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PERIOPERATIVE MANAGEMENT OF DIABETES MELLITUS: STRIVING FOR METABOLIC BALANCE

Periodic management of a diabetic patient should always strive for the best glucose control achievable. There are several variables that affect glucose levels in the diabetic patient undergoing surgery. The levels of preoperative glucose control (especially the type of pharmacotherapy used to regulate glucose), the complexity of the surgical procedure, the type of nutrients administered preoperatively and postoperatively, the impact of stress hormones and perioperative drug therapy are all major factors that determine how well glucose can be controlled in the diabetic patient undergoing surgery.

PREOPERATIVE MANAGEMENT

Basal metabolic needs use up about half of an individual's insulin, even when the patient is "non per os" (NPO). However, when a preoperative diabetic patient's first morning glucose is relatively low or low-normal (eg, 80 mg/dL), it is not uncommon for insulin to be withheld, the rationale being that the patient's NPO status reduces the need for insulin. Patients who are NPO receive their nutrients as dextrose 5% in water (D5W). This is not trivial, since every liter of D5W includes about 200 calories of glucose. This caloric level, coupled with the significant effects of anesthesia and anxiety on glucose levels, will likely increase the need for insulin. Therefore, most NPO preoperative patients probably need one half to two thirds of their usual insulin dose.

Counterregulatory factors influence the need for insulin. Although insulin lowers glucose, at least four other hormones raise the glucose level, and the stresses of surgery influence their effect. For example, adrenaline and glucagon both act quickly to raise glucose. Growth hormone elevates glucose 4 to 6 hours after its release, and its effect surges after anesthetic induction. Cortisol affects glucose levels about 8 to 24 hours after its release, and cortisol levels go up during periods of stress, such as that caused by surgery.

Both quantity and timing of nutrient intake influence the need for insulin. Quantity relates to the total caloric load, especially simple carbohydrates, and timing relates to whether nutrients are being delivered continuously or by bolus. The route of insulin delivery—intravenous (IV) or subcutaneous—also is a factor, because it affects the speed with which insulin affects the glucose level. In general, these patients should receive insulin subcutaneously; but in markedly hyperglycemic patients it may be prudent to titrate the glucose down with IV insulin the night before surgery.

"Coverage" insulin administration, or waiting until insulin levels drop before administering another dose, is inappropriate for these patients because coverage insulin is always about 4 hours too late. Insulin must be administered in anticipation of the effects of nutrients and stress. If insulin is needed repeatedly to cover the patient at a particular time of day, that amount of insulin should be incorporated into the subsequent treatment schedule.

POSTOPERATIVE MANAGEMENT

Postoperative nutrients also are usually delivered via D5W. In addition, counterregulatory factors will have an impact—namely, hormones and, in complicated patients, pressors.

Most coronary artery bypass graft patients emerge from surgery in a hyperglycemic state, despite aggressive preoperative insulin therapy. Insulin requirements during bypass surgery may increase by 10-fold, especially during the rewarming period. The mechanism may be that oxygenator membranes bind compounds that contain sulfide groups. Therefore, the patient may lose insulin to some of these membranes.

Because of the need for aggressive management, insulin administration by IV drip rather than subcutaneously is worthwhile. However, IV bolus administration is not recommended. The insulin bolus has a half-life of about 10 minutes, with a total clearance of 30 to 40 minutes. This has a limited effect on glucose, but can have an acute effect on potassium. In fact, deaths from hypokalemia have been reported in conjunction with insulin administration by IV bolus. Ten

units of insulin administered as an IV drip will stay in the system longer, without untoward effects on potassium.

When the patient is eating, the preoperative insulin requirement is a reliable predictor of postoperative insulin needs. A patient who needed 50 units of insulin before surgery is likely to require about the same amount postoperatively, although the better quality of a hospital diet may reduce the requirement somewhat. Another general guideline is that most people require 0.5 to 1 unit/kg. It may take several days of dosage adjustment to achieve this target level.

PARENTERAL AND TUBE FEEDING

Patients on total parenteral nutrition (TPN) usually receive regular insulin, administered intravenously either as part of the TPN solution or as a supplemental drip. The supplemental drip may be easier to manage. It is important to monitor the caloric level in a TPN solution. Sometimes profound *apparent* insulin resistance develops in patients who are receiving the usual 35 to 40 kcal/kg/24 hours via TPN. They may receive 90 to 100 units of insulin per hour and still be hyperglycemic. When the total caloric intake is calculated, including the contribution of D5W and other nutrients, it is not unusual to find that the patient is receiving more than 50 kcal/kg/24 hours. This exceeds the amount that can be disposed of by the body and is simply managed by decreasing the TPN rate.

Mechanisms that are not insulin-mediated dispose of 30% to 40% of all caloric intake, predominantly through the central nervous system and formed elements in the blood. If the rate of nutrient disposal is relatively fixed, then the quantity of nutrients in conjunction with insulin levels changes as a function of the rate of IV infusion. This concept is applicable if the TPN infusion contains insulin. For example, when hypoglycemia occurs on TPN, the usual strategy is to discontinue the TPN (to reduce the dose of insulin in the next bag) and administer a bolus or infusion of D5W or D10W. If the glucose level is in the range of 60 to 70 mg/dL, the simplest approach is to increase the TPN rate, which will increase the level of calories per unit of insulin. A parallel insulin drip may be advantageous for the TPN patient who has wide fluctuations because of medications and other factors that influence the glucose level.

