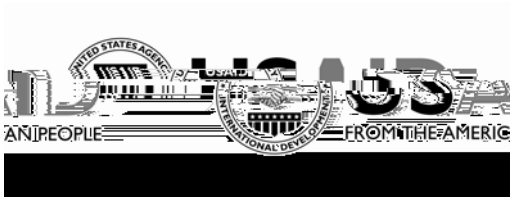
MODULE

Diabetes Mellitus



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Important Guidelines for Printing and Photocopying

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UNIT ONE

INTRODUCTION

1.1 Purpose and Use of the Module

This module is intended to serve as a general learning material for diabetes mellitus by the health center team: health officers, nurses, environmental health officers and medical laboratory technicians.

This module can also be used by other categories of health professionals. It should be kept in mind, though, that it is not a substitute for standard textbooks.

1.2 Directions for Using the Module

Before starting to read this module, please follow the instruction given below.

- Start with the pre-test before going through the core module.
- Use a separate sheet of paper to write your answers. The pretest contains to parts: Part One and Part Two.
    - Part one contains common questions to be attempted by all categories of the health center team.
    - o

UNIT TWO

CORE MODULE

2.1 Pre test

Answer the questions as appropriate on a separate answer sheet.

2.1.1 Pretest for all diploma level health professionals

Write true or false for questions 1-3 and give short answers for questions 4 through 8.

1. The prevalence of diabetes mellitus is declining in recent years due to improved management of cases.
2. Diabetes mellitus is a curable illness.
3. Diabetes mellitus is a disease of adults.
4. How is diabetes mellitus classified currently?
5. What are the laboratory tests that could be carried out to make a diagnosis of diabetes mellitus?
6. What are the acute metabolic complications of diabetes mellitus?
7. Compare and contrast type 1 and type 2 diabetes mellitus.
8. Mention the goals of long term treatment of patients with diabetes mellitus.

2.1.2 Pretest for Specific Categories

2.1.2.1 Nurses

Answer the following questions on the separate sheet

1. Which of the following is the best line for short acting insulin administration?
    A. Morning before meal
    B. Morning after meal
    C. At any time through a day
    D. Evening only
2. Which action would be inappropriate to include in diabetic teaching plan?
    A. changing position hourly to increase circulation
    B. inspect legs and feet's daily for any charge
    C. keep legs elevated on tow pillows

D. keep insulin not in use in the refrigerator

D. RBS>180ml/dl

7. The majority of calories of a diabetic patient should be obtained from
   A. Complex carbohydrate
   B. Simple carbohydrate
   C. Proteins
   D. Fats
   E. C&D
8. There is a positive association between type 2 DM and
   A. Hypotension
   B. Kidney dysfunction
   C. Obesity
   D. Sex
   E. None
9. The nurse should encourage exercise in diabetic patient because it
   A. decrease total triglyceride level
   B. Improves insulin utilization
   C. Lower, blood glucose
   D. Accomplish all of the above
   E. None

Part II Case study

10. Ato Kebede, a newly diagnosed IDDM patient is admitted in the medical ward. You further assessed him and found that patient has polyphagia polydypsia and wa.1024 Tw [(that p

2.1.2.2 Medical laboratory technologists

Instructions: choose the appropriate answer from the alternatives given for each question and write the answers on a separate sheet of paper.

1. Why is there a discrepancy between the whole blood glucose concentration and the plasma glucose concentration?
    A. Because there is a different distribution of Glucose in whole blood and plasma
    B. Because there is a high amount of water in plasma
    C. Because the cellular component in whole blood use glucose frequently
    D. None
2. One of the following methods of Glucose determination does use enzymatic reaction
    A. Folin- MU copper Reduction method
    B. Alkaline ferric cyanide method
    C. Hexokinase n.v. method
    D. Somogyi-Nelson method
3. Which of the following method is highly specific for glucose determination
    A. Alkaline ferric cyanide method
    B. Copper Reduction method
    C. Glucose oxidase method
    D. O-Toluidine method
4. When does glucose appear in the wine
    A. When the urine glucose level higher than blood glucose level
    B. When blood glucose level is between 60-11omg/de
    C. When the blood glucose level is greater than 180-200 mg/dl
    D. When a person is started
5. One of the following methods for urinary glucose determination is highly specific
    A. Copper reduction method
    B. O-Toluidine method

C. Reagent strip Tests

D. A and B

6. Sodium fluoride additive used in a specimen collected for Glucose

A. Inhibits glycol tic enzymes from destroying the glucose

B. Precipitates the protein present

C. Prevents non glucose reducing substances from interfering with the testing

D. None of the above

7. In a person with normal glucose metabolism, the blood glucose level usually increases rapidly after carbohydrates are ingested, but returns to a normal level after

A. 30 minute

B. 60 minute

C. 90 minute

D. 15 minute

8. Which of the following organs uses glucose from digested carbohydrates and stores it as glycogen for later use as a source of immediate energy by the muscles?

A. Kidneys

B. Liver

C. Pancreas

D. Thyroid

9. Which of the following samples good for Glucose determination

A. Serum/ plasma

B. Whole blood

C. Urine

D. All

10. To say the oral Glucose Tolerance test normal

A. The fasting blood sugar level should be 60-110mg/dl

B. The fasting blood sugar level should be higher than 110mg/dl

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E. none of the above

5. The main causative agent of DM is
   A. Bacteria
   B. Viruses
   C. Fungus
   D. Parasites
   E. none of the above

Subjective questions for Environmental Health technicians

1. How do you describe DM case prevalence with environmental health facilities and sanitation?
2. Do environmental health science and DM have direct or indirect relationships? What are they?

2.2 Significance and Brief Description of Diabetes Mellitus

Diabetes mellitus is a chronic illness that affects more than 170 million people world wide. It is an important cause of morbidity and mortality.

It is

- Responsible for many cases of ESRD
- An important cause of blindness
- A leading cause of non-traumatic lower limb amputations
- Closely related with cardiovascular disease which is
  - A major cause of diabetes related deaths
  - 2-4 times more common in patients with diabetes mellitus than in the general population
- Associated with an increased risk of cerebrovascular accidents
- Associated with reduced life expectancy by as much as 5-10 years in middle aged patients

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On further questioning it was found out that he lives in a one room thatched roofed house with his seven siblings and parents. There is no window in the house; the cattle are kept in the same room and firewood is burned in the same room.

The house is very badly lit with the only source of light being the day light coming through the door. He comes from a rural village 15Km far from the health center and had to be carried all the way to the health center by his relatives.

There is no family history of DM in the family.

Questions related to the case study

1. What are the diagnostic possibilities?
2. Were appropriate investigations requested by the health officer?
3. What is the first step to be taken in managing the above patient?
4. What management difficulties do you anticipate in managing this patient?

DEFINITION

Diabetes Mellitus is a clinical syndrome comprising a heterogeneous group of metabolic diseases that are characterized by chronic hyperglycemia and disturbances in carbohydrate, fat and protein metabolism secondary to defects in insulin secretion, insulin action or both.

CLASSIFICATION OF DIABETES MELLITUS

Based on the pathologic process considered to be responsible for hyperglycemia, diabetes mellitus can be classified into

- **Type 1 Diabetes Mellitus**

  Autoimmune destruction of the pancreatic islet β-cells with absolute loss of insulin secretion

  In few patients the pathogenesis remains idiopathic

- **Type 2 Diabetes Mellitus**

Is a heterogeneous group of disorders usually characterized by variable degrees of insulin resistance, impaired insulin secretion, β-cell dysfunction, dysregulated hepatic glucose production and increased intestinal glucose absorption.

- **Other specific subtypes of Diabetes Mellitus**
  - Genetic defects of β-cell function
  - Genetic defects of insulin action
  - Diseases of the exocrine pancreas
  - when the majority of pancreatic islets (80%) are destroyed
    - pancreatitis
    - pancreatectomy
  - Endocrinopathies
    - acromegaly
    - Cushing's disease
    - Pheochromocytoma
    - Glucagonoma
    - Etc
  - Drug or chemical induced
  - Infection
    - Congenital rubella
    - Cytomegalovirus
  - Etc
- **Gestational Diabetes Mellitus**

Is glucose intolerance that develops and first becomes recognized during pregnancy

- Insulin resistance related to the metabolic changes of late pregnancy increases insulin requirements and may lead to hyperglycemia or impaired glucose tolerance.

