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Unraveling Diabetes Mellitus: From Past to Present and Beyond

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ABSTRACT:
Diabetes mellitus (DM) represents a significant global health challenge with its prevalence quadrupling over the last three decades, now ranking as the ninth leading cause of mortality worldwide. This review provides an in-depth exploration of DM, encompassing its historical perspective, underlying biochemical mechanisms, economic implications, and management strategies, while also shedding light on future perspectives. With approximately 1 in 11 individuals affected globally, Asia, particularly China and India, emerges as major epicenters of this epidemic. While genetic predisposition plays a role, lifestyle factors such as poor diet and sedentary habits contribute significantly to susceptibility. The paper underscores the importance of preventive measures, including maintaining a healthy weight, balanced diet, moderate alcohol consumption, and regular physical activity, in averting many cases of DM. Moreover, it delineates the pathophysiology and management approaches for both Type 1 and Type 2 DM, highlighting the role of insulin and oral hypoglycemic agents, alongside emerging herbal treatments. This comprehensive review aims to provide a consolidated resource for researchers and healthcare professionals, integrating updated epidemiological data, risk factors, complications, and therapeutic interventions pertinent to the multifaceted challenge of diabetes mellitus.

Keywords: Diabetes mellitus, global epidemic, Asia, China, India, lifestyle factors, preventive measures, Type 1 diabetes, Type 2 diabetes, insulin, oral hypoglycemic agents, herbal treatments.

I. INTRODUCTION:

Introduction: Diabetes Mellitus (DM) represents a metabolic disorder characterized by abnormal insulin secretion, action, or both, leading to hyperglycemia and perturbations in glucose, fat, and protein metabolism. This condition is classified into two main types: insulin-dependent diabetes (Type I) and non-insulin-dependent diabetes (Type II). Type I diabetes results from autoimmune destruction of pancreatic insulin-producing cells, whereas Type II diabetes arises from a combination of insulin resistance and insufficient insulin secretion. The complications associated with diabetes are numerous and severe, including cardiovascular diseases, peripheral vascular diseases, stroke, neuropathy, kidney failure, retinopathy, and visual impairment.

The global burden of diabetes has been escalating rapidly, with projections estimating a staggering increase from 200 million affected individuals in 2010 to over 300 million by 2025. Recognizing the gravity of this epidemic, guidelines and strategies for managing diabetes were first established in the mid-20th century, with successive updates and recommendations by authoritative bodies such as the World Health Organization (WHO) and the American Diabetes Association (ADA). These guidelines emphasize the importance of early diagnosis, effective management, and preventive measures to mitigate the adverse outcomes associated with uncontrolled diabetes.

II. HISTORYOF DIABETES MELLITUS :

Diabetes mellitus (DM) traces back over three millennia, mentioned in Egyptian literature around 1500 B.C. Indian physicians recognized the sweetness of diabetic urine, labeling it "Madhumeha." Ancient Indian texts by Susruta and Sharuka detailed symptoms and differentiated between type I and type II DM. Greek physician Aretaeus of Cappadocia coined the term "diabetes" and distinguished mellitus from insipidus. Thomas Willis added "mellitus" after rediscovering the sweetness of urine due to high blood glucose levels. Matthew Dobson confirmed excess glucose in blood and urine. Aulus Cornelius Celsus provided a clinicaldescription in Latin in 30 BC-50 AD. Claude Bernard established liver's role in glucose production in 1857. In 1889, von Mering and Minkowski's pancreas removal experiments linked pancreas to diabetes. Banting and Best's isolation of insulin in 1921 marked a monumental breakthrough in diabetestreatment, earning them the Nobel Prize in 1923.

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III. TYPES OF DIABETES MELLITUS

1. Type I Diabetes (Insulin Dependent Diabetes Mellitus)
- Characterized by autoimmune insulitis, resulting in the destruction of insulin-producing beta cells in the pancreas.
- Requires exogenous insulin therapy for survival.
- Can occur in children, young adults, and individuals of any age.
- Genetic and environmental factors, such as viral infections and certain chemicals, may contribute to its development.

2. Type II Diabetes (Non-Insulin Dependent Diabetes Mellitus)
- Most common type, comprising about 90% of diabetic cases.
- Typically occurs in adults.
- Body is capable of producing insulin, but it may not be sufficient or the body may be resistant to its effects (insulin resistance).
- Leads to elevated blood glucose levels due to ineffective insulin action.

3. Gestational Diabetes:
- Occurs during pregnancy, usually around the 24th week.
- Some women develop insulin resistance, possibly due to hormones produced by the placenta.
- Often resolves after delivery, but women with gestational diabetes have an increased risk of developing Type II diabetes later in life.

IV. SYMPTOMS OFDIABETES MELLITUS:

1. Polyuria: Increased urination.
2. Polydipsia: Excessive thirst.
3. Polyphagia: Excessive hunger.
4. Fatigue: Feeling unusually tired.
5. Unexplained weight loss.
6. Blurred vision.
7. Slow healing of wounds.
8. Numbness or tingling in hands or feet.
9. Recurrent infections, such as urinary tract infections or skin infections.
10. Dry, itchy skin.