Complicated patients often receive nutrients by continuous tube feeding. Frequent administration of mixed insulin will take advantage of the mechanisms by which

insulin absorption occurs and will achieve a steady state. Intermediate-acting insulin typically has its peak effect about 10 hours after injection, while the effect of regular insulin peaks about 3 hours after administration. A combination of regular and intermediate-acting insulin on a q6h or q8h regimen works well and decreases the need for coverage. We have discharged tube feeding patients to nursing homes on this regimen, with good results. This strategy also is advantageous if tube feeding must be stopped, because the patient is less likely to become hypoglycemic.

THE IMPACT OF DIABETIC COMPLICATIONS

Hypoglycemic unawareness is a problem in some postoperative patients, particularly those with long-standing type I diabetes. Because the adrenergic response to hypoglycemia is lost, the usual symptoms of shakiness and palpitations tend not to occur. It is important for the nursing staff to be aware of the onset of subtle neuroglycopenic symptoms, such as mental confusion. If this occurs, glucose levels should be checked immediately.

Nephropathy is a common problem in these patients, and it increases the susceptibility to other renal insults, such as radiocontrast materials or nephrotoxic drugs. The onset of nephropathy may be identified by proteinuria, even in the face of near-normal serum creatinine determinations. Diabetic patients with peripheral neuropathy are postoperatively at increased risk of pressure-induced trauma, especially to the lower extremities. Such patients may not notice pressure on the back of the heels or the bottom of the feet and may be unaware of blisters. These problems can be prevented with proper beds and foot care.

POSTOPERATIVE WOUND INFECTIONS

The incidence of postoperative surgical wound infections is higher in diabetic than in nondiabetic patients. Although the glucose level that increases risk has never been clearly documented, there is evidence of neutrophil dysfunction with profound hyperglycemia.

This dysfunction may be one of the contributing mechanisms. Studies currently underway indicate that diabetic patients who develop infections tend to have higher preoperative glucose levels than those who do not develop infections.

There is an increase in morbidity and costs associated with such infections. For example, in patients undergoing coronary artery bypass graft procedures,

sternal wound infections increase the length of hospital stay by about 50 days. Studies are still needed to evaluate whether rigorous preoperative and perioperative glucose management will reduce the risk for wound infections, and to assess whether it is cost-effective to admit patients the night before surgery in order to titrate glucose levels down.

At present, it is prudent to try to achieve the best glucose control possible in patients undergoing surgery to try to reduce the risks for infections.

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SUGGESTED READING

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ASTHMA: INCREASED MORTALITY WARRANTS AGGRESSIVE, SPECIFIC TREATMENT

Despite an increasing understanding of the pathogenesis of asthma, morbidity and mortality from this disease have risen at an alarming rate during the past decade. What is behind this trend, and what can be done to turn it around?

POTENTIAL CAUSES ARE MANY

There is as yet no general agreement on the reason for the current upswing in asthma-related morbidity and mortality. However, numerous retrospective studies have examined the circumstances of asthma-related deaths, and the evolving consensus from these studies is that adequate and efficacious therapy for asthma is complicated by a host of factors, any or all of which may be contributing to the rise in morbidity and mortality.

A history of prior serious asthma-related emergency room visits and prior respiratory failure seems to contribute to increased risk of death. A change in the prevalence or severity of the disease may play a role.

Poor compliance and poor access to health care appear to play a role. Race may be a factor: for example, in the United States, the asthma-related mortality rate for blacks is three times higher than for whites. Inadequate assessment of asthma severity is apparently frequent in patients who die from the disease. Patients underestimate severity of their asthma. A British study found that among a large group of patients receiving therapy for accurately diagnosed asthma, almost all had at least one episode of nocturnal awakening per month, and 40% were awakened nightly by asthma attacks. Patients did not report these events unless specifically asked.

Some potential factors are related to treatment, such as toxicity of current therapeutic agents, inadequate therapy, or inadequate clinical assessment. During the past decade, a consensus has been evolving for the central role of airway inflammation in the pathogenesis of airway hyperreactivity and asthma. Inadequate treatment with either inhaled or systemic corticosteroids and cromolyn sodium is a frequently described finding in patients with poorly controlled asthma or in patients at greatest risk of death.

Recently, much controversy has arisen concerning the potential role of beta-agonists and theophylline preparations in the increasing asthma mortality. The hypothesis is that these agents would alone or in combination produce arrhythmias leading to sudden death. Additional data suggest that regular use of inhaled beta-agonists is worse than use as needed for acute relief of symptoms. Overall, the exact contribution of beta-agonists to the recent mortality trends remains unknown. Perhaps the asthmatic patient's overreliance on inhaled beta-agonists may be a clinical marker for sub-optimal control of asthma.

RECOMMENDATIONS

Confirmation of the diagnosis of bronchial asthma is usually straightforward. However, unusual causes of wheezing (congestive heart failure, vocal cord paralysis, obstructing tracheal or bronchial tumors) may occur and confuse the differential diagnosis. Ruling out or identifying these problems is generally not difficult. Subsequently, it is important to identify the subgroups of patients at highest risk and to target them with specific treatment strategies.