NB The terms insulin-dependent diabetes mellitus (IDDM) and noninsulin-dependent diabetes mellitus (NIDDM) are obsolete.

Epidemiology

The prevalence of diabetes mellitus has risen dramatically in the past two decades; it is also projected that the number of individuals with DM will continue to increase in the near future.

The prevalence of diabetes mellitus is reaching epidemic proportions, in large part because of obesity and sedentary life style in both adults and children

The incidence and prevalence of diabetes mellitus in the general Ethiopian population are unknown. A population based study done near Gondar on 2381 individuals using glycosuria screening with blood glucose confirmation showed glucose intolerance in only 0.5%. 86% of the study subjects were under 20 years of age, however, and the figure for those above 40 was found to be 2.4%.

CLINICAL FEATURES

Classical symptoms

- Thirst
- Polyuria
- Nocturia
- Rapid weight loss
- Increased susceptibility to infection in patients with uncontrolled diabetes
- Chronic fatigue and malaise

Signs

- Signs related to acute and chronic complications

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- Diabetic ketoacidois
- Nonketotic hyperosmolar state
- Hypoglycemia

- Chronic complications
  - Affect many organ systems
  - Are responsible for the majority of morbidity and mortality associated with the disease
  - Can be subdivided into vascular and non-vascular complications
  - Multiple pathogenic processes are involved in all forms of complications, 'and the divisions are rather arbitrary'
  - The vascular complications are further subdivided into
    - Microvascular complications that includes
      - Diabetic retinopathy
      - Diabetic nephropathy
      - Diabetic neuropathy
    - Macrovascular complications
      - Coronary artery disease
      - Peripheral vascular disease
      - Cerebrovascular disease
  - The non-vascular complications are
    - Gastroparesis
    - Sexual dysfunction
    - Skin changes

Laboratory Evaluation

Aims

- To determine degree of metabolic control
- Define associated complications

Extent of tests shall be individualized

Tests to be Carried Out

- Generally included are
- Fasting blood glucose (FBS)
- Random blood sugar (RBS)
- HbA1c
- Urinalysis
    - Ketones
    - Glycosuria
    - Protein
        - Serum lipid profile
        - Serum BUN and creatinine
        - Baseline electrocardiography

MANAGEMENT

LONG-TERM TREATMENT

OVERALL PRINCIPLES

The goals of therapy for type 1 or type 2 diabetes mellitus are to:

- eliminate symptoms related to hyperglycemia,
- reduce or eliminate the long-term microvascular and macrovascular complications of diabetes mellitus and
- allow the patient to achieve as normal a life-style as possible

The care of an individual with either type 1 or type 2 diabetes mellitus requires a multidisciplinary team.

Patient education, dietary management and exercise play a central role in managing diabetic patients in addition to pharmacologic therapy.

Patient Education

- It should be viewed as a continuing process with regular visits for reinforcement and not just a one time affair.
- educates the patient about a number of issues important for optimal diabetes care, including
    - o self-monitoring of blood glucose
    - o urine ketone monitoring (type 1 diabetes mellitus)
    - o insulin administration
    - o guidelines for diabetes management during illnesses
    - o management of hypoglycemia
    - o foot and skin care
    - o diabetes management before, during, and after exercise; and
    - o risk factor-modifying activities

Dietary Management

This involves optimal coordination of caloric intake with other aspects of diabetes therapy like insulin, exercise and weight loss

Aims of Dietary Management

- Abolish symptoms
    - Avoidhypoglycemia

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- In type patients with type 2 DM, it should address the greatly increased prevalence of cardiovascular risk factors (hypertension, dyslipidemia, obesity) and disease in this population. The majority of these individuals are obese, and weight loss is still strongly encouraged and should remain an important goal
- Food intake must be spread evenly throughout the waking hours and taken at regular times in relation to the insulin dose.
- Patients should be advised to spread whatever food is available through the day and the reasons explained.
- The diet should be balanced in relation to its composition of fats (<30%), protein (10-20%), and carbohydrates (50-60%).
- Simple sugars that are rapidly absorbed should be avoided.
- Soluble fiber in the diet that delays the absorption and dampens postprandial hyperglycemia should be taken.

General Dietary Instructions

Food items the diabetic should avoid (rapidly absorbed carbohydrates)

- Sugar, honey, jams, candy, marmalade
- Cakes, Sweet Biscuits
- Soft drinks(coca cola, mirinda etc)
- Alcohols

Foods which the diabetic can take with restrictions

- Foods from grains enjera, bread, kinche, kita, atmete
- Foods prepared from peas beans lentils chick peas
- Potato sweat potato kocho bulla

Food items the diabetic can take freely or with minimal restrictions

- Lean meat and fish
- Eggs, milk, cottage cheese
- Green leafy vegetables (cabbage, tomato, pumpkin, carrots, onion)

- Tea, coffee and lemon juice without sugar, Ambo water, other mineral waters
- Spices: pepper, garlic, 'berbere'

MANAGEMENT OF THE TYPE 1 DIABETIC PATIENT

Insulin Therapy in Type 1 Diabetes Mellitus

Type 1 diabetic patients have an absolute requirement for insulin.

In general, they require 0.5-1.0 U/Kg per day of Insulin.

Insulin formulations are available as U-100 (1ml of solution equivalent to 100 units) or U-40 (1ml of solution equivalent to 40units).

It is very important that one designs and implements an insulin regimen that mimics physiologic insulin secretions.

Twice daily administration of a short acting and intermediate acting insulin, given in combination before breakfast and the evening meal, is the simplest and most commonly used regimen.

Two thirds of the dose is given in the morning and one third is given in the evening.

Side effects of insulin therapy

- Hypoglycemia
- Weight gain
- Peripheral edema (in the short term)
- Insulin antibodies
- Local allergy
- Lipodystrophy at insulin injection sites

Insulin Preparations

Main types of therapeutic insulin

Species	Bovine
	Porcine
	Human
Purity	Conventional
	Single peak
	Highly purified
Duration of action	Short
	Intermediate
	Long

MANAGEMENT OF THE TYPE 2 DIABETIC PATIENT

Goals of Therapy

- Improved glycemic control
- Treatment of conditions associated with type 2 diabetes mellitus
  - Obesity
  - hypertension
  - Dyslipidemia
  - Cardiovascular disease
- Detection and management of diabetes mellitus related complications

In a newly diagnosed type 2 diabetic, one should resort first to dietary management and exercise before embarking on pharmacologic measures.

Glycemic control is reassessed and if response is not achieved, pharmacologic agents may be tried.

Oral glucose lowering agents are preferred as the initial choices to lower serum glucose levels.

As type 2 diabetes is a progressive illness, monotherapy is seldom successful in the long term.

Therapy is initiated with one class of agent, depending on patient characteristics and a second agent is added if adequate glycemic control is not achieved.

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Physical findings

- Tachycardia
- Hypotension
- Tachypnea/respiratory distress
- Kussmaul respirations(deep, fast beathing)
- Fever/hypothermia
- Dry mucous membranes/reduced skin turgor
- Abdominal tenderness
- Lethargy/obtundation/ possibly coma

Signs of infection, which may precipitate DKA, should be sought on physical examination, even in the absence of fever.

Abdominal pain may be severe and sometimes suggests acute pancreatitis or ruptured viscous.

Pathophysiology

DKA results from insulin deficiency combined with counterregulatory hormone excess (glucagon, catecholamines, cortisol, and growth hormone). Both insulin deficiency and glucagon excess, in particular, are necessary for DKA to develop.

The hyperglycemia of DKA results from

- increased hepatic glucose production
    - gluconeogenesis
    - glycogenolysis
- Impaired peripheral

Average losses of Fluid and Electrolyte in DKA of moderate severity

- Water: 6 Liters
- Sodium: 500 mmol
- Chloride: 400 mmol
- Potassium:350 mmol

Precipitating Events

- Inadequate insulin administration
- Infection (pneumonia, UTI, gastroenteritis, sepsis)
- Infarction (cerebral, coronary, mesenteric, peripheral)
- New onset diabetes
- Drugs

Laboratory Abnormalities and Diagnosis

DKA is characterized by

- Hyperglycemia RBS>250mg/dL,
- Ketosis
    - Ketone bodies positive at serum dilution of $\geq$1:2
    - Ketonuria of 2+ or above
- metabolic acidosis (increased anion gap)
    - P^H of 7.3 or lower and a bicarbonate level of $\leq$15 mEq/L

Despite a total-body potassium deficit, the serum potassium at presentation is typically at the high end of the normal range or mildly elevated secondary to the acidosis.