IV. EPIDEMIOLOGY OF DIABETES MELLITUS:

- In 2011, approximately 366 million people had diabetes mellitus (DM), with projections indicating a rise to 552 million by 2030.
- Type 2 DM is on the rise globally, with 80% of affected individuals residing in low- and middle-income countries.
- DM contributed to 4.6 million deaths in 2011.
- By 2030, an estimated 439 million people are expected to have type 2 DM.
- The incidence of type 2 DM varies significantly across different geographical regions due to environmental and lifestyle risk factors.
- Predictions suggest a substantial increase in DM prevalence over the next two decades, particularly in developing countries, where the majority of patients are aged between 45 and 64 years.

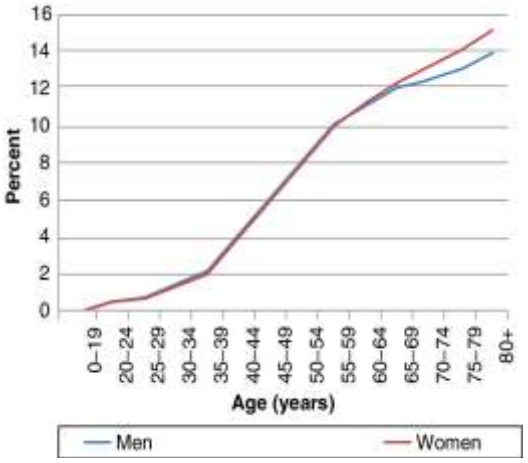

Fig no.1: Epidemiology of Diabetes

VI. PATHOPHYSIOLOGICAL ASPECTS :

Type 1 DM:
- Occurs predominantly in children or adolescents and is not typically associated with obesity.
- Has a strong genetic predisposition, with a 10-fold increased incidence in first-degree relatives.
- Initiated by exposure to environmental factors, such as viral infection, leading to autoimmune destruction of pancreatic beta cells.
- Overt diabetes occurs when more than 90% of beta cells are destroyed.

Type 2 DM:
- Characterized by insulin resistance, declining insulin production, and pancreatic beta-cell failure.

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- Results in decreased glucose transport into liver, muscle, and fat cells, along with increased fat breakdown and hyperglycemia.
- Often associated with obesity and typically manifests in adulthood, with incidence rising with age.

Pathophysiological Mechanisms:

- Both types of diabetes involve insulin resistance and impaired insulin secretion.
- Insulin resistance leads to beta-amyloid (Aβ) plaque formation and tau hyperphosphorylation.
- Hyperinsulinemia results in Aβ accumulation and plaque formation.
- Decreased insulin receptor signaling inhibits Akt and activates GSK-3β, leading to tau proliferation.

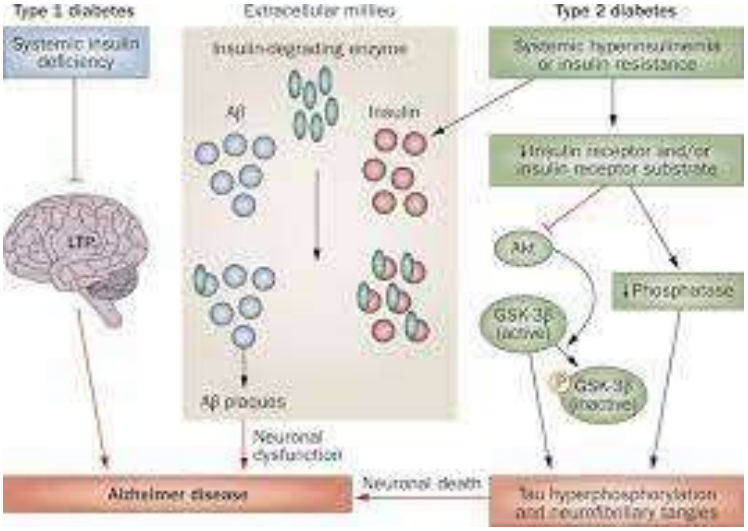

Fig no.2 :Pathophysiology of Type I and Type II diabetes. Abbreviations: Aß- Amyloid ß, GSK- 3ß-glycogen synthase kinase 3ß, LTP- long term potentiation- Phosphate

VII.DIAGNOSIS OF DIABETES MELLITUS:

According to the American Diabetes Association (ADA), the following criteria are used for diagnosing diabetes:

1. Fasting Plasma Glucose (FPG) Test:

- Fasting blood glucose concentration should be used in routine screening for diabetes.
- A fasting plasma glucose level ≥126 mg/dL (7.0 mmol/L) on two separate occasions indicates diabetes.

2. Postprandial Blood Sugar:

- Postprandial blood sugar levels are measured after meals.
- Elevated postprandial blood sugar levels may indicate diabetes.

3. Random Blood Sugar:

- Random blood sugar levels are measured at any time of the day, regardless of the timing of the last meal.
- A random blood sugar level ≥200 mg/dL (11.1 mmol/L), along with classic symptoms of diabetes, suggests diabetes.

