Preoperative Carbohydrate Loading and Nutritional Supplementation: A Scientific Update

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The gastrointestinal surgical patient is one among many, but despite the different types of procedures these patients undergo, one commonality among surgical patients is the organic response triggered by the stress of the operation. In this regard, the body behaves according to its previous metabolic, immunologic, and nutritional status, which directly depends on previous and/or concomitant comorbidities. These web-like phenomena are the response to the different surgical stimuli that start before the operation, such as the psychological stress of the surgical challenge, the common preoperative fasting state, and a suboptimal nutritional status.[1]

The organic response is marked by the release of stress hormones such as the corticotropin-releasing hormone (CRH), the antidiuretic hormone (ADH), aldosterone, glucagon, and several catecholamines (dopamine, norepinephrine and epinephrine). Once the stress event occurs, the activated sympathetic nervous system triggers the release of CRH in the hypothalamus, which goes on to stimulate the adrenal gland to produce catecholamines. Simultaneously, the alpha-pancreatic cells release glucagon, which together with the catecholamines, induce the liver production of the enzyme phosphorylase that converts stored glycogen to glucose. The enzyme phosphorylase is only available in the liver; the other organs depend on other mechanisms to produce glucose. Simultaneously to this event, the available plasma glucose depends on cell insulin carriers for transport inside muscle and fat cells. However, the phenomenon "insulin resistance" often occurs as a result of insulin signaling defects, mainly on the glucose transporter type 4 (GLUT4) carrier. According to the World Health Organization, insulin resistance is a state in which, under hyperinsulinemic-euglycemic conditions, glucose uptake is below the lowest quartile for the population under investigation.[2]

Insulin resistance, which happens together with decreased muscle glucose oxidation, and increased muscle catabolism leading to negative nitrogen balance, is further associated with decreased muscle mass, and thus reduced muscle strength. Insulin resistance is directly proportional to the magnitude of the surgical insult and is related to postoperative complications due to different events. For example, reduced muscle mass and strength impair respiratory function causing increased risk of pulmonary complications, such as pneumonia. It is still unclear as to whether all of these events have a common signaling pathway. Nonetheless, insulin resistance is a risk factor for hyperglycemia, which negatively impacts surgical outcomes.[3]

Ata et al[4] assessed a 2,090 general and vascular surgery patient database. They reported that, among general surgical patients, those with serum glucose levels between 110 to 140 mg/dL had a risk of surgical site infection (SSI) of 3.61; for those with levels between 141 to 180 mg/dL, the risk was 6.26; in between 181 to 220 mg/dL, it was 5.62; and higher than 220 mg/dL, there was a very high risk of SSI (odds ratio of 12.13).

Metabolically speaking, under normal physiological conditions, insulin is the predominant hormone released throughout the day, leading to storage of substrates. When excess carbohydrates are present, fat is stored. On the contrary, nighttime fasting states normally result in a decrease in insulin production while the hormones glucagon and cortisol increase. Thus, there is substrate breakdown of fat and carbohydrate release. Under the organic response to stress, the latter process is complicated by the release of all the other aforementioned hormones, essentially glucagon and cortisol, leading to increased substrate breakdown (release of glucose), which at the same time, due to insulin resistance, will lead to hyperglycemia. Concomitantly, the muscle lacks energy (ie, no glucose available from outside and no enzyme phosphorylase), therefore it undergoes protein breakdown to provide glucose through gluconeogenesis. It is noteworthy to mention that the nutritional status of the patient also plays a key role in this whole metabolic milieu.

It has long been acknowledged that a deficient nutritional status negatively impacts body composition and function. In a 1950 Minnesota study, healthy young men that underwent a 24-week semi-fasting period lost approximately 23% of their usual weight and developed mental and physical function impairments. The level of depression among these men increased by 30%, while muscle and respiratory function decreased by 30% and overall physical functional capacity decreased by 70%.[5] In a historical study from 1936 assessing surgical patients, Studley reported the association between nutritional status and surgical outcomes among patients undergoing gastric procedures for ulcer treatment.[6] Those that lost more than 20% of their usual body weight had a 33% mortality rate versus 3.1% in the group that lost less than 20% of their usual weight. In a later historical study from 1955, Rhoads and Alexander clearly showed the association between preoperative nutritional status and surgical outcomes.[7] More recently, Kassin et al., used the standard National Surgical Quality Improvement Project protocol to assess postoperative outcomes on patients undergoing general surgery procedures at a single academic center between 2009 and 2011.[8] They showed that “failure to thrive/malnutrition” was the third most common risk factor for hospital readmissions. It is evident from these studies that the association between poor nutritional status and negative surgical outcomes has been documented for many years.

It seems there would be a logical pathway between this apparent malnutrition associated with surgical patients and a call to action to reduce these aforementioned complications. However, metabolic and nutritional conditioning of surgical patients is still not widely recognized among surgeons. It seems there is a gap that exists between what is known and what is done. This is well expressed in Ana Cleveland’s article, “Miles to go before we sleep: education, technology, and the changing paradigms in health information”.[9]

Preoperative fasting is routine worldwide, although clear liquids can be safely offered up to two hours before surgery.[10] Standard clear liquids, however, do not contain enough carbohydrates to provide sufficient energy. Providing a metabolic conditioning drink preoperatively, ie, a carbohydrate-rich drink, would model the fasting state in a postprandial status. The first studies on preoperative oral carbohydrate-rich drinks from the 1990’s and early 2000’s showed that this approach was not only clinically feasible, but also impacted insulin production and insulin resistance.[11,12] In addition, preoperative carbohydrate drinks improved patient well-being mainly through improvement in thirst and hunger sensations.[13]

More recently, it was shown that preoperative carbohydrate loading (175-200 g CHO) attenuates protein breakdown and maintains whole-body protein balance following surgery.[14] Overall, preoperative carbohydrate loading has been shown to improve clinical outcomes. However, carbohydrate loading is still not a reality in most surgical centers.