TREATMENT

- Supportive care
- Treatment of the precipitating cause when applicable
- Rehydration
- Insulin
- Management of acid base disturbance
- Management of electrolyte imbalance

- Resumption of subcutaneous insulin therapy once patient is out of the state of DKA
- Patient education

With appropriate therapy, the mortality of DKA is low (<5%).

Mortality is related more to the underlying or precipitating event, such as infection or myocardial infarction.

Complications of DKA

- The major non-metabolic complication of DKA therapy is cerebral edema, which most often develops in children as DKA is resolving.
    - Over replacement of free water should be avoided.
- Venous thrombosis and adult respiratory distress syndrome occasionally complicate DKA.
- Disseminated intravascular coagulation (rare)
- Acute circulatory failure

HYPOGLYCEMIA

Hypoglycemia is defined as a recorded blood glucose concentration less than normal.

- Sometimes defined as a plasma glucose level <45 to 50 mg/dl

The glucose thresholds for hypoglycemia-induced symptoms and physiologic responses vary widely, depending on the clinical setting.

Clinically significant hypoglycemia is based on the demonstration of **Whipple's triad** that includes

- symptoms consistent with hypoglycemia
- a low plasma glucose concentration(<45mg/dL)
- relief of symptoms after the plasma glucose level is raised

CAUSES

Most commonly occurs as a side effect of the treatment of diabetes mellitus

Incidence increases with attempts to achieve euglyemia with tight control of glucose concentrations

Other causes in patients with diabetes include

- Overdose of insulin or oral agents c02.425 Tw [( )-760(Overdose of insulin or)-7h diabetes inclu
  - κ

CLINICAL MANIFESTATIONS

The various signs and symptoms of hypoglycemia appear at different glycemic thresholds, related to different mechanisms.

They are subdivided into autonomic and neuroglycopenic manifeststions.

Autonomic signs and symptoms

Increased autonomic nervous system activity

- Palpitations
- Tremor or shaking
- Nervousness, Anxiety
- Irritability
- Sweating
- Hunger
- Nausea, vomiting
- Tingling, Paresthesia
- Tachycardia
- HypertensionT4 1 Tf0 Paresthesia

- Visual disturbance
- Tingling around the mouth
- Convulsions
- Focal neurologic deficits e.g. hemiplegia

TREATMENT

Urgent treatment is necessary in patients with suspected hypoglycemia.

Blood should be drawn, whenever possible, before the administration of glucose to allow documentation of the plasma glucose level.

Oral treatment with glucose tablets or glucose-containing fluids, candy, or food is appropriate if the patient is able and willing to take these. A reasonable initial dose is 20 g of glucose. If neuroglycopenia precludes oral feedings, par.72ng to take these -1.

UNIT THREE

SATELLITE MODULES

3.1 SATELLITE MODULE FOR PUBLIC HEALTH OFFICRES

Diabetes Mellitus

I. Definition

A group of metabolic disorders characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both

II. Classification

1. Type 1 diabetes Mellitus

Previously called insulin dependent DM or Juvenile onset DM due to its usual onset in adolescence or childhood

It includes about 5-10% of all diabetic patents and is caused by autoimmune destruction of the B-cells of the pancreas. The resulting hyperglycemia is responsible for the acute and chronic complications of the disease.

In few patients with type 1 DM the pathogenesis remains idiopathic.

2. Type 2 DM

This class of diabetes also known as non-insulin dependent DM accounts for 90-95% of the population with DM. It is common in people older than 40yrs and results from variable combinations of insulin resistance and defects in insulin secretion.

Learning Activity

In the exercise in the core module,

1. Identify the key historical findings suggesting the diagnosis.
2. Identify the key physical findings supporting the diagnosis of type 1DM

3. In the hypothetical case already mentioned the health officer requested the following laboratory investigations with the results shown below.

RBS = 450mg/dL

U/A - glucose = 4+

- ketones =4+
- Albumin =negative

3.1. Do the findings on laboratory investigation support (refute) your clinical suspicion?

3.2. What additional investigation would you request if resources permit?

III. Diagnosis

1. Clinical features

The presentation of patients depends on the type of diabetes and the stage of pathologic process.

1.1. Type 1 DM

Patients with type 1 DM commonly present with the classic acute symptoms of hyperglycemia: excessive thirst (polydipsia), polyuria, polyphagia and weight loss. Twenty five percent of type 1 diabetics present for the first time with diabetic ketoacidosis (DKA) characterized by hyperglycemia, ketosis and acidosis.

1.2. Type 2 DM

The presentation of type 2 diabetes is less acute than type 1 with “poly” symptoms and accompanying lethargy and fatigue.

The disease is often present for many years before the diagnosis and chronic hyperglycemia may be responsible for susceptibility to infections (eg. vaginitis)

2. Criteria for the Diagnosis of DM

DM can be diagnosed in the presence of any of the following

2.1. "Poly" symptoms plus casual plasma glucose greater than or equal to 200mg/dl
2.2. Fasting blood glucose (FBG) greater than or equal to 126 mg/dl
2.3 Two hours plasma glucose of greater than or equal to 200 mg/dl during an oral glucose tolerance test (OGTT).
(OGTT – Plasma glucose measurement after 75g of anhydrous glucose load).

NB: In the absence of unequivocal hyperglycemia the criteria should be confirmed by repeat testing on a different day.

IV. Management

The goals of management are:

1. Short term – immediate treatment to relieve the symptoms such as polydipsia, polyuria, or acute infection.
2. Intermediate – to return the patient to physiologic state and social life.
3. Long term – to prevent the development or delay progression of complications of diabetes

The treatment of diabetes can be categorized as non-drug therapy and drug therapy.

1. Non – Drug Therapy
   1.1. Regular Physical exercise

This results in improvements in the sense of well being, cardiovascular fitness, blood pressure, insulin sensitivity, weight reduction and glycemic control. Regular physical exercise for at least 30 minutes a day is recommended.

Blood glucose should ideally be measured before any exercise which shouldn't be undertaken with FBS of 300 mg/dl and above on the other hand if FBS is less than 100mg/dl exercise may precipitate hypoglycemia and carbohydrate should be

consumed in advance medical evaluation is advised to determine the level of fitness and appropriate exercise based on the presence and degree of macrovascular and cardiovascular complications.

1.2. Dietary Control

A general dietary recommendation includes consumption of a balanced health diet composed of:

- 10 – 20% protein
- 30% fat
- 50-60% carbohydrate

Patients should be advised to avoid dimple sugars like table sugar, honey etc and low saturated fat and cholesterol white high fiber diet is recommended.

2. Drug Therapy

2.1. Type 1 DM

Patients with type 1 diabetes have on absolute requirement of insulin for survival. Insulin is also used in type 2 diabetics when a combination of oral agents fails to achieve glucose targets and temporarily in patients with serious infection or surgery. The types of insulin available are rapid acting, short acting, intermediate acting and long acting.

Standard insulin therapy consists of one to two injections per day using intermediate or long acting insulin with or without regular insulin. Starting insulin does vary from 0.15 to 0.50/kg (as high as 1.5 u/kg in cases of severe insulin resistance) depending on patient size and degree of glycemia.

Adults of normal weight may be started with 20-25 u/d of intermediate acting insulin and increased to maintain a blood sugar level of 80-120 mg/dl.

2.2. Type 2 DM

Provided pharmacologic therapy is not required immediately all patients should be given at least a one month trial of diet, exercise and weight management. If this regimen does not lead to adequate blood glucose control, oral antihyperglycemic agents with or without insulin are indicated. Insulin may be needed in symptomatic patients who have type 2 DM with FBG values greater than 250 mg/dl. The common antihyperglycemic agents in use are discussed below.

a. Glibenclamide

Dosage

- 2.5– 20mg daily or in two divided doses

Side effect

- hypoglycemia.

Contraindications

- hepatic and renal impairment.

Drug interactions

- alcohol – flushing

Dosage form

- tablets of 5mg

b. Metformin

Dosage

- 500 – 2000 mg PO daily in divided doses

Side effects

- anorexia, nausea, vomiting, abdominal discomfort and diarrhea

Contraindications

- renal disease, hepatic disease, alcoholism

Dosage forms

- tablets of 500mg.

