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# Type I and Type II Diabetes Mellitus: Pathophysiology and Nursing Anesthesia Considerations

Megan Przybysz
*Otterbein University*, przybysz1@otterbein.edu

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*Megan Przybysz, BSN, RN, CCRN, CFRN*
*Otterbein University, Westerville, Ohio*

## Introduction

Diabetes Mellitus (DM) is a group of metabolic diseases "resulting from defects in insulin secretion, insulin action, or both "(McCance, 2014, p. 734).

- 22 Million people in the USA have DM (Pontes et al., 2017)
- 10-25% of people with DM don't know it (Cornelius, 2016)
- 7th leading cause of death in the US (Cornelius, 2016)
- $245 Billion in national healthcare costs (Cornelius, 2016)
- DM is the most common medical condition and 25% of diabetics will need surgery at some point (Moningi et al., 2018)
- DM I decreases life expectancy by 20 years, DMII by 10 years (Cornelius, 2016)

Because of the prevalence of DM in the US, it is imperative that the Nurse Anesthetist is knowledgeable about the pathophysiology of DM and how that may affect anesthetic care.

## Risk Factors

- Age greater than 45
- Hypertension
- Obesity (90% DM patients are obese) (Cornelius, 2016)
- Sedentary lifestyle
- Familial history

(Pontes et al., 2017)

## Signs and Symptoms

- Polyuria
- Polydipsia
- Weight loss
- Diabetic Ketoacidosis (DKA) (DM I only)
- Nocturia
- Hunger
- Blurred Vision
- Dry skin
- Slow Healing wounds

(McGinlay & Mruthunjaya, 2017; CDC, 2021)

## General Pathophysiology

- DM is result of the inability of the body to properly metabolize fats, proteins and carbohydrates, as a result of insufficient insulin or the inability to utilize insulin (Cornelius, 2016)
- Lack of insulin leads to glycogenesis and glycogenolysis by the liver, as well as a reduced uptake of glucose. (Levitsky, p.47, 2021)
- DM is often seen as a part of metabolic syndrome: increased triglycerides, insulin resistance, obesity, hypertension and hyperlipidemia (Levitsky, 2021)

In states of chronic hyperglycemia, glucose combines with free fatty acids. Accumulation of these glycation end products can lead to microvascular complications. (McGinlay & Mruthunjaya, 2017)

- Microangiopathic: endothelial hyperplasia and thickened capillary basement membranes lead to vasoconstriction and hypoxia, eventually leading to retinopathy, nephropathy, neuropathy, etc.
- Macroangiopathic: atherosclerosis and increased risk of blood clots (Moningi et al., 2018)

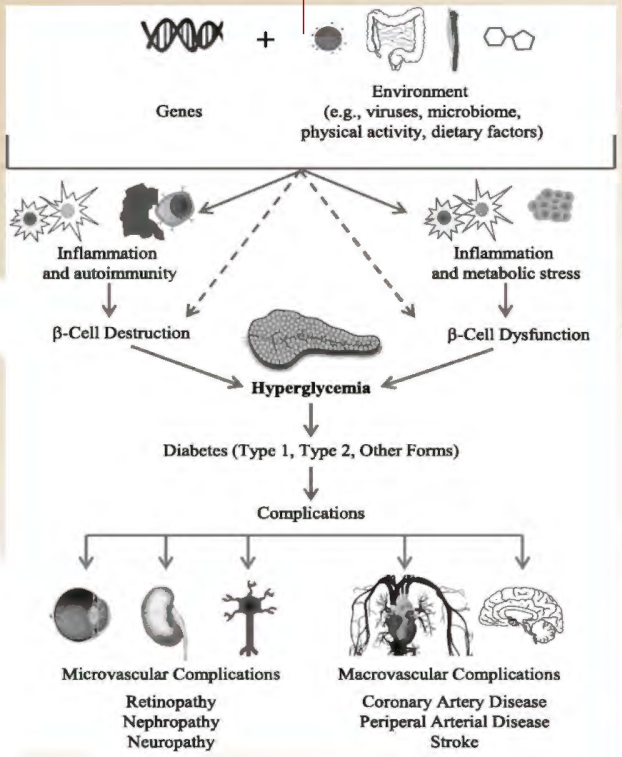


*Figure 1: Pathophysiology and Complications of Diabetes (Skyler et al., 2017)*

## Type I Diabetes

- Autoantigens expressed on pancreatic islet cells which activate T helper lymphocytes.
- Activation leads to inflammatory cytokine secretion
- Autoimmune destruction of pancreatic Beta cells in the Islet of Langerhans (McGinlay & Mruthunjaya, 2017)

## Type II Diabetes

- Pancreatic dysfunction due to "glycotoxicity, lipotoxicity and amyloid formation" (Pontes et al., 2017)
- Insulin resistance leads to insufficient of defective insulin secretion (McGinlay & Mruthunjaya, 2017)

