Perioperative Anesthetic Management of Diabetic Children in Emergency Conditions

An Essay

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ABSTRACT

Pediatric patients with diabetes are managed with increasingly complex regimens that have direct implications for their perioperative care. In addition to recognizing the relevant differences among diabetes treatment regimens, pediatric anesthesiologists must also consider a child's metabolic control, age, size, pubertal development, the intended surgical procedure, and its length when devising a perioperative plan.

As diabetes treatment options for children continue to change, such algorithms will need to be updated. Formal assessment of the impact of such algorithms on clinical outcomes, satisfaction with care, and cost of care would provide additional insight into their revision.

Emergencies in pediatric diabetic patients could be; medical, that include hypoglycemia or hyperglycemia and DKA or surgical, that include victims of polytrauma and supracondylar fractures, airway foreign bodies, post tonsillectomy bleeding or pyloric stenosis.

New guidelines has been postulated for the management of diabetic patients throughout surgical interference as tight glycemic control in diabetic patients undergoing major surgery wether elective or emergency has been shown to improve perioperative morbidity and mortality rates.

However, this aggressive strategy requires frequent monitoring of blood glucose concentrations as surgery induces a considerable stress response mediated by the neuroendocrine system through the release of catecholamines, glucagon and cortisol which results in peripheral insulin resistance, increased hepatic glucose production, impaired insulin secretion, fat and protein breakdown and potential hyperglycemia and even ketosis in some cases.

The regimen selected to manage diabetics undergoing surgery has become standardized in most facilities in recent years with a target glucose and maintenance in the range of 80-110 mg/dl but still the key to success of any regimen is careful frequent monitoring to detect any alterations in metabolic control and correct them before they become severe.

Although the mechanism by which to achieve optimal diabetes control in the perioperative period may still be debated, recognition that hyperglycemia may have deleterious short-term as well as long-term consequences highlights the importance of consistently aiming for this goal in the perioperative period just as in the outpatient setting.

INDEX

LIST OF ABBREVIATIONS

ACTH	Adrenocorticotropic hormone
ADA	American diabetes association
AVPU scale	Alert, responsive to Voice, responsive to Pain or Unresponsive
BOHB	blood ß-hydroxybutyrate
cAMP	cyclic Adenosine monophosphate
CRT	capillary refill time
DKA	diabetic ketoacidosis
DM	diabetes mellitus
DPP-4	dipeptidyl peptidase-4
FFA	free fatty acids
FPG	fasting plasma glucose
GA	general anaesthesia
GAD65	Glutamic acid decarboxylase autoantibodies
GCS	Glasgow Coma Scale
GIP	glucose-dependent insulinotropic peptide / gastric inhibitory polypeptide
GLP-1	Glucagon-like peptide-1
HLA	human leucocyte antigen
IAAs	Insulin autoantibodies
ICAs	Islet cell autoantibodies

IDDM	Insulin dependant diabetes mellitus
IFG	impaired fasting glycemia
IGT	impaired glucose tolerance
ISPAD	International Society for Pediatric and Adolescent Diabetes
IV	intra venous
LADA	Latent Autoimmune Diabetes in Adults
MODY	maturity onset diabetes of youth
OGTT	oral glucose tolerance test
OR	The operating room
T1DM	type 1 diabetes mellitus
T2DM	type 2 diabetes mellitus

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Surgical operations needing general anesthesia carry a greater risk to the child with diabetes than to the child without diabetes. Every such surgical procedure and anesthesia should be taken seriously and meticulously to prevent perioperative hypoglycemia, hyperglycemia, or electrolyte disturbance. ***(Rhodes et al,2005)***

Surgical operations for children with diabetes include elective surgeries. About half of these are for dental procedures and the rest mostly for ear, nose, and throat operations. They also include emergency operations such as appendectomy or trauma. ***(Chadwick and Wilkinson, 2004)***

Goals of anesthetic management of diabetic child are to minimize physiological stress, to maintain euglycemia, to avoid ketoacidosis and to minimize the risk of postoperative infection. ***(Diab, 2003)***

The peri-operative plan should be developed in consultation with a pediatric endocrinologist, as management of these patients is becoming increasingly complex due to the complexity and variability of current diabetes treatment options. ***(McCavert et al, 2010)***

Anesthesiologist must carefully consider not only the pathophysiology of the disease, but also each child's specific diabetes treatment regimen, glycemic control, child metabolic state, age, pubertal development, intended surgery and its length, and anticipated postoperative care when devising an appropriate perioperative management. ***(Glister and Vigersky, 2003)***

Optimal management should maintain adequate hydration and near to normal glycemic control, while minimizing the risk of hypoglycemia. The stress of surgery may cause acute hyperglycemia, which increases the risk of postoperative infection. ***(Van den berghe, 2003)***

Centers performing surgical procedures on children with diabetes should have available written protocols for post-operative management of diabetes on the wards where children are admitted. ***(Marik and Bellomo, 2013)***

AIM OF THE WORK

The aim of our essay is to discuss the proper perioperative anesthetic management of a diabetic child in emergency conditions to maintain euglycemia and minimize the physiological stress of surgery, thus avoiding the possible complication in the form of hyperglycemia, hypoglycemia and ketoacidosis.

