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Preoperative Carbohydrate Loading in Elective Surgery: A Narrative Review

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Abstract

Introduction and aim: Preoperative fasting has been a cornerstone of anesthetic practice for decades, yet prolonged nil-by-mouth regimens exacerbate perioperative insulin resistance, amplify the surgical stress response, and worsen patient comfort. Preoperative oral carbohydrate loading has been incorporated into Enhanced Recovery After Surgery (ERAS) protocols as a strategy to maintain a fed-like metabolic state before elective surgery, yet clinical

evidence is heterogeneous, effect sizes on hard endpoints are modest, and key questions on optimal timing, dosing, and suitability in high-risk subgroups remain unresolved. This review critically appraises the effects of preoperative carbohydrate drinks on perioperative metabolic outcomes, patient-centered comfort, clinical recovery endpoints, and safety across multiple surgical specialties.

Material and method: This narrative review prioritized systematic reviews, network meta-analyses, and randomized controlled trials evaluating preoperative oral carbohydrate drinks in adult elective surgical patients. Evidence was organized across four domains: metabolic effects, patient-centered outcomes, clinical recovery, and safety, with dedicated analysis of special populations including elderly, bariatric, and diabetic patients.

Results: The most consistent physiological signal is attenuation of postoperative insulin resistance, with mechanistic trials demonstrating up to a 50% reduction in the immediate postoperative fall in whole-body insulin sensitivity compared with fasting. Patient-centered outcomes, including reductions in preoperative thirst, hunger, dry mouth, and anxiety, are robustly improved across diverse surgical settings. Effects on length of hospital stay are favorable but modest, averaging approximately half a day in several meta-analyses, and benefits for gastrointestinal recovery, postoperative nausea and vomiting, and overall morbidity are procedure-dependent and attenuate in higher-quality ERAS-based trials. No clinically meaningful increase in aspiration risk has been observed when drinks are administered 2-3 hours before anesthesia in appropriately selected patients. Metabolic responses are more variable in patients with type 2 diabetes, where some trials report worsened glycemic variability while others show improved insulin sensitivity depending on regimen design.

Conclusions: Evidence for preoperative carbohydrate loading is strongest for metabolic and comfort outcomes and weaker for major clinical endpoints such as complications or mortality. A consistent signal for reduced insulin resistance exists, but effects on length of stay and morbidity are modest and context-dependent. Broad, protocol-free adoption is not supported by current data. Future trials should standardize carbohydrate formulations and dosing schedules, include larger diabetic and frail cohorts, and use harmonized outcome sets to enable more robust cross-study comparisons.

Keywords: preoperative carbohydrate loading; ERAS; insulin resistance; perioperative nutrition; fasting; surgical outcomes; patient comfort; elective surgery; glycemic control

1. Introduction

1.1. Background

Preoperative fasting has long been part of standard anesthetic practice used to reduce the risk of pulmonary aspiration[1,2]. However, prolonged fasting may exacerbate perioperative catabolic stress, worsen insulin resistance, and contribute to patient discomfort, including thirst, hunger, and anxiety[3–5]. Enhanced Recovery After Surgery (ERAS) pathways have challenged this dogma by supporting shortened fasting intervals and the liberalization of clear fluid intake up to two hours before induction[2,6]. Within these modern frameworks, preoperative oral carbohydrate loading has emerged as a strategy to mitigate physiological stress by maintaining a "fed-like" metabolic state[1,2,4].

1.2. Physiological rationale

Surgical trauma induces a metabolic response marked by increased counter-regulatory hormones, insulin resistance, and protein catabolism, which can prolong hospital stays[3,7,8]. Carbohydrate drinks attenuate this response by improving perioperative insulin sensitivity and supporting endogenous carbohydrate oxidation at the time of incision[3,7,8].

Recent network meta-analyses suggest that a single dose administered approximately three hours before anesthesia may be the most effective regimen for maintaining this metabolic balance[11,12].

