and my knowledge

18) How do you do about updating your knowledge about the ophthalmologic complications of diabetes?

a) Scientific Journal
b) Books
c) Congresses, seminars
d) Internet
e) I don't know

<u>SECTION III</u>: ATTITUDES TOWARDS DIABETIC RETINOPATHY AND DIABETIC MACULOPATHY.

19) Do you do a fundoscopy to all your diabetic patients yourself?

a) Yes

b) No

20) Do you systematically ask all your diabetic patients for a fundoscopy?

a) Yes

b) No

21) Once the diagnosis of diabetic retinopathy or maculopathy has been established

a) You continue the diabetic follow-up of the patient and delegate the follow-up of the DR to an ophthalmologist

b) You delegate the follow-up of the 2 to the ophthalmologist

22) Once the diagnosis of diabetic retinopathy has been established:

a) You ask for an ophthalmological check-up at each patient's visit to your home

b) You ask for an ophthalmological check-up after 3 months

c) You ask for an ophthalmological check-up after 6 months

d) You request an ophthalmologic check-up after 1 year

e) you no longer ask for an ophthalmologic check-up

23) Once the diagnosis of maculopathy has been established:

a) You ask for an ophthalmologic check-up at each patient's visit to your home –

b) You ask for an ophthalmologic check-up after 1 month

c) You request an ophthalmological check-up after 3 months

d) You request an ophthalmological check-up after 6 months

e) You request an ophthalmological check-up after 1 year

f) You no longer request an ophthalmological check-up

24) The ophthalmology training in medical school was enough to detect patients with retinopathy and maculopathy diabetics

a) yes
b) No

<u>SECTION IV</u>: PRACTICES OF GENERALIST PHYSICIANS CONCERNING DIABETIC RETINOPATHY AND DIABETIC MACULOPATHY.

24) Do you have an ophthalmoscope?

c) yes
d) No

25) Do you perform eye fundoscopy with an ophthalmoscope in diabetic patients?

a) yes
b) No

If yes question 26

26) What eye drops do you use for dilation?

a) Mydriatic
b) Atropine
c) Cyclopentolate
d) Neosynephrine

27) Have you ever diagnosed diabetic retinopathy on fundoscopy with your ophthalmoscope?

a) Yes
b) No

28) Have you ever diagnosed diabetic maculopathy on the fundoscopy with of your ophthalmoscope?

a) Yes
b) No

29) Regarding the micro aneurysms of diabetic retinopathy,

a) I have already had to identify them

b) I have never identified them LI

30) Regarding retinal hemorrhages in diabetic retinopathy

a) I already had to identify them I

b) I never identified them

31) Regarding dry exudates

a) I already had to identify them -

b) I have never identified them

32) Regarding the cottony nodules

a) I have already had to identify them

b) I never identified them |

33) Regarding the pre-retinal neo vessels

a) I have already had to identify them

b) I have never identified them

34) How many eye fundoscopy do you do per year?

a) None
b) > 5