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Necessity for Excellent Glycemic Control Before, During and After CABG Surgery

Sheri Clouse
Otterbein University, sheri.clouse@otterbein.edu

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Sheri Clouse, RN, CDE, Diabetic Education Coordinator at Marion General Hospital

Otterbein University, Westerville, Ohio

Case Study

A 72 year old male patient was admitted to the hospital presenting with sharp sub-sternal pain and pressure to the left upper chest rated a "10" out of 10. Patient complained of chest pain even at rest which was relieved by a nitroglycerin infusion. Patient had established coronary artery disease as evidenced by five prior stent placements, with the last stent placement being in 2010. The patient also presented to the Emergency Room with a blood glucose level over 600 mg/dL and because of his complaints of chest pain, was transferred to a neighboring hospital facility to have a cardiac catheterization procedure. Past medical history included: uncontrolled type 2 diabetes with an A1c value of 10.0 %, coronary artery disease, hyperlipidemia, hypertension, gastroesophageal reflux disease (GERD), and osteoarthritis. Cardiac catheterization procedure was performed and recommendation for him to have open heart surgery due to three vessels being 90-100% occluded was given. Patient underwent three vessel coronary artery bypass graft procedure (CABG) the following week and was discharged to an extended care facility (ECF) for rehabilitation another week later after having difficulty managing blood sugars under 225 mg/dL. Other postoperative course in the hospital was unremarkable and uneventful.

One week later, the patient was re-admitted to the hospital with blood sugars in the 400 mg/dL range and complaints of increased soreness to the chest in the incision area. The sternal wound showed signs of dehiscence to the point of stretching the sternal wires. After two days of antibiotic therapy, patient underwent mediastinal exploration with removal of sternal wires and sternal plate, and an advanced pectoralis flap surgery was performed. Patient returned to the ECF for rehabilitation after being medically stabilized. Two months later, the patient was re-admitted to the hospital for signs and symptoms of wound infection. After antibiotic treatment, the patient returned to the ECF for the remainder of rehabilitation.

Unfortunately, this is a true case study and occurs in many facilities across the country. What could have been done differently to facilitate a better outcome?

Introduction

The stress of surgery has often been explained as a major factor in patients experiencing hyperglycemia in the acute hospital setting. Quantifying the effects of poor glycemic control in hospitalized patients is often difficult. Numerous studies have been conducted to focus on better blood sugar management for medically hospitalized patients, but far fewer have been conducted to show the poor outcomes from hyperglycemia with surgical patients. In many patients, the stress of surgery can cause high blood sugars due to increased stress hormones such as epinephrine and norepinephrine. Growth hormone, glucagon, gluconeogenesis, and cortisol levels also increase under stressful conditions contributing to a worsening hyperglycemic state. Another problem that arises is a decrease in insulin levels due to reduced secretion from the pancreas and increased insulin resistance at the receptor sites on muscle cells (Raju, Torjman, & Goldberg, 2009, p. 1283).

A study conducted by the Department of Endocrinology at Boston University Medical Center was able to surmise that up to 80% of patients that had cardiac surgery developed high blood sugars over 200 mg/dL at some point in the surgical process. This suggests prolonged length of stay and increased hospital costs (Alexanian, McDonnell, & Akhtar, 2011, p. 1).

Another study conducted by the Department of Cardiothoracic Surgery at The Boston Medical Center states that up to 40 % of patients having a coronary artery bypass graft procedure (CABG) already have a diagnosis of either diabetes or metabolic syndrome. These patients are at very high risk of needing repeat procedures and hospitalizations due to poor healing and increased infection of the incisions to the chest and to the sites of the graft vessels (Lazer, 2012, p. 1).

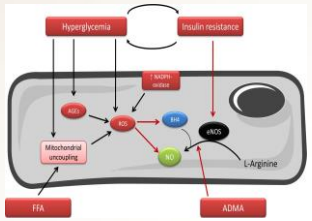
The goal of this poster presentation is to demonstrate how excellent glycemic control before, during, and after coronary artery bypass graft procedure can dramatically decrease mortality and morbidity for these patients.

Detrimental Effects

In normal heart function, the main energy source for the non-ischemic myocardium is free fatty acids. During ischemic events, free fatty acids can no longer be used as the myocardium's energy source, and so, glucose is chosen. In diabetic patients who are already insulin resistant, impaired glucose metabolism leads to increased serum glucose levels. Increased levels of free fatty acids due to ischemia increases oxygen use, creates insulin resistance, decreases pumping ability, increases risk of lethal arrhythmias, increases risk for thrombus and plaque rupture, and impairs function of platelets. An increased blood sugar over 250 mg/dL can place a patient at a 10-fold increase of complications after surgery (Lazer, 2012, p. 1-2).

Hyperglycemia impairs wound healing by hindering collagen production leading to decreased strength in the surgical wound placing the patient at high risk for dehiscence. Infection risk is increased due to impairment of leukocyte phagocytosis and chemotaxis (Lynn Gieger, 2009, p. 12). During surgery, insulin requirements increase due to increased insulin resistance caused by hypothermia, increased glucose from cardioplegic solution, and inotropic support.

All of these factors combined place the diabetic patient at extreme risk of wound dehiscence, infected incision, and sepsis thereby increasing the risk of mortality (Lazer, 2012, p. 4). Medical staff must be vigilant in excellent blood sugar control to prevent these complications.



