Comparison between Glucose Containing Solution D2.5% and Ringer Lactate as a Maintenance Fluid Management in Infants Undergoing Inguinal Hernia Repair

Thesis

Submitted for Partial Fulfillment of Master Degree
in ***Anesthesia, Intensive Care and Pain Management***

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2019

سورة البقرة الآية: ٣٢

Acknowledgments

First and foremost, I feel always indebted to ***Allah*** *the Most Beneficent and Merciful.*

I wish to express my deepest thanks, gratitude and appreciation to ***Prof.Dr.Dalia Abd El Hameed Mohamad Nasr****, Professor of Anesthesia, Intensive Care and Pain Management, Faculty of Medicine, Ain Shams University, for her meticulous supervision, kind guidance, valuable instructions and generous help.*

Special thanks are due to ***Dr. Amin Mohamed El Ansary****, Lecturer of Anesthesia, Intensive Care and Pain Management, Faculty of Medicine, Ain Shams University, for his sincere efforts, fruitful encouragement.*

I would like to express my hearty thanks to my father , mother , brother , sisters and great thanks for my wife and my son Malek for their support and prayers till this work was completed.

Mohammed Hosny Hasan Mohamed

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List of Abbreviations

Abb.	Full term
α	*Alfa*
Acetyl-CoA	*Acetyl coenzyme A*
ACLS	*Advanced cardiac life support*
AIDS	*Acquired immunodeficiency syndrome*
ASA	*American Society of Anesthesiologists*
Atls	*Advanced trauma life support*
ATP	*Adenosine triphosphate*
B-cells	*Beta cells*
BG	*Blood glucose*
cAMP	*Cyclic adenosine monophosphate*
ECG	*Electrocardiogram*
ED	*Emergency department*
EGDT	*Early use of "goal-directed therapy*
EGP	*Endogenous glucose production*
ELBW	*Extremely low-birth weight*
FADH	*Flavin adenine dinucleotide*
FFA	*Free fatty acid*
GIP	*Glucose-dependent insulinotropic peptide*
GLP	*Glucagon-like peptide*
GLUT2	*Glucose transporter 2*
GPCRs	*G-protein-coupled receptors*
GTP	*Guanosine 5' triphosphate*
HI	*Hyperinsulinism*
HR	*Heart Rate*
ICU	*Intensive care unit*
IR	*Insulin Receptor*
IV	*Intravenous*
IVFs	*Intra venous fluids*

List of Abbreviations cont...

Abb.	Full term
LBW	*Low birth weight*
NADH	*Nicotinamide adenine dinucleotide*
NIBP	*Non-Invasive Blood Pressure*
NO	*Nitric oxide*
PACU	*Post-anesthesia care unit*
PALS	*Pediatric advanced life support*
PNDM	*Permanent neonatal diabetes mellitus*
RBS	*Random blood sugar*
RQ	*Respiratory quotient*
SD	*Standard deviation*
SGA	*Small for gestational age*
SIRS	*Systemic inflammatory response syndrome*
SPO2	*Peripheral capillary oxygen saturation*
SPSS	*Statistical package for social sciences*
TNDM	*Transient neonatal diabetes mellitus*

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INTRODUCTION

Children have low glycogen stores in the liver, which results in a rapid decrease in endogenous glucose production (EGP). This explains why in particular children younger than three years experience hypoglycemia more readily than adults do during periods of fasting ***(Zijlmans-Wilco et al., 2009)***.

The brain derives 90% of its energy from glucose during times of fasting and the ratio of a baby's brain-to-body weight is six times higher than that of an adult: the brain of a 3 kg newborn weighs 400 g, while an adult's brain weighs 1400 g ***(Zijlmans-Wilco et al., 2009)***.

Infants and neonates are at particular risk of hypoglycemia when suffering from sepsis, asphyxia and hypothermia ***(Zijlmans-Wilco et al., 2009)***. A prospective study showed that up to 20% of preterm infants who were ready for discharge were still at risk of hypoglycemia when a feed was delayed ***(Hume et al., 2005)***. In contrast, surgery and critical illness may cause hyperglycemia ***(Huidekoper et al., 2014).***

Hyperglycemia is harmful to the nervous system, especially when associated with ischemia or hypoxia, and may additionally lead to an osmotic diuresis with subsequent dehydration ***(Arya, 2012).***

Careful glucose management is therefore required in neonates and infants, especially in infants with co-morbidities.