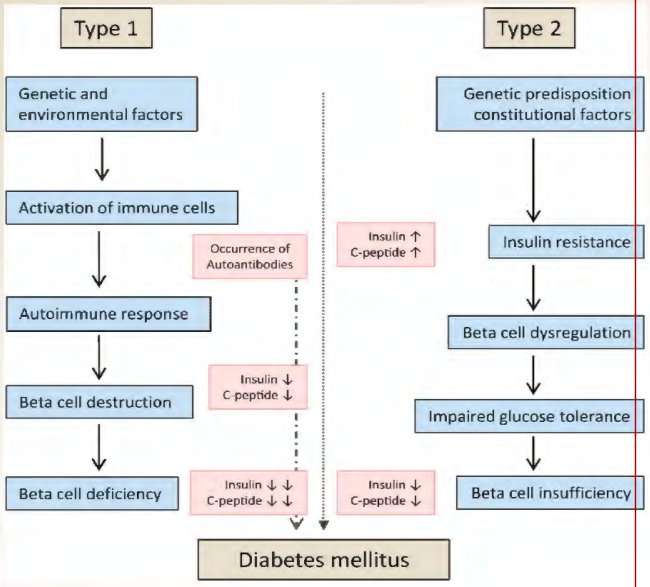


*Figure 2: Type I vs. Type II Diabetes (Horber et al., 2019)*

## Autonomic Neuropathy (AN)

- Present in approximately 20% of DM patients (Cornelius, 2016)
- "Glycosylation of endoneurial blood vessels may cause neural hypoxia, resulting in the dysfunction of the autonomic nerves of the heart" leading to increased risk if silent ischemia (Cornelius, 2016)
- AN can lead to the loss of autonomic responses to hypoglycemia (the patient will not show classic signs and symptoms of hypoglycemia) (Pontes et al., 2017)

AN affecting the vagus nerve causes:

1. Unopposed sympathetic nervous system (SNS) response leading to tachycardia
2. Impaired SNS response to cardiac output
3. Neurogenic bladder/ erectile dysfunction
4. Anemia from decreased erythropoietin production
5. Gastroparesis

(Cornelius, 2016; Moningi et al., 2018)

## Significance of Pathophysiology

- Only 14% of DM pts have no comorbidities (Cornelius, 2016)
- Comorbidities: obesity, cardiovascular disorders, hypertension, hyperlipidemia, chronic kidney disease (CKD), depression, sleep disorders, increased cancer risk (Cornelius, 2016)

Cardiovascular:

- Major cause of death in DM, 10x increase in death if heart rate over 105bpm for over 5 minutes in the postoperative period (Cornelius, 2016)
- Increased risk of hypertension, coronary artery disease, CHF, silent myocardial ischemia, and peripheral vascular disease (McGinlay & Mruthunjaya, 2017)
- Hyperglycemic states lead to "prothrombotic, proinflammatory, proatherogenic state and impairs vasodilation" (Pontes, et al, 2017)

Nephropathy:

- CKD present in 40% of DM patients (Cornelius, 2016)
- CKD leads to anemia, platelet dysfunction and albuminuria (Pones et al., 2017)

Hepatic

- Fatty liver disease is closely related to DM and obesity, leading to the development of non-alcoholic chronic liver disease and hepatocellular cancers (McGinlay & Mruthunjaya, 2017)
- Liver disease is one of the primary causes of death in DMII (Cornelius, 2016)
- Increased incidence of hepatitis B/C and hemochromatosis (Cornelius, 2016)

Immune System:

- DM I has 15% increased incidence of other autoimmune disorders (Pontes et al., 2017)
- Increased risk of hypothyroid, celiac disease, myasthenia gravis, and adrenal insufficiency (McGinlay & Mruthunjaya, 2017)

Peripheral:

- Peripheral neuropathy
- Stiff joint Syndrome: "glycosylation of proteins and abnormal collage cross linking in joint" as a result of chronic hyperglycemia (Pontes et al., 2017)

## Implications for General Nursing Care

- Decreased GI motility and increased gastric volumes from chronic hyperglycemia increase risk of vomiting and aspiration (Pontes et al., 2017)
- IV starts may be difficult due to diabetic scleroderma (Cornelius, 2016)
- Impaired blood flow may lead to delayed wound healing (Moningi et al., 2018)
- DMI patients MUST receive insulin to meet basal metabolic needs and prevent ketoacidosis (Pontes et al., 2017)
- NSAIDs/COX inhibitors decrease renal blood flow and may cause edema. Can cause acute renal failure or electrolyte imbalances (Pontes et al., 2017)

## Implications for Anesthetic Care

- Perioperative mortality is 50% higher with DM and more likely for perioperative complications(reintubation, longer post operative ventilator time, need for resuscitation (Pontes et al., 2017)
- Hyperglycemia can cause intra/post operative:DKA, wound infections/delayed healing, HHNK (Cornelius, 2016)
- Increased susceptibility to nerve injuries: increased risk with peripheral nerve blocks and vascular damage at block site (Moningi, 2018)
- Stiff neck syndrome can cause reduced mobility in the cervical spine, leading to increased difficulties in intubation (Pontes et al., 2017)
- Anesthesia can affect blood glucose via SNS tone: (Pontes et al., 2017)

1. GABA agonists reduce cortisol secretion
2. Clonidine reduces SNS and NE release
3. Inhaled anesthetics inhibit insulin

## Conclusions

- The decision to place a patient with DM under general anesthesia should not be taken lightly. There are many facets to consider
- Discussions between the surgeon, anesthesia provider and the patient are paramount to discuss acceptable blood glucose both before and during surgery.
- The successful management of DM and any complications allow for the best surgical outcome for the patient, not only the perioperative period, but also their post-surgical recovery

## References

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