4. Glucose Tolerance Test (GTT):

- GTT involves measuring blood sugar levels before and after consuming a glucose solution.
- A blood glucose level ≥200 mg/dL (11.1 mmol/L) two hours after ingesting the glucose solution indicates diabetes.

VIII. TREATMENT :

Insulin Therapy:

- Aims to mimic natural insulin secretion to regulate blood sugar levels effectively.
- Administration site of insulin injection is crucial for optimal action, can be intramuscular or intravenous.
- Various insulin preparations available, including human, beef, and pork insulin.
- Adverse effects include weight gain and hypoglycemia, particularly with inappropriate dosing or meal-insulin timing mismatch.

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Oral Hypoglycemic Drugs:

1. Sulfonylureas (e.g., glibenclamide, glipizide):
- Stimulate insulin release from pancreatic β-cells by binding to sulfonylurea receptors.
- Can cause hypoglycemia.
- Increases insulin secretion by reducing hepatic clearance.
2. Biguanides (e.g., metformin):
- Antihyperglycemic rather than hypoglycemic.
- Does not stimulate insulin release.
- Improves peripheral glucose uptake and reduces hepatic glucose output when administered orally.
- Possible mechanism involves impaired glucose absorption from the gut.

Herbal Treatment of Diabetes:

In recent decades, plant-based treatments have gained prominence due to their eco-friendly, bio-friendly, cost-effective, and relatively safe nature. With increased research in traditional medicine, herbal remedies have transitioned from the periphery to mainstream treatment options. Numerous authors have conducted literature reviews on anti-diabetic herbal agents, highlighting their potential benefits.

The World Health Organization (WHO) has identified 21,000 plants worldwide used for medicinal purposes, with India alone possessing 2500 species, 150 of which are utilized on a commercially significant scale. India is recognized as the largest producer of medicinal herbs and is often referred to as the "herbal garden of the world."

Alternative Therapies for Diabetes Mellitus:

Several effective alternative therapies have emerged for treating diabetes mellitus, particularly in India. These therapies offer high efficacy with minimal or no troublesome side effects, gaining popularity in recent years. Some notable alternative therapies include:

1. Yoga:
- Derived from the Sanskrit word 'Yuj,' meaning union of body, breath, and mind.
- Yoga exercises involve stretching of the abdomen, which can regenerate pancreatic cells and enhance glucose metabolism in peripheral tissues.
- Improved blood supply to muscles during yoga enhances glucose uptake and reduces blood glucose levels.
- Yoga practice also enhances lipid metabolism, increases insulin sensitivity in pancreatic β-cells, and improves overall metabolic health.

2. Acupuncture:
- Originally known for treating chronic pain, acupuncture has been explored for diabetes treatment.
- Stimulates the pancreas to increase insulin synthesis and enhances glucose utilization, leading to reduced blood glucose levels.
- While effective, the exact mechanism of action of acupuncture in diabetes treatment remains unclear.

3. Hydrotherapy:
- Hot-tub therapy is recommended for type II diabetes mellitus patients unable to perform regular exercise.
- Hot-tub therapy increases blood flow to skeletal muscles, leading to reduced body weight and improved glycemic control.
- Proper water sanitation and temperature control are essential when prescribing hot-tub therapy for diabetic patients.

4. Medicinal Plants:
- Ayurveda identifies numerous medicinal plants with antidiabetic properties, offering minimal or no side effects.
- Herbal preparations from these plants have been used since ancient times for managing diabetes.
- Common antidiabetic herbal plants include Aloe vera, Neem, Bitter Apple, Ivy Gourd, Gurmar, Karela, Mulberry, Tulsi, and Jamun.
- Modern allopathic medicines for diabetes are often developed from active chemicals found in these medicinal plants.
- Despite the wide acceptability of herbal medicines, the lack of standardized herbal drugs due to regulatory standards poses challenges for large-scale usage.

Overall, alternative therapies, including yoga, acupuncture, hydrotherapy, and medicinal plants, offer promising options for managing diabetes mellitus alongside conventional treatments.

IX. CONCLUSION:

In conclusion, diabetes mellitus (DM) poses a significant global health challenge, with its prevalence steadily rising over the past few decades. This comprehensive review explored the historical perspective, underlying mechanisms, epidemiology, and management strategies for DM.

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Lifestyle factors, genetic predisposition, and environmental influences contribute to the increasing prevalence of DM, particularly in Asia. Preventive measures, including maintaining a healthy lifestyle, are crucial in averting many cases of DM. The paper highlighted the pathophysiology and management approaches for Type 1 and Type 2 DM, emphasizing the role of insulin, oral hypoglycemic agents, and emerging herbal treatments. Additionally, alternative therapies such as yoga, acupuncture, hydrotherapy, and medicinal plants offer promising options for managing DM alongside conventional treatments. Overall, this review serves as a valuable resource for researchers and healthcare professionals, providing insights into the multifaceted challenge of diabetes mellitus and strategies to address it effectively.

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