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# Insulin resistance due to obesity

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## Introduction

Diabetes is defined as a common metabolic disorder where hyperglycemia or elevated glucose levels are prevalent (Shah & Vella, 2014). The most common form of diabetes is type two diabetes (T2DM) and effects around 9.3% of the population in the United States (Cornell, 2015, p. 631). The pathophysiology of this disease includes involvement from the pancreas, liver, skeletal muscle, adipose tissue, gastrointestinal tract, brain, and kidneys. Hyperglycemia is high blood sugar levels that effects multiple organs (Rymaszewski & Breakwell, 2013). Protocols are developed to allow nurses to identify and treat hyper/hypoglycemia. Patient education is a direct impact of the long term effects of this illness. Maintaining a blood glucose level of 80-110 for hospitalized patients is a key component to faster recovery and less hospital days (Dumont & Bourguignon, 2012). Obesity is directly related to an increase of diabetes in the United States. There are many risk factors for T2DM including age, race, pregnancy, stress, genetics, and obesity. Obesity leads to a decreased ability to produce insulin properly and development of T2DM. Diabetes is largely preventable by maintaining a healthy weight with proper diet and exercise.

## Underlying Pathophysiology

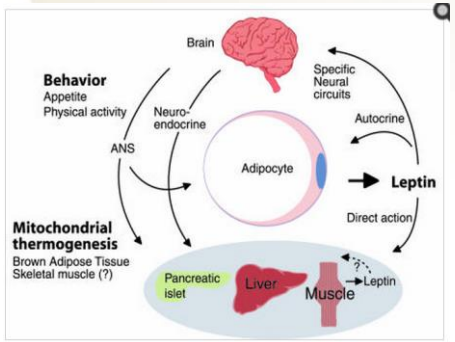
Insulin resistance T2DM is directly related to obesity. Obesity is due to a difference in the amount of energy used verses the amount of food eaten. The excessive accumulation of adipose tissue can lead to obesity and increased inflammation. Adipose tissue is where energy is stored and released. Energy is in the form of triglycerides. Adipose sites contain multiple cell types such as adipocytes, preadipocytes, endothelial cells, and immune cells. An excessive amount of fat accumulation promotes the release of free fatty acids. Hypertrophy or enlargement of adipocytes are associated with obesity and play an important role in insulin resistance. When energy is needed, such as with exercise, the triglycerides are mobilized by lipolysis and FFA's are released. The FFA's are then transported to other tissues and used as energy. FFA's are a key link to obesity and metabolic disorders such as insulin resistance T2DM (Jung & Choi, 2014). FFA's enter the liver portal, serve as a ligand-toll receptor, and produce cytokines and macrophages that cause inflammation.

## Pathophysiology of Diabetes

The pathophysiology of Diabetes involves multiple organs. The pancreas is responsible for the B-cell function and insulin secretion. People that have impaired glucose tolerance may have lost 80% of their b-cell function early on in the disease (Cornell, 2015). A decline in B-cell function is due to elevated glucose levels and free fatty acids, age, genetics, poor diet and lack of exercise. The liver is the main organ where glucose is produced. Diabetic patients have an overproduction of glucose by the liver (Cornell, 2015).).

Overproduction of hepatic glucose comes from gluconeogenesis and glycogenolysis. Gluconeogenesis is the formation of glucose from sources other than carbohydrates. The process takes place in the liver. Glucogenolysis is the process of glycogen forming into glucose. Glucose is needed for energy and metabolic function. The muscles aid in disposal of exogenous glucose and transportation of glucose to the skeletal muscles. Patients with T2DM have a resistance to the action of insulin in the muscles due to lack of physical activity. This causes a decrease in the glucose uptake, which further leads to hyperglycemia. The adipose tissue become resistant to insulin which leads to an excess amount of free fatty acids (FFA) in the blood stream. Chronic high levels of FFA's stimulate gluconeogenesis. "Brown fat" is a very metabolically active adipose tissue found in patients with weight control concerns (Cornell, 2015. Newer research suggest that brown fat may play an important role in how the body metabolizes glucose and energy production. Insulin crosses the blood brain barrier and can become resistant over time. Leptin is a hormone that acts on the hypothalamus by controlling food intake and energy (Cornell, 2015). Many patients with T2DM are obese and have high levels of circulating leptin. Amylin is a peptide that is secreted from B-cells along with insulin. It works to slow digestive emptying and reduce glucagon release.