V. Complications

The complications of DM can be divided into acute and chronic complications

1. Acute complications

1.1 Diabetic ketoacidosis (DKA)

It is a clinical condition that may be defined as a triad of

- Hyperglycemia
- Ketosis
- Acidosis

It usually occurs in the setting of type 1 DM and is primarily caused by relative or absolute insulin deficiency.

Common precipitating factors are infection and omission of insulin dose. Patients may also come with DKA on initial presentation.

Symptoms include nausea, vomiting, polydipsia, polyuria, abdominal pain and weakness. On examination, signs include tachycardia, orthostatic hypotension, poor skin turgor, warm or dry skin and mucous membranes, deep and fast breathing (Kussmaul's respiration), hypothermia or normothermia, acetone breath, and altered mental status or coma.

Investigations:

- Blood glucose greater than 250 mg/dl
- Ketosis: ketonuria of 2+ to 3+

Treatment

-Treatment

-

-Treatment

Tretment

urinary ketones) regular insulin is given 6 hours subcutaneously according to random blood sugar (RBS) level as follows:

RBS> 250mg/dl- 12u

RBS: 180-250mg/dl-8u

RBS – 120-180mg/dl –4u

RBS < 120 but >70 mg/dl-70mg/dL-no insulin

RBS<70mg/dL- Hold insulin and give juice or meal and recheck blood glucose in one hour.

Fluid Replacement

Normal saline IV should be given rapidly as soon as the patient arrives.

Total fluid given may be as high as 10 litres depending on the patient's response & urine output.

Fluid replacement may proceed in the following manner.

2-3L of 0.9% saline over first 1-3 hour (5-10mL/Kg per hour); subsequently, 0.45% saline at 150-300mL/hr; change to 5% glucose and 0.45% saline at 100-200mL/hr when plasma glucose reaches 250mg/dL.

Electrolyte Replacement

Potassium replacement should be according to serum potassium values. Potassium, 20 meg 1h is generally safe if renal function is normal

SE. renal failure

Dosage forms, injection 20 meg /10 ml ampoule of kc/

3.2 SATELLITE MODULE FOR DIPLOMA NURSES

Directions for using the module

Before starting to read this module, please follow the directions given below

- ü Go through all the contents of the Core Module by starting with the pre test
- ü Use a separate sheet of paper to write your answers and label it as pre-test answers

Learning objectives

On completion of this module, the learner will able to

1. Differentiate between type 1 and type 2 diabetes
2. Describe etiologic factors associated with diabetics
3. Relate the clinical manifestation of diabetic mellitus to the associated pathophysiologic alteration
4. Recognize the seriousness of DM with reference to morbidity and mortality
5. Identify the diagnostic and clinical significance of blood glucose tests
6. Describe the various type of insulin
7. Explain the dietary modification used for management of person with diabetes
8. Describe the relationship between diet, exercises and modification for persons with diabetes
9. Develop a plan for teaching insulin self administration
10. Learn on the pharmacological calculation of insulin to reach on accurate dose(units to milliliter from a vial containing 40,80 or100 units)
11. Differentiate between hypoglycemia and Diabetic ketoacidocis and HHNS
12. Describe the major macro vascular, micro vascular and neuropathic complication of diabetic and self care behavior important in the prevention
13. Explain why the feet are of such importance

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Diagnostic Criteria for Diabetic Mellitus

Fasting plasma glucose (FPG) >126mg/dl

Random blood glucose (RBS) >200mg/dl with symptoms

2hr post load glucose >200mg/dl

See the Core Module for the details

Management

Goal: - to try to normalize insulin activity & blood glucose levels in an attempt to reduce the development of the vascular & Neuropathic complications.

There are five components of management for diabetes:-

- Diet
- Exercise
- Monitoring blood glucose
- Medication (as needed)
- Education

I. Dietary Management

Goal: - provision of all the essential food constitutes (e.g.,CHO,protien,fat vitamins , minerals)

- Achievement and maintenance of reasonable weight
- Meeting energy needs
- Prevention of wide daily fluctuations in blood glucose levels with Blood glucose level as close to normal as is safe and practical
- Decrease blood lipid levels, if elevated

A. Calories

The most important objective in dietary management of DM is control the total calorie intake and to attain or maintain a reasonable body weight and control of blood glucose levels.

The general recommendation include consumption of a balanced health diet composed of the following

- 50% to 60% of calories to be derived from carbohydrates
- Less than 30% obtained from fat and
- The remaining 10% to 20% from protein

*__Food which diabetic should avoid (rapidly absorbed carbohydrate/simple sugar__)

1) Sugar, honey, jam, marmalade and candy
2) Cakes and sweet biscuits
3) Soft drink (Fanta, coca cola, etc)
4) Alcohol (Cognac, tej, araki, whisky)

There are types of alcohols which are allowed in moderation, that is less sweat drinks i.e. light beer or dry wine(not more than 2 drinks for men,1 drink for women/day). Alcoholic beverage equivalent to12 oz beer, 5 oz wine and 1.5 oz spirit. It should be always taken with food.

***Foods which diabetic should take with restriction (cereals or starch 50 - 60 %)**

a. Foods from grain e.g. injera ,bread, kinche , dabo kolo, kita ,atemit
b. Foods prepared from peas ,beans, e Tc0.0024 Tw [kf

G) tomato, pumpkin ,carrot, Onion, chili pepper

II. Exercise

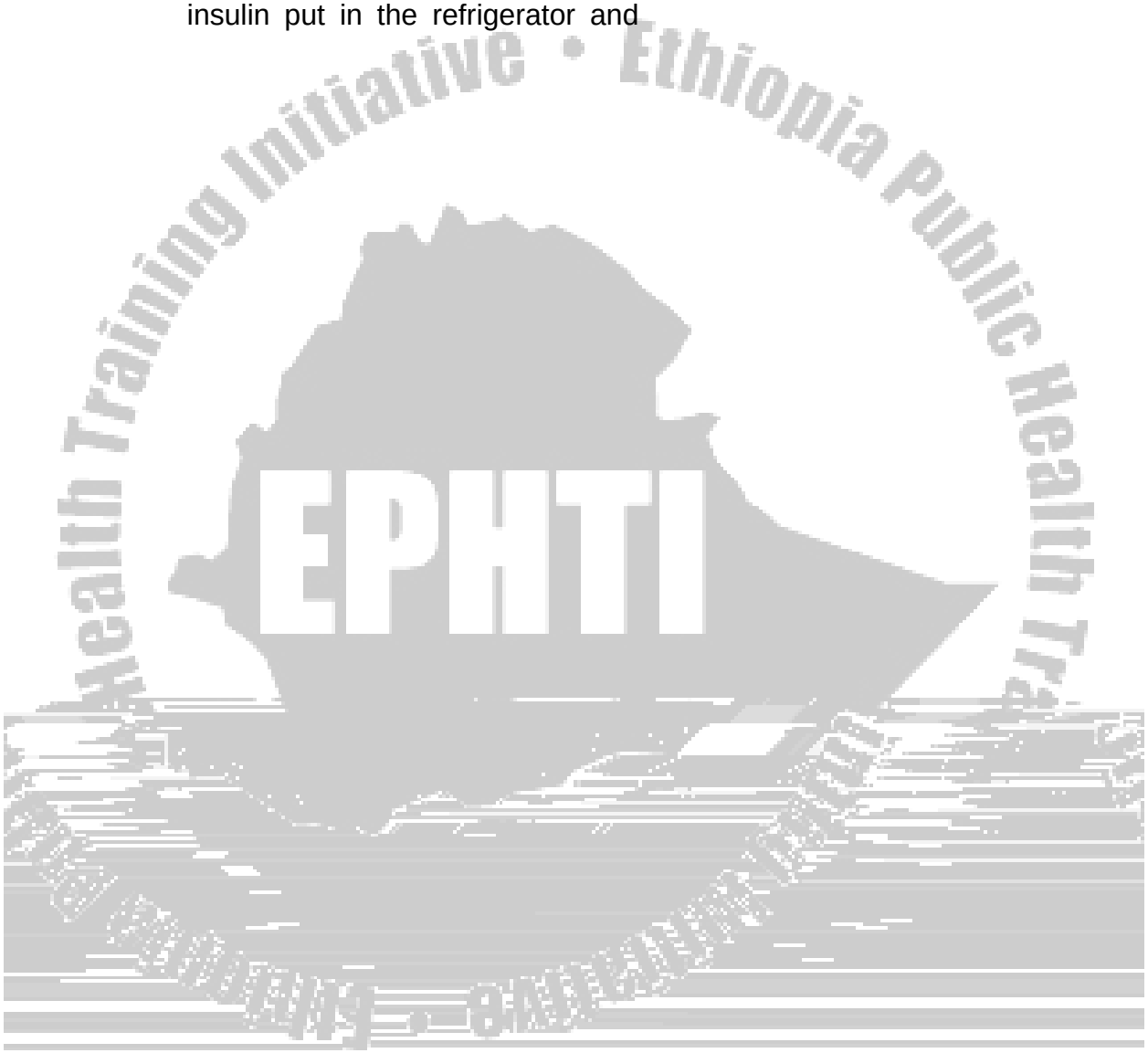
- Is extremely important in the management of diabetes because of its effect on lowering blood glucose and r