1—*Principal mechanisms responsible for endothelial dysfunction in diabetes. NO is the principal anti-atherosclerotic endothelium-derived mediator. It is formed from L-arginine by eNOS, being tetrahydrobiopterin (BH4), a crucial cofactor for the reaction. Endothelial dysfunction is defined by the presence of a reduced NO bioavailability. In the presence of diabetes, characterized by the existence of insulin resistance and hyperglycemia, endothelial dysfunction is due to both reduced production (increased circulating levels of the eNOS endogenous inhibitor asymmetric dimethylarginine [ADMA], decreased cellular levels of BH4 and decreased eNOS activation) and to an increased breakdown of NO by ROS. AGEs, advanced aging end products; FFA, free fatty acids (*Versari, Daghini, Virdis,Ghiadoni, & Taddei, 2009 pS314.

Implications for Nursing

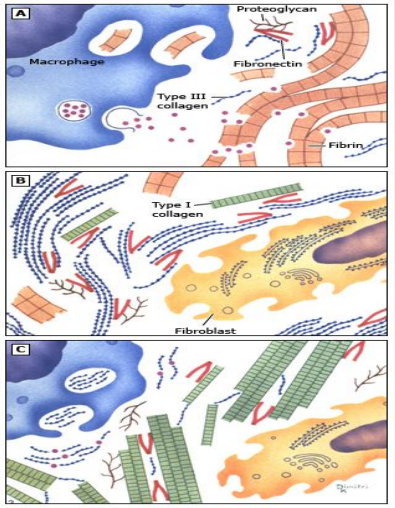
Nurses play a vital role in the management of the insulin infusion in the ICU setting. According to the hospital's algorithm, titration of the infusion rate is managed by hourly blood sugar measurements. Nurses must be knowledgeable in the management of diabetic patients as often, their needs for insulin change in the postoperative setting. Staff education regarding management of the insulin infusion, parameters for expected blood sugar values, and when to notify the physician should be completed. Patient education must be performed at every juncture within the surgery process. Instruction is given during pre-admission testing as to whether to give or hold home oral hyperglycemics as well as how much of the insulin dose to be given 24 hours prior to surgery. Sternal precautions need to be taught and reinforced throughout the hospital stay. Lastly, prior to discharge, the bedside nurse gives instruction regarding home medications to be taken , dietary regimen, and frequency of blood sugar measurements to be recorded.

Role of Insulin During CABG Procedure

IV insulin during CABG surgery and the post-operative period is the preferred choice of correction of increased blood sugars due to its short half-life and rapid action. IV insulin should be maintained for at least 24 hours after surgery to ensure the best blood sugar management (Alexanian, McDonnell, & Akhtar, 2011, p. 2). Studies show that insulin encourages myocardial glucose uptake, inhibits release of free fatty acids, and reverses the harmful effects of oxidative stress caused by hyperglycemia on the myocardium. Insulin has also been shown to better preserve the neutrophil's phagocytic function which can aid in reduction of wound infections often seen in diabetic CABG patients (Lazer, 2012, p. 2) Metformin is recommended to be discontinued for 48 hours prior to surgery and not restarted until kidney function is optimal. Metformin can increase the risk for lactic acidosis in the intraoperative period (Raju, Torjman, & Goldberg, 2009, p. 1283). IV insulin can be used in lieu of metformin throughout the hospital stay. The guidelines to postpone CABG surgery due to poor blood sugar control has not been established at this time. Surgeons and medical staff must consider several factors including: urgency of surgery, overall health of the patient, and metabolic status to ensure the best possible outcome for the diabetic cardiac patient (Alexanian, McDonnell, & Akhtar, 2011, p. 2). The blood sugar goal to best ensure optimal healing is under 180 mg/dL and most easily attained by IV insulin infusion (Lazar, et al., 2009, p. 3).

Other Factors Causing Dysfunction in Blood Sugar Management

Cardioplegic solution often used to paralyze the heart in order to perform CABG surgery contains amino acids, MSG (Monosodium glutamate), MSA (monosodium aspartate), CPD (Citrate Phosphate Dextrose Solution), Dextrose, Thromethamine, and KCL. The dextrose present in cardioplegic solution serves as a substrate for glycolysis to supply the myocardium during the bypass procedure, however, the additional glucose load leads to increased hyperglycemia and insulin resistance in the already compromised diabetic heart (Minasian, Galagudza, Dmitriev, Kurapeev, & and Vlascov, 2013, p. 3).



Summary of the healing process.
Intermediate phase of the repair reaction.
(A) As a new extracellular matrix is deposited at the wound site, the initial fibrin clot is lysed by a combination of extracellular proteolytic enzymes and phagocytosis.
(B) Concurrent with fibrin removal, there is deposition of a temporary matrix formed by proteoglycans, glycoproteins, and type III collagen.
(C) Final phase of the repair reaction. Eventually the temporary matrix is removed by a combination of extracellular and intracellular digestion, and the definitive matrix, rich in type I collagen, is deposited.

Conclusion

Hyperglycemia during CABG and cardiac procedures increases the likelihood of complications caused by increased release of free fatty acids, inflammation and oxidative vascular stress. Poor neutrophil phagocytic function and decreased collagen production in the sternal wound leads to increased risk for infection and wound dehiscence in the post-operative phase. Insulin infusion during the procedure, and 24 hours post procedure, helps ensure blood sugar management under 180 mg/dL, where experts have determined the point of lowest risk for complications during recovery. Nurses are pivotal in the role of insulin infusion management in the ICU. Nurses, physicians, and other supportive personnel need to work together to promote the environment that excellent glycemic control is necessary in the management of diabetic patients before, during, and after CABG and cardiac procedures to ensure the best outcomes for their patients.

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Picture of CABG procedure obtained through www.uptodate.com Oct. 2014.

Picture of Summary of the Healing Process obtained through www.uptodate.com Oct. 2014.

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