In summary-CHO loading

- Reduces insulin resistance and hyperglycemia
- Reduces preoperative discomfort
- Decreases postoperative nausea and vomiting
- Preserves muscle mass

If malnutrition *per se* interferes with surgical outcomes, providing preoperative nutrition therapy to these patients should be a standard practice. Simple nutrition screening and assessment tools, such as those proposed by the feedM.E. (Malnutrition Awareness & Education) Global Study Group, can quickly and effectively address preoperative nutritional status and intervention (Figure).[15] Providing early oral nutritional supplementation, for those with no contraindication to use the gastrointestinal tract, was shown to increase energy and protein intake resulting in a favorable impact on the number and severity of surgical complications.[15,16]

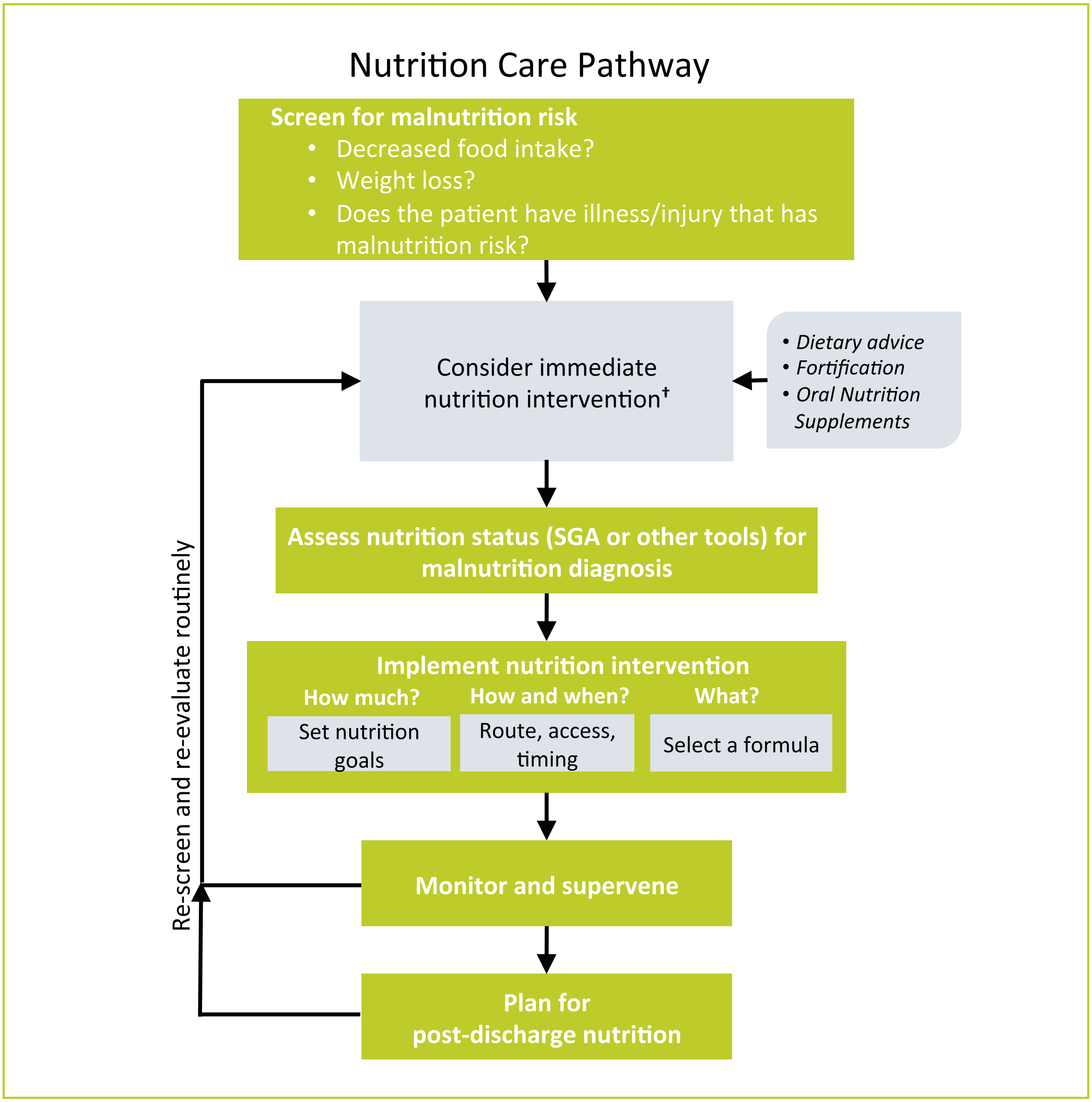

Figure. The Nutrition Care Pathway.[15]

†For individuals who can tolerate oral feeding
SGA=Subjective Global Assessment

Source: Correia MI et al. Evidence-based recommendations for addressing malnutrition in health care: an updated strategy from the feedM.E. Global Study Group. *J Am Med Dir Assoc*. 2014;15(8):544-550.

In conclusion, the metabolic and nutritional conditioning of surgical patients should be prioritized based on current scientific knowledge. However, communication strategies must be improved to more effectively implement science into practice.

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