IV. Medications

Insulin therapy

- In type 1 diabetes, the body loses the ability to produce insulin, thus, exogenous insulin must be administered indefinitely. A standard insulin treatment consists of one or two injection/day, using intermediate or long acting insulin with or with out regular insulin.
- In type 2 diabetes, insulin may be necessary on a long term basis to control glucose levels if diet and oral

- The long acting must be mixed (gently inverted or rolled in the hands) before use
- Before injection it should have room T^{o} which may require rolling it in the hands or removing it from a refrigerator for a time before the injection. Actually there is no significant difference in the biologic activity between insulin put in the refrigerator and



Rotation

- Rotation of injection site is required to prevent lipodystrophy, localized changes in fatty tissue,

The patient is instructed as:

1. Do not use a site > once every 4 to 6 weeks
2. Sites should be 1 to 1 ½ inches apart
3. Use all sites in one geographic area, then move to the next area
4. Document site use

Side effects of insulin injections

1. Local allergic reactions.
   - This appears in the form of redness, swelling, tenderness, and indurations or a 2 to 4 cm wheal may appear at the injection site 1to 2 hrs after injection
   - Usually occur during the beginning stage of therapy and disappear with continued use of insulin
   - Antihistamine will be given 1 hr before injection
   - A local reaction is usually not dangerous unless it becomes more extensive over time
2. Systemic allergic reaction-are rare
   - Can be life threatening
   - Local skin reaction that gradually spreads in to generalized urticaria which can include laryngeal edema with respiratory distress

   Treatment involves: - desensitization, gradually increasing the amount of insulin under cautious observation.
3. Insulin lipodystrophy
   - Refers to a localized disturbance of fat metabolism in the form of lipoatrophy (loss of subcutaneous fat and appears as slight dimpling or more serious pitting of subcutaneous fat) or lipohyperthrophy (is the development of fibro fatty masses at the injection site and is caused by the repeated use of injection site)

- If insulin is injected in to scarred areas the absorption may be delayed

Treatment: Patient should avoid injection on the areas and prevent by rotating injection sites

3. Insulin Resistance
   - Insulin requirements up to 1u/kg can be seen with obesity stress,aging
   - Modest insulin resistance-2-3u/kg wt-can be seen frequently with type 2
   - Extreme insulin resistance (>3u/kg)-is rare and may be caused by a variety of autoimmune and genetic disorder

Oral Anti diabetic agents

Effective for type 2 DM patients who do not respond to diet and exercise alone and who are able to produce some insulin

A. Glibenclamide

Dosage: 2.5 – 20mg daily or in two divided doses

Side effect: hypoglycemia.

Contraindications: hepatic and renal impairment.

Drug interactions occur with alcohol leading to flushing

Dosage form: tablet 5mg

B .Metformin

Dosage, 500 – 2000 mg Po daily in divided doses

Side effects: anorexia, nausea, vomiting, abdominal discomfort and diarrhea.

Contra-indication: renal disease, hepatic disease alcoholism

Dosage form: tablet, 500mg and 850mg

A. Acute complications of diabetes

1. Hypoglycemia (Insulin Reactions)
   - Occurs when blood glucose level falls below 50 to 60 mg /dl (2.7 to 3.3 mmol/L)

Caused by: Too much insulin or hypoglycemic agents

-Too little food or

-Excessive physical exercise or excessive alcohol

-Occurs also if meals are delayed or snacks are omitted

Symptoms includes

Mild hypoglycemia

- Sweating
- Tremor
- Tachycardia
- Palpitation
- Nervousness and
- Hunger

Moderate hypoglycemia

- Inability to concentrate
- Headache
- Light headedness
- Confusion
- Memory lapses
- Numbness of the lips and tongue
- Slurred speech
- In coordination
- Emotional changes
- Irrational behavior
- Double vision and drowsiness

Severe hypoglycemia

- Seizures
- Difficulty arousing from sleep or
- Loss of consciousness

Treatment for Mild and moderate hypoglycemia

10 to 15 mg of a fast acting sugar orally

Hard candies 2-3tsp sugar, 2-3tsp honey, 4 to6 tsp fruit juice or glucose tablets 2 to4

Treatment for Severe hypoglycemia

The initial treatment of a confused, comatose patient is to infuse a bolus of 50 ml of 50% glucose; preferably after a blood sample for lab analysis has been obtained. This bolus is followed by the continuous infusion of 5 to 10 % of glucose at a rate sufficient to keep the plasma glucose level> 100mg/dl

Patient education: - prevented by following a regular pattern for eating, administering insulin, and exercising

- Because unexpected hypoglycemia may occur all patients treated with insulin should wear an identification **bracelet or tag** indicating that they have diabetes and should keep sugar or candy in their pocket
- Patient and family members should be aware of signs of hypoglycemia

2. Diabetic Ketoacidosis (DKA)

DKA is caused by an absence or markedly inadequate amount of insulin Patients with sever DKA can become severely dehydrated with the loss of electrolyte. Volume loss is highly variable as is Na^+ and K^+ decreasing. Paradoxically potassium appear elevated as a response to acidosis, though this is a temporary shift of potassium from intra to extra cellular space

Sign and symptoms:- anorexia , nausea , vomiting & abdominal pain

- Acetone breath (a fruity odor)
- Kussmaul respiration (very deep& and fast respiration)
- Lab.value : Blood glucose level 300 to 800 mg /dL

Causes: - A reduced or missed dose of insulin, an illness or infection

Treatment of DKA includes

- Fluid replacement if kidney functions is normal and there is no concern for heart disease
- 0.9% normal saline of a very high rate usually 0.5 to l lit /hr for 2 to 3 hrs, then the decrease the rate to 250-500ml/hr as orthostatic change disappear.
- Fluid may need to be given cautiously in renal impaired or older patients who may have underlying new problems

- hypo tonic normal saline (0.45%) for hypertensive
- K- replacement – Give none with the first liters of saline, then 20 mmol hourly in saline up to a total of 80 mmol
- Insulin IV at a slow, continuous rate (start with a 10u bolus of regular insulin IV, followed immediately by a continuous IV insulin infusion at 0.1u /kg/hr if weight is known, if not 6u/hr. when the patient start to eat and rink change to subcutaneous 30 min before meal and discontinue insulin infusion 30-60 min after meal.
- Hourly monitoring of blood glucose level, urine glucose level, blood ketone level Alter insulin if necessary accordingly
- Bicarbonate infusion- Don't give routinely. Give 50 mmol slow IV only if patients condition is critical.

3. Hyperglycemic Hyperosmolar Nonketotic syndrom

- is a situation in which hyperosmolarity and hyperglycemia predominate, with alteration of the sensorium (sense of awareness) .See the core module for the details

Clinical manifestations

* Symptoms of hypotension
  - Profound dehydration
  - Tachycardia and
  - Neurologic signs (e.g. altered sensorium, seizures , hemiparesis)

Causes:- Occurs most frequently in older peoplpa2 50-70 yrs) who had no previous history of DM or only mild type 2 diabetes and renal impairment

Precipitating events

- Acute illness
- Ingestion of medication known to provoke insulin insufficiencya2 thiazide diuretics , propranolol) or
- Therapeutic procedures

Management - Similar with diabeticketoacidos is (DKA)

Fluid, electrolyte and insulin replacement

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- Leading to loss of pain and pressure sensation and autonomic neuropathy
- Leads to increased dryness and fissuring of the skin 2^{o} to increased sweating)
    - o

11. Do not place feet near sources of heat
    e.g fireplace, heater , hot water bottle, ect
12. Wear shoes when outdoors that protects toes and soles of feet from cuts and bruises.
13. Referral to a specialist when necessary.