Under anesthesia the metabolic rate, and therefore demand, decreases while the stress response leads to an increase in endogenous glucose production ***(Berleur et al., 2003).***

It was shown that giving 0.9% or 1% dextrose in Ringer's lactate as maintenance in anesthetized children maintained glucose levels, and even improved glucose levels in some hypoglycemic patients, without causing hyperglycemia ***(Berleur et al., 2003).***

The Association of Pediatric Anesthetists of Great Britain and Ireland's guidelines on perioperative fluid management do not recommend that dextrose-containing maintenance fluid be given to healthy infants, and that infants at risk of hypoglycemia be monitored intraoperatively while dextrose can be added to maintenance fluid ***(Sümpelmann et al., 2011).*** However the European Association of Pediatric Anesthetists, recommend the use of an isotonic maintenance solution containing 1–2.5% dextrose for infants ***(Murat and Dubois, 2008; Amod et al., 2012).***

Normal glucose values: - Hyperglycemia can be defined in terms of diabetes, which is diagnosed in infants if the fasting glucose is 7.0 mmol/l or higher, or the post glucose challenge value is 11.0 mmol/l ***(Adamkin, 2015).***

Glucose as low as 2.2 mmol/l have been used as cut of for hypoglycemia or 2.5 mmol/l in neonates ***(Zijlmans-Wilco et al., 2009)***.

AIM OF THE WORK

Assessment of glucose containing solutions 2.5 % as a maintenance fluid management intra operative in infants undergoing hernia repair as regard hyperglycemia and hypoglycemia.

Chapter 1

PHYSIOLOGY OF GLUCOSE METABOLISM

Glucose homeostasis is tightly regulated to meet the energy requirements of the vital organs. The liver has a major role in the control of glucose homeostasis by controlling various pathways of glucose metabolism, including glycogenesis, glycogenolysis, glycolysis and gluconeogenesis. Allosteric control by various metabolic intermediates constitute the acute control of these pathways, and the controlled expression of the genes encoding these enzymes represents the longer-term regulation of these metabolic pathways ***(Han et al., 2016).***

Under feeding conditions, dietary carbohydrates are digested by various glucosidases, and the resultant monosaccharide hexose glucose, are transported into various tissues. The catabolism of glucose into pyruvate, termed glycolysis, is preserved as a major pathway in eliciting ATP. In tissues with abundant mitochondria, cytosolic pyruvate is transported into the mitochondrial matrix, converted to acetyl-CoA by pyruvate dehydrogenase complex, and incorporated into the tricarboxylic acid cycle in conjunction with oxaloacetate. The cycle generates energy equivalent to ATP (that is, GTP) as well as both NADH and $FADH_2$, which are electron carriers for electron transport chain-oxidative phosphorylation, resulting in the generation of ATP ***(Jeon et al., 2012).***

In some cases, such as red blood cells lacking mitochondria, pyruvate is converted into lactate in the cytosol to regenerate the NAD^+ that is necessary for the continued generation of ATP by substrate-level phosphorylation via anaerobic glycolysis. Excess carbohydrates in the liver are converted into glycogen by glycogenesis. Besides, the excessive dietary carbohydrates are also converted into fatty acids via lipogenesis using the acetyl-CoA generated from glycolysis-driven pyruvate, which is incorporated into very low density lipoproteins for transport to adipose tissue ***(Brouwers et al., 2015).***

Under fasting conditions, the liver has a major role in generating glucose as a fuel for other tissues, such as the brain, red blood cells and muscles. Initially, an increase in the pancreatic hormone glucagon initiates the cascade of kinase action that releases glucose from the stored glycogen via glycogenolysis. Normally, stored glycogen is critical for maintaining glucose homeostasis overnight ***(Agius, 2015).***