1.3. Why the topic remains controversial

Despite a plausible physiological rationale and endorsement in many ERAS guidelines, the clinical effectiveness of preoperative carbohydrate loading remains debated[1,2,13]. Existing trials and meta-analyses span a wide range of surgical populations, including abdominal, colorectal, orthopedic, neurosurgical, bariatric, obstetric, and otolaryngological procedures, often with differing baseline care pathways[1,9,12,14,15]. Comparator strategies vary from prolonged fasting to clear fluids, placebo drinks, or water, and carbohydrate regimens differ in concentration, volume, timing, and dosing schedule, making direct pooling and interpretation challenging[11,12,16].

As a result, benefits appear more consistent for metabolic and comfort outcomes than for postoperative complications, readmission, or mortality and the magnitude of effect on length of stay is generally modest[1,5,8,17].

1.4. Clinical relevance

In recent years, the evidence base for preoperative carbohydrate loading has expanded beyond traditional major abdominal surgery to include colorectal, arthroplasty, neurosurgery, bariatric surgery, donor hepatectomy, very elderly patients, and selected obstetric populations[9,10,14,15,18,19]. At the same time, increasing data from bariatric, elderly and diabetic cohorts have highlighted important safety and subgroup considerations, particularly around aspiration risk and glycaemic variability[15,20–22]. Given this evolving and heterogeneous literature, an updated narrative synthesis focused on metabolic and patient-centered outcomes is clinically relevant to help clinicians decide when and how to incorporate preoperative carbohydrate drinks into elective surgical care[1,4,12,16].

2. Aim

2.1 Main Aim

The primary aim of this narrative review is to summarize current evidence on preoperative oral carbohydrate loading in adult elective surgical patients, with particular emphasis on metabolic effects, patient-centered comfort outcomes, clinical recovery endpoints, and safety considerations[1,2,12,17].

2.2. Secondary objectives

Secondary objectives are to explore how the effects of preoperative carbohydrate loading vary across surgical specialties, including abdominal, colorectal, orthopedic, neurosurgical, bariatric and obstetric procedures[9,10,14,19].

Finally, we seek to highlight areas of uncertainty and safety considerations in higher-risk groups, particularly older and frail patients, individuals with obesity undergoing bariatric surgery, and patients with diabetes or impaired glucose tolerance[15,18,21,23].

3. Methods

3.1. Design

This article is designed as a narrative review of the literature on preoperative oral carbohydrate loading in adult patients undergoing elective surgery[4,16]. Rather than conducting a formal systematic review and meta-analysis, our goal is to integrate mechanistic data, patient-reported comfort outcomes, and clinical endpoints across multiple surgical specialties to provide a pragmatic synthesis for perioperative practice[1,12,17].

3.2. Scope of included evidence

Priority was given to systematic reviews, meta-analyses, randomized controlled trials, and selected prospective comparative studies that evaluated preoperative oral carbohydrate drinks in adult elective surgery[1,8,12,16,17]. Studies focused exclusively on parenteral or enteral nutrition without a defined preoperative oral carbohydrate intervention, or those addressing general preoperative nutrition therapy without specific carbohydrate loading, were not central to this review[4,6]. Where available, we preferentially cite higher-quality meta-analyses and large or specialty-specific trials to illustrate key points, complemented by illustrative smaller studies in special populations such as bariatric, elderly, and diabetic cohorts[10,14,15,22].

3.3. Outcomes of interest

For the purposes of this review, outcomes were grouped into four domains. Metabolic outcomes included measures of insulin resistance or sensitivity, perioperative glucose homeostasis, and inflammatory or endocrine stress markers such as C-reactive protein and interleukin-6[7,8,11,12,24]. Patient-centered outcomes comprised patient-reported thirst, hunger, dry mouth, weakness, anxiety, overall well-being, and structured quality-of-recovery scores[5,10,25,26]. Clinical outcomes included length of hospital stay, time to gastrointestinal recovery, time to ambulation, postoperative pain, postoperative nausea and vomiting, complications, and readmission where reported[1,9,14,17,27]. Safety outcomes focused on aspiration-related events, gastric volume and pH, and perioperative glycaemic control in higher-risk subgroups such as bariatric and diabetic patients[15,20–22].

3.4. Analytical approach

Because