Keys for the pretest and post test questions for Nurses

1. A
2. C
3. C
4. E
5. A
6. C
7. A
8. C
9. D
10. a) - site of injection
    -preparations of medication
    -Rotations
    -about syringe and needle
    -some problems with insulin injections
    b) -too much insulin
    -too little food or
    -excessive physical exercise
    -delay of meal or omitting of snacks
    c) -sweating
    -tremor
    -tachypnea
    -confusion
    -seizure

-loss of consciousness

d) Having snack, not delaying the meal, right dose of medications, having candies at hand

f)-assess foot daily for sensation, redness and broken skins

-wash dry feet daily

- If skin is dry apply a thin coat of lubricating oil

-tie shoes loosely but firmly

-If your feet perspire, change shoe and stocking during the day

-wear shoe and stocking that gives room for the movement of the toe

3.3 SATELLITE MODULE FOR MEDICAL LABORATORY TECHNICIANS

Introduction

1. Purpose of the module

Diabetes mellitus is a diverse group of hyper glycemic disorders with different etiologies and clinical picture, therefore timely diagnosis and management based on true laboratory results are crucial.

This satellite Module on Diabetes Mellitus is intended to resolve the critical shortage of clinical chemistry reference Materials bot

Ą Practice different quality control procedures in laboratory diagnosis of diabetes mellitus

4. Laboratory tests for diagnosis and management of diabetes mellitus

- Determination - Blood glucose
  - Serum/ plasma glucose
  - Urine glucose
- Determination of urine keton bodies
- Determination of urine protein

4.1 Types and collection of different sample

Laboratory diagnosis of Diabetes Mellitus may be performed on specimens of :-

- Fasting whole blood
- Plasma or serum (Free of hemolysis)
- Urine

But, serum or plasma is more preferrerable for the determination of glucose due to the following reasons:-

- Since plasma or serum contains approximately 10% to 15% more water than whole blood the total glucose in plasma or serum is about 10% to 15% greater than in whole blood.
- It is easier to interpret values obtained from a single component system (plasma) than a two component system (whole blood)
- Because there are several substances in blood (particularly in red cells) that interfere with tests for blood glucose either because they are measured as glucose or because they interfere in enzyme procedure.
- As indicated above, values based on whole blood tend to vary with the hematocrit.
- Glucose is more stable in plasma or serum than in whole blood, as many glycolytic enzymes are present in RBC.

- Plasma or serum is easier to handle, to pipette precisely and to store than is whole blood.

In the fasting state the arterial (capillary) blood glucose concentration is 5 mg/dl higher

concentration should normally be less than 110 mg/dl and the serum or plasma glucose taken 2 hours 140 mg/dl. Including in the new criteria from the expert committee on the diagnosis and classification of Diabetes Mellitus are three diagnostic criteria for diabetes Mellitus:

1. a fasting serum or plasma glucose level equal to or greater than 126 mg/dl; or
2. a random blood glucose (on blood drawn with out considering time since the last meal) equal to or greater than 200 mg/dl, along with symptoms of diabetes (polyuria, polydipsia, and un explained weight loss),
3. a 2- hour post load glucose level equal to or greater than 200 mg/dl during an oral glucose tolerance test. Impaired glucose tolerance (IGT) is indicated if the fasting glucose is between 110 an 126 mg/dl and one post prandial glucose level is greater than 200 mg/dl.

7. Methods for quantitative determination of Glucose.

The various methods for the quantitative determination of glucose can be divided in to three general categories.

- Enzymatic Methods,
- oxidation Reduction methods, and
- aromatic amine methods.

of these, enzymatic methods using hexokinase or glucose oxidase methodology are most commonly used

7.1. Enzymatic methods

Almost all currently used glucose Methods utilize enzymatic techniques. The use of enzymes is a means of achieving absolute specificity in the determination of glucose concentration. The two most widely used automated enzyme glucose methods are based on the enzymes hexokinase and glucose oxidase. Glucose oxidase is also used in the most common manual methods.

7.2. Oxidation- Reduction Methods

Oxidation methods for blood glucose depend on the fact that glucose contains an aldehyde group as part of its chemical structure. The presence of this aldehyde gives glucose its reducing properties. Other substances in blood also have reducing properties. Some of these non glucose reducing substances are other sugars and metabolic compounds and materials such as urine acid, creatinine, ascorbic acid certain amino acids, homogentisinc acid, creatine, phenol and glucose and acid. The oxidation-reduction methods for determining blood glucose differ primarily in the way they handle the non glucose reduction substances. When the non glucose reducing substances are removed as part of a glucose determination, the resulting value is called the true glucose value.

7.3. Aromatic amine methods

Aromatic amine methods depend on the fact that various aromatic amine methods depend on the fact that various aromatic amines react with glucose in hot acetic acid to form colored derivatives.

7.4 Glucose Tolerance Test (GTT)

In the detection and treatment of diabetes it is sometimes necessary to have more information than can be obtained from only testing the fasting specimen for Glucose. There fore the GTT usually performed:-

- When a person has been found to have a fasting serum or plasma glucose concentration above that of most non diabetic persons (about 110 mg/dl)
- To identify hypoglycemia, an abnormal response to a glucose load that results in a serum or plasma glucose concentration much below the normally accepted range

Since early detection and management of diabetes are important to avoid the many complications of the disease, it is desirable to detect these early cases of diabetes or pre diabetes. For these reasons, the physician may request a glucose to tolerance.

a. Oral glucose Tolerance Test.

2. The rate of absorption may be low in conditions of mal absorption and high in hyperthyroidism. This may result in low peak level or an early high peak.
3. Diet preceding the day of test: Starvation or carbohydrate free diet will decrease the carbohydrate tolerance of the individual and cause hyperglycemia and glycosuria when the individual is subjected to GG. There fore, in order to get the correct diet of the carbohydrate tolerance 9H oo-0.0004e 9H745 0 TD415and high in

9. Urine Glucose determinations

Chemical screening tests for glucose (dextrose) are generally included in every routine urinalysis. The occurrence of Gluocse in the urine indicates that the metabolic disorder diabetes mellitus should be suspected, although several other conditions result in glycosuria (glucosuria).

The lowest blood glucose concentration that will result in glycosuria is termed the renal threshold (180-200 mg/dl). It is possible to use both enzymatic technique and oxidation-reduction technique to determine urine glucose

9.1 Enzymatic technique

9.1.1 Reagent strip (Glucose oxidase) Tests

Principle and specificity

Since the reagent strip tests for urinary sugar use glucose oxidase which only react in the presence of glucose they are highly specific. Reagent strip tests for urine glucose are double sequential enzyme reactions. Glucose oxidase will oxidize glucose to gluconic acid and at the same time reduce atmospheric oxygen to H_2O_2. the hydrogen peroxide formed will, in the presence of the oxidized form, which is indicated by the color change of an oxidation- reduction indicator.

Step 1:

Glucose + O2 *Glucose* Gluconic acid + H_2O_2
(in urine) *oxidase*

Step 2

H_2O_2 + Reduced *Proxidase* oxidized form of dye + H2O
Form of dye

Note:

9.1.1.1 Procedure

1. Collect the urine sample will clean, dry, free from any antiseptic and wide mouth

semiquantitated as a change in color ranging from blue to green, yellow, and orange, depending on the amount of sugar present.

$2CUSO_4$ + Reducing substance alkali CU_2O (copper) + oxidized from of

Specificity

5. Copper reduction tests such as clinitest are non-specific tests for reducing substances (sugars). The glucose is acting as reducing agent, and any compound with free aldehyde or ketone group will give the same reaction

Sensitivity

6. clinitest reagent tablets will detect as little as 250 mg/ dl sugar (0.25 g/dl) This is less sensitive than the reagent strip tests for glucose

9.2.1.2 Interferences

– False positive results

- Since it is reducing substance, the presence of extremely large amount of ascorbic acid
- Specimens that have a low specific gravity and contain glucose may give slightly elevated result
- Large quantities of nalidixic acid, cephalosporins and probenecid.

7. False negative results

- Mixing the test tube before the 15 second wait after boiling stops, due to reoxidation of the cuprous ions to cupric ions by atmospheric oxygen

10. Determination ketone bodies in urine

- ketone bodies are a group of three related substances: acetone, aceto acetic acid, and β – hydroxyl butyric acid.
- When ever fat (rather than carbohydrate) is used as the major source of energy, ketosis and ketonuria may result.
- The two out standing causes of ketone accumulation are diabetes mellitus and starvation
- In diabetes mellitus, the body is unable to use carbohydrate as an energy source and attempts to compensate by resorting to fat catabolism, which results accumulation of ketone more than normal, that the body is unable to utilize it.