CLASSIFICATION AND DIAGNOSIS OF DIABETES MELLITUS IN CHILDREN

Definition

Diabetes is diagnosed in the presence of either a blood glucose concentration of 11.1mmol/L [200 mg/dL] or a fasting glucose concentration of 7mmol/L [126mg/dL]. The diagnosis of diabetes when symptoms are present is usually straight forward and a glucose tolerance test is rarely needed. Glucose tolerance testing may be indicated following the identification of a borderline blood glucose concentration (e.g. in the sibling of a child with diabetes, or in children with disorders such as cystic fibrosis predisposing to diabetes which, in the early stages, may be asymptomatic). ***(World Health Organization, 2006)***

Diabetes is a heterogeneous condition which may be classified on the basis of pathogenesis. Type 1 diabetes is the most common form of diabetes in children. ***(World Health Organization, 2006)***

Classification

Recent advances in knowledge of the etiology and pathogenesis of DM has led to revised classifications. The changes have been made in an attempt to describe diabetes on the basis of the pathogenic process that leads to hyperglycemia, as opposed to the criteria such as age of onset or type of therapy. ***(American Diabetes Association, 2014)***

Table 1 presents a recent classification of the pediatric population. ***(Zeitler et al, 2014)***

Table (1): Etiologic classification of diabetes mellitus.

Type 1 diabetes (β-cell destruction, usually leading to absolute insulin deficiency)
1. Immune mediated
2. Idiopathic
Type 2 diabetes (may range from predominantly insulin resistance with relative insulin deficiency to a predominantly secretory defect with insulin resistance)
Other specific types
1. Genetic defects of β-cell function
1. Chromosome 12, HNF-1α (MODY3)
2. Chromosome 7, glucokinase (MODY2)
3. Chromosome 20, HNF-4α (MODY1)
4. Chromosome 13, insulin promoter factor-1 (IPF-1; MODY4)
5. Chromosome 17, HNF-1β (MODY5)
6. Chromosome 2, NeuroD1 (MODY6)
7. Mitochondrial DNA
8. Others
2. Genetic defects in insulin action
1. Type A insulin resistance
2. Leprechaunism
3. Rabson-Mendenhall syndrome
4. Lipoatrophic diabetes
5. Others
3. Diseases of the exocrine pancreas
1. Pancreatitis
2. Trauma/pancreatectomy
3. Neoplasia
4. Cystic fibrosis
5. Hemochromatosis
6. Fibrocalculous pancreatopathy
7. Others
4. Endocrinopathies
1. Acromegaly
2. Cushing's syndrome
3. Glucagonoma
4. Pheochromocytoma

5. *Hyperthyroidism*
6. *Somatostatinoma*
7. *Aldosteronoma*
8. *Others*

5. *Drug or chemical induced*

1. *Vacor*
2. *Pentamidine*
3. *Nicotinic acid*
4. *Glucocorticoids*
5. *Thyroid hormone*
6. *Diazoxide*
7. *β-adrenergic agonists*
8. *Thiazides*
9. *Dilantin*
10. *γ-Interferon*
11. *Others*

6. *Infections*

1. *Congenital rubella*
2. *Cytomegalovirus*
3. *Others*

7. *Uncommon forms of immune-mediated diabetes*

1. *"Stiff-man" syndrome*
2. *Anti-insulin receptor antibodies*
3. *Others*

8. *Other genetic syndromes sometimes associated with diabetes*

1. *Down syndrome*
2. *Klinefelter syndrome*
3. *Turner syndrome*
4. *Wolfram syndrome*
5. *Friedreich ataxia*
6. *Huntington chorea*
7. *Laurence-Moon-Biedl syndrome*
8. *Myotonic dystrophy*
9. *Porphyria*
10. *Prader-Willi syndrome*
11. *Others*

9. *Gestational diabetes mellitus*

(Zeitler et al, 2014)

Type 1 diabetes (insulin-dependent diabetes mellitus, IDDM) accounts for 90% of cases in children. It is by far the most common