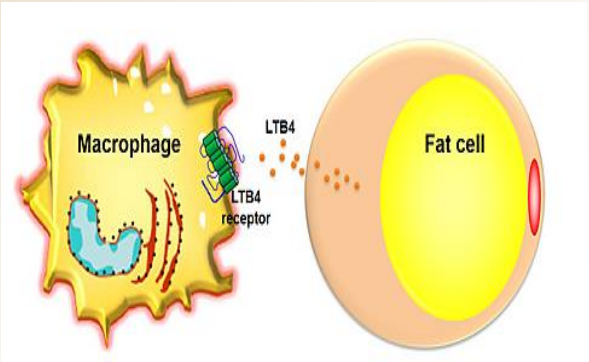
Since patients with T2DM have a decrease production of B-cells, amylin secretion is also decreased. Glucagon-like peptide (GLP-1) and glucose-dependent insulin tropic polypeptide (GIP) are released by the gastrointestinal tract and stimulate the release of insulin. There is a decline in production of GLP-1 and GIP, which results in hyperglycemic effects. The kidneys work to filter the glucose. When the glucose levels exceed the renal threshold (180ml/dL) the glucose is excreted into the urine. Patients with T2DM are able to absorb glucose by the kidneys and return it to circulate in the body causing hyperglycemia (Cornell, 2015).




Note: adapted from Molecular Link between Obesity and Type 2 Diabetes Reveals Potential Therapy (2015).

## Significance of Pathophysiology

Insulin resistance is a decreased ability for the tissues such as adipose tissue to react to insulin. Insulin is activated by binding to the cell receptor causing phosphorylation of the insulin receptor substrate (IRS) proteins that signal two pathways. These pathways aid in the transport of glucose to the plasma membrane, resulting in hypertrophic adipose tissue. Obesity produces extracellular concentrations of lipids and abundance accumulation of macrophages in adipose tissue which causes insulin resistance. Inflammation, cytokines and other bioactive substances are linked to obesity induced insulin resistance. The significant impact of obesity has nearly doubled from 1980 to 2008 (Jung & Choi, 2014). This fast growing concern with obesity related insulin resistance leads to the development of T2DM along with other health conditions such as heart disease, stroke, retinopathy, encephalopathy, neuropathy, and peripheral vascular disease (Jung & Choi, 2014).




Note: adapted from Intensifying type 2 diabetes therapy: assessing the options by Brunton, S. A. (2010).

## Nursing Care

The first line of treatment for a newly diagnosed T2DM is metformin and exercise (Brunton, 2010). Unfortunately, side effects of Metformin include hypoglycemia and weight gain. According to Dumont and Bourguignon, the insulin dosage calculator improves the patients' blood glucose measurements, as well as increasing nurse's satisfaction by decreasing amount of workload needed for diabetic patient control (Dumont & Bourguignon, 2012). Best practice shows that dosing insulin based on weight, carbohydrates, and blood glucose improves overall control. Scientist are continuing to understand what pharmacological and non-pharmacological approaches are best for this disease. A recent research noted that an increased body mass index (BMI) directly correlated with insulin resistance and is due to the increase in abdominal adiposity (Cummings, Dubose, Imai, & Collier, 2009). It is suggested that a low cardiorespiratory fitness will help patients decrease their BMI and abdominal adiposity. Caring for patients with T2DM requires close monitoring, great glycemic control, encouraging exercise, and addressing the underlying cause of hyperglycemia (Casey, 2011). The hemoglobin (A1C) should be monitored in diabetic patients at least two times a year if levels are under control, and up to four times a year for patients with uncontrolled diabetes (Cornell, 2015). Diabetes signs and symptoms include: polyuria (excessive amounts of urine), polydipsia (excessive thirst), polyphagia (excessive hunger), and fatigue (Casey, 2011)

## Conclusion

There is no cure for T2DM. Physicians, nurse practitioners, and nurses play a key role in the education about this disease, including how to prevent and manage T2DM. Oral medication and insulins are effective treatment options, but ultimately controlling the glucose levels by diet and exercise help decrease the severity of the illness. Diabetes can affect many other organs including your heart, kidneys, brain, eyes, and vascular system. Optimal glucose control is achieved by early diagnosis and intense treatment. Diet and exercise play a key role in decreasing the risk of developing T2DM. Understanding how to keep a body mass index below30 $kg/m^2$ will help with insulin resistance.


Note: adapted from National Institute of diabetes and digestive and Kidney disease. (2015).

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## Additional resources:

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