- The clinical result is an increased concentration of ketones in the blood (ketonemia) and in the urine (keton uria.)

Since the presence of ketone bodies in urine is an early indication of lack of adequate insulin control, reagent strips that combine tests for glucose and ketone are often used.

10.1 dipstick test

Principle: the reagent strip tests for ketone bodies are based on legal's (Rothera's) test, a color Rxn with sodium nitroprusside (nitro ferricyanide)./ Acetic acid will react with sodium nitro prusside in an alkaline medium to form a purple color.

10.1.1 Procedure

1. After collecting the urine sample from the pt, transfer into a clean, dry and free of disinfectant test tube
2. Then immerse the dipstick into the urine
3. Then drain and let it stand for certain seconds for the reaction to takes place
4. Read the result by comparing the color produced with the standard on the strip container

Note acetone and aceto acetic acid can be detected by d/t dip stick tests, but there is no reagent strops test for β - hydroxyl butyric acid

10.1.2 Interferences

- The presence of various:-
  - Pigments
  - Drugs or
  - Urine specimens presents problems in reading results
- False-positive may result due to:-
  - Specimens containing phthaleins, very large amounts of phenyl ketones or the preservative 8-hydroxy quinoline
  - Highly concentrated urine specimens
  - 2- Mercaptoethan esulfonic acid or other compounds containing sulfhydryl groups

- False -negative

  • Conversion of acetoacetic acid to acetone with subsequent evaporation from the specimen in improperly stored urine specimen.

11 Determination of urine protein

Microalbuminuria

- Diabetes mellitus causes progressive changes to the kidneys and ultimately results in diabetic renal nephropathy. This complication progresses over a period of years and may be delayed by aggressive glycemic control
- An early sign that nephropathy is occurring is an increase in urinary albumin
- It is thought that the early development of renal complications can be predicted by the early detection of consistent micro albuminuria. And this early detection is desirable, as better control of blood glucose levels may delay the progression of renal disease

11.1 Methods of measurement

Test for urinary protein are of two major types:

a. Tests that are based on the use of the protein error of PH indicators
   - This is the methodology employed in the various reagent strip tests
   - They are more sensitive to the presence of albumin than to other proteins.

b. Tests that are based on the precipitation of protein by chemical or coagulation by heat
   - This test will detect all proteins, including albumin, glycoproteins, globulins, Bence Jones protein & hemoglobin

11.1. a Reagent strip test

Principle: Reagent strip tests for urinary protein involves the use of PH indicators substances that have characteristic colors at specific PH values. The phenomenon of showing different color at different PH is called. “the protein error of indicators” The PH

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11.1.b. Confirymator tests (sulfosalicylic acid (SSA) test

SSA test or another protein precipitation method may be used to confirm the presence of protein when reactions indicating a trace or more are obtained or when reagent strip results are in doubt.

SSA test

Principle: This test is based on the cold precipitation of protein with a strong acid, namely sulfosalicylic acid.

11.1b.1 procedure for SSA test for urine protein

- centrifuge a 12 ml aliquot urine
- Decant 11 ml of the supernatant urine into a 16x125 mm test tube. Note the clarity of the centrifuge urine
- Add 3 ml of 7g/dl sulfosalicylic acid reagent
- Stopper the tube and mix by inverting twice
- Let stand exactly 10 minutes
- Invert tube twice
- Observe the degree of precipitation and grade the results
- To observe the degree of precipitation, tilt the test tube while simult ancously viewing the quality and quantity of precipitate in the mirror

Table shows SSA protein test result

SSA result	**Description**	**Approximate protein [ ] in mg/dl**
Negative	- No turbidity, or no increase in turbidity clear ring is visible at bottom of tube when viewed from above	<5 mg/dl
Trace	- Barely perceptible turbidity in ordinary room light printed material distorted but readable through the tube can not see a ring at bottom	5-20 mg/dl

	of tube when viewed from above	
+1	Distinct turbidity but no distinct granulation	30mg/dl
2+	- Turbidity with granulation but no flocculation	100mg/dl
3+	Turbidity with granulation and flocculation	300-500 mg/dl
+4	- Clumps or precipitated protein or solid precipitate	> 500mg/dl

11.1b.2 Interference

False- positive results

- Turbidity (cloudiness) in the urine specimen. Urine must be clarified before testing

False- Negative results

- The occurrence of highly buffered alkaline urine if the buffer is sufficient to neutralize the acid in SSA.

Quality control

- For producing Laboratory results in determination of different analyst in different clinical samples for the diagnosis of diabete mellitus and its complications quality control procedures are mandatory practicing
- Commonly to produce correct laboratory results we will control the following factors.

1. Pre analytic factors

This factors are commonly appear before the analysis of the analyte. For example during

A. Patient preparation
B. Sample collection
C. Sample handling and storage

A. Patient preparation- during this time a lot of things can be done for example. The patient should be asked about his nutritional status, a recent mead. Alcohol, drugs etc. Which all affect the value of the anlyte.

B. Sample collection:- During sample collection the laboratory personnel should be a ware of the type of sample, time of collection, area of collection (ream or capillary) , etc.

C. Sample handling and storage here the type of test tube, anti coagulants and storage temperature with respect to the type of sample should be considered.

2. Analytical factors

The laboratory is more able to control the analytical factors, which depend heavily on instrumentation and reagents

A. Instrumentation

- Instrument function checks that are to be routinely performed should be detailed in procedure manual and their performance should be documented

B. Reagents and kits

Reagents and kits should be dated when received and also when opened. New lots of reagents should be run in parallel with old reagent lots before being used for analysis.

3. Post analytical factors

The post analytical factors consist of the recording and reporting of patient data to the physician with in the appropriate time interval

Post test

Go back to the pretest questions & do them carefully

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Identification of an environmental trigger has been difficult because the event may precede the onset of DM by several years. Though this is the case, but still it is strongly

6. Many jobs are becoming sedentary rather than exercise/movement demanding and in turn these furnish the ground for the people to become more obese.
7. Physical exercise is not taken as a routine life activity among the people especially living in developing country where the living places are not comfortable to make exercises at continual basis.

culprit /predisposing chemicals./ (especially Rodenticides (vacor), Biological factors (viruses) physical agents (radiations).

5. Controlling rays, by enclosing the potential ray emanating sites with radiation proof construction materials.
6. Promoting personal hygiene any DM patients as they are most susceptible and potentially frequently be affected with different kinds of skin infections.
7. Routine hospital sanitation inspection will be beneficial in preventing the admitted DM case clients from other nosocomial infections.
8. Health information promotion regarding DM is the crucial area where the environmental health officers are expected to play a vital role.
9. The environmental health officers are most needed here to apply their expertise knowledge of housing and institutional sanitation, nutrition and food hygiene and safety, environmental chemistry. Organic chemistry and environmental quality control courses in conformity with the preventing and controlling strategies of DM.
10. It has to be emphasized that E.H.Ts should have deep concern about safe injection of insulin and proper disposal of used needles. No room should be left for contamination that will follow secondary infection of DM patients.
11. Give refreshment trainings on DM for health extension workers from environmental health point of view.

Post – test

First try to look and do the pretest again, then keep on attempting the following questions.

1. What situation makes difficult the study of causation of environmental factors and to link conclusively with DM?
2. Why diabetes mellitus patients are most susceptible for different kinds of skin infections?
3. What is the basic reason for the fact that E.H.Ts are supposed to be highly concerned to make the working places free of any possible causalities for DM patients?
4. What are the known environmental factors that are thought to cause DM?
5. What parcel of Health information is highly beneficial for the family or community with strong DM history?

- Having gone through the module, try to attempt the presented questions.
- Study the task analysis for the health center team members in comparison with that of your own.

Objectives

2.3 Learning Objectives

After reading the module, one will be able to

- Explain the importance of diabetes mellitus as a public health problem
- Describe diabetes mellitus, its classification and clinical presentation.
- Outline the diagnostic tests for diabetes mellitus.
- Describe the logic behind appropriately employed treatment.
- Describe the role played by each member of the health center team.
- Describe the overall principles of management.