During a longer term fast or starvation, stored glycogen in the liver is depleted, and gluconeogenesis is responsible for the generation of glucose. Major non-carbohydrate precursors for gluconeogenesis are lactate, which is transported from peripheral tissues such as skeletal muscles or red blood cells, and glycerol, which is released from the adipose tissues via enhanced lipolysis during fasting. Most of the initial precursors for gluconeogenesis are generated in the mitochondria (except glycerol 3-phosphate

via glycerol kinase activity), but the majority of the reaction occurs in the cytosolic part of the cell ***(Ros et al., 2009).***

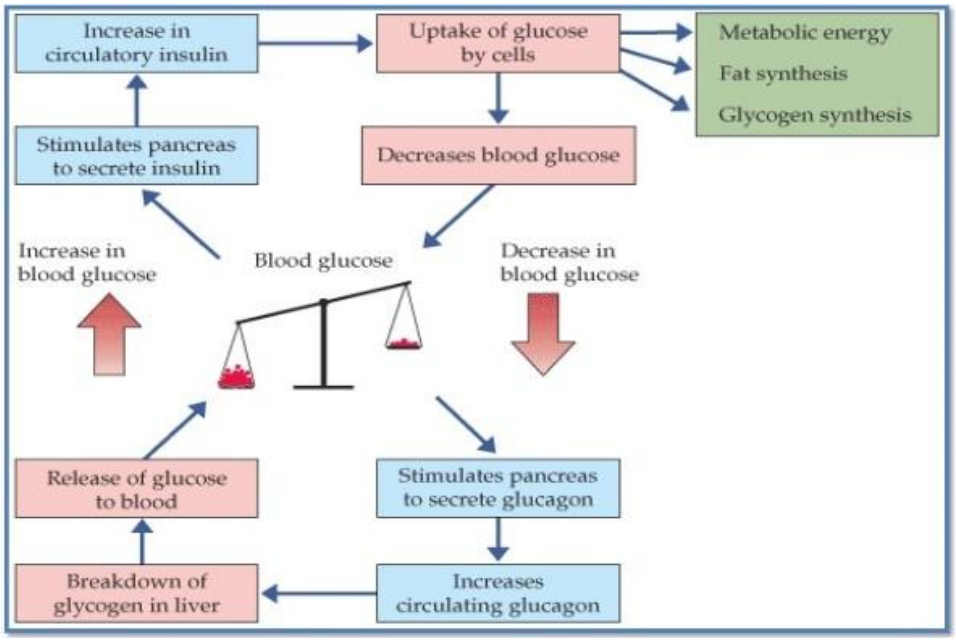

Figure 1: Glucose homeostasis: roles of insulin and glucagon.

This figure shows that when serum blood glucose level is lowered, pancreas secretes glucagon which breakdown glycogen in liver to increase serum blood glucose level . while in the other hand when the level of serum blood glucose level increases the pancreas secretes insulin that increases the uptake of glucose by cells so the level of blood glucose level returns to normal ***(Aronoff et al., 2004).***

The Glucoregulatory Hormones

Insulin

Insulin, a small protein composed of two polypeptide chains containing 51 amino acids, is a key anabolic hormone that is secreted in response to increased blood glucose and amino acids following ingestion of a meal. Insulin affects glucose transport via binding of Insulin Receptor (IR) in organ systems involved in glucose regulation, including fat, liver, and muscle cells. The primary action of insulin is to stimulate glucose disappearance. Insulin helps control postprandial glucose in three ways. Initially, insulin signals the cells of insulin-sensitive peripheral tissues, primarily skeletal muscle, to increase their uptake of glucose ***(Rorsman and Braun, 2012).***

Secondly, insulin acts on the liver to promote glycogenesis. Finally, insulin simultaneously inhibits glucagon secretion from pancreatic B-cells, thus signaling the liver to stop producing glucose via glycogenolysis and gluconeogenesis. Other actions of insulin include the stimulation of fat synthesis, promotion of triglyceride storage in fat cells, promotion of protein synthesis in the liver and muscle, and proliferation of cell growth. In addition, several factors highlight insulin's antioxidant, antithrombotic, and antifibrinolytic properties ***(Morello et al., 2009).***