Diabetes mellitus

Definition

Diabetes Mellitus is a clinical syndrome comprising a heterogeneous group of metabolic diseases that are characterized by chronic hyperglycemia and disturbances in carbohydrate, fat and protein metabolism secondary to defects in insulin secretion, insulin action or both

Types

Type 1And type 2

CLINICAL FEATURES

Classical symptoms

- Thirst
- Polyuria
- Nocturia

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The lowest blood glucose concentration that will result in glycosuria is termed the renal threshold (180-200 mg/dl). It is possible to use both enzymatic technique and oxidation-reduction technique to determine urine glucose

2.1 Enzymatic technique

2.1.1 Reagent strip (Glucose oxidase) Tests

Principle and specificity

Since the reagent strip tests for urinary sugar use glucose oxidase which only react in the presence of glucose they are highly specific. Reagent strip tests for urine glucose are double sequential enzyme reactions. Glucose oxidase will oxidize glucose to gluconic acid and at the same time reduce atmospheric oxygen to H_2O_2. The hydrogen peroxide formed will, in the presence of the oxidized form, which is indicated by the color change of an oxidation- reduction indicator.

Note: The glucose oxidase, peroxidase and

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4. Determination of urine protein

Microalbuminuria

- Diabetes mellitus causes progressive changes to the kidneys and ultimately results in diabetic renal nephropathy. This complication progresses over a period of years and may be delayed by aggressive glycemic control
- An early sign that nephropathy is occurring is an increase in urinary albumin
- It is thought that the early development of renal complications can be predicted by the early detection of consistent micro albuminuria. And this early detection is desirable, as better control of blood glucose levels may delay the progression of renal disease

4.1 Methods of measurement

Test for urinary protein are of two major types:

a. Tests that are based on the use of the protein error of PH indicators
   - This is the methodology employed in the various reagent strip tests
   - They are more sensitive to the presence of albumin than to other proteins.

b. Tests that are based on the precipitation of protein by chemical or coagulation by heat
   - This test will detect all proteins, including albumin, glycoproteins, globulins, Bence Jones protein & hemoglobin

4.1.1 Reagent strip test

Principle: Reagent strip tests for urinary protein involves the use of PH indicators substances that have characteristic colors at specific PH values. The phenomenon of showing different color at different PH is called. “the protein error of indicators” The PH of the urine is held constant by means of buffer, so that any change of color of the indicator will indicate the presence of protein.

4.1.1.1 Procedure

It is the similar with other reagent strip test procedure. (But the reading time can vary manufacture to manufacturer instruction on the leaf late)

Complications

- may be classified into acute and chronic complications
- Acute complications are
    - Diabetic ketoacidois
    - Nonketotic hyperosmolar state
    - Hypoglycemia
- Chronic complications
    - Affect many organ systems
    - Are responsible for the majority of morbidity and mortality associated with the disease
    - Can be subdivided into **vascular** and **non-vascular** complications
    - The vascular complications are further subdivided into
        - Microvascular complications that includes
            - Diabetic retinopathy
            - Diabetic nephropathy
            - Diabetic neuropathy
        - Macrovascular complications
            - Coronary artery disease
            - Peripheral vascular disease
            - Cerebrovascular disease
    - The non-vascular complications are
        - Gastroparesis
        - Sexual dysfunction
        - Skin changes

Therapeutic approach

There are four components of management for diabetes which is carried by the health extension workers:-

- Diet
- Exercise
- Monitoring
- Education

I. Dietary Management

Goal:- provision of all the essential food constitutes (eg, vitamins , minerals)

- Achievement and maintenance of reasonable weight
- Meeting energy needs
- Prevention of wide daily fluctuations in blood glucose levels with BGL as close to normal as is safe & practical
- Decrease of blood lipid levels, if elevated

A. Calories

The most important objective in dietary management of DM is control of total calorie

*Foods which diabetic should

- avoid exercise in extreme heat or cold
- inspect feet daily after exercise
- avoid exercising during periods of poor metabolic control.

III. Monitoring of Glucose and Ketones

Blood glucose level and urine for ketone and glucose should be assessed frequently by self or by having follow up in the health unit

Pt education -about Insulin Injection

- Insulin injections are administered into the

- Hips

Absorption is greatest in abdomen and decreases progressively in the arm, thigh, and hips.

Rotation

- Rotation of injection site is required to prevent lipodystrophy , localized changes in fatty tissue,

Pt is instructed as:-

1. Do not use a site > once every 4 to 6 weeks
2. Sites should be 1 to 1 ½ inches apart
3. Use all sites in one geographic area, then move to the next area
4. Document site use

Side effects of insulin injections

1. Local allergic reactions.
   - in the form of redness, swelling , tenderness , and indurations or a 2 to 4 cm wheal may appear at the injection site 1to 2 hrs after injection
   - usually occur during the beginning stage of therapy and disappear with continued use of insulin
   - antihistamine will be given 1 hr before injection
   - if alcohol is used to clean the area the skin should be allowed to dry
2. Systemic allergic reaction
   - are rare
   - local skin reaction that gradually spreads in to generalized urticaria

   RX:- desensitization , gradually increasing the amount of insulin
3. Insulin lipodystrophy
   - refers to a localized disturbance of fat metabolism in the form of loss of sc fat and appears as slight dimpling or more serious pitting of sc fat or is the development of fibrofatty masses at the injection site and is caused by the repeated use of injection site

- if insulin is injected in to scarred areas the absorption may be delayed

R_x :-Pt should avoid injection on the areas and prevent by rotating injection sites

Risk identification

- Those above 45 years of age every three years
- Those with family history of diabetes mellitus (parent or sibling with type 2 diabetes mellitus)
- Obesity as evidenced by BMI$\geq$ 27Kg/m^2
- History of delivering a baby weighing above 4Kg in a lady or previous episode of gestational diabetes mellitus
- Hypertension

Prevention:

- **Screening**
- A number of lifestyle modification and pharmacologic agents are suggested to prevent or delay its onset.

High risk individuals should be encouraged to

- Maintain a normal body mass index
- Engage in regular physical exercise

No specific intervention is proven to prevent type 2 diabetes mellitus.

UNIT FOUR

TASK ANALYSIS

Table - Knowledge

Learning Objectives	HO	Nurses	Medical Laboratory	Environmental Health
Describe DM	Define DM study the pathogenesis and clinical manifestations	Define DM study the pathogenesis and clinical manifestations	Define DM study the pathogenesis and clinical manifestations	Define DM study the pathogenesis and clinical manifestations
Understand the diagnostic approach of DM	Study history and physical examination Study diagnostic procedures	Study history and physical examination Study diagnostic procedures		

Table - Attitude

Learning Objectives	HO	Nurses	Environmental	Laboratory
To believe that screening of high risk individuals for DM can reduce the occurrence of clinical DM				

Table – Practice

Learning Objectives	HO	Nurses	Environmental	Laboratory
Demonstrate methods and techniques of Diabetic patient examination				
Label patients as high and low risk and follow them accordingly				
Manage diabetics related complication				
Identify risk factors				
Develop necessary skills on laboratory investigations				
Follow the standard reporting and recoding technique	perform the appropriate laboratory tests - Follow the scientific procedures to do the tests - order routine lab investigations	performappropriate laboratory tests - Follow the scientific procedures to do the tests - order routine lab investigations	perform the appropriate laboratory tests - Follow the scientific procedures to do the tests	perform the appropriate laboratory tests - Follow the scientific procedures to do the tests

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Keys for the pretest and post test questions for Nurses

1. A
2. C
3. C
4. E
5. A
6. C
7. A
8. C
9. D
10. a- site of injection
    -preparations of medication
    -Rotations
    -about syringe and needle
    -some problems with insulin injections
    b) -too much insulin
    -too little food or
    -excessive physical exercise
    -delay of meal or omitting of snacks
    c) -sweating
    -tremor
    -tachypnea
    -confusion
    -seizure
    -loss of consciousness
    d) Having snack, not delaying the meal, right dose of medications, having candies at hand
    f) -assess foot daily for sensation, redness and broken skins
    -wash dry feet daily
    -If skin is dry apply a thin coat of lubricating oil

-tie shoes loosely but firmly

-If your feet perspire, change shoe and stocking during the day

-wear shoe and stocking that gives room for the movement of the toe

Answer for environmental Health

1. E
2. D
3. D
4. A
5. E

Key for laboratory technicians

1. B	6. A
2. C	7. C
3. C	8. B
4. C	9. A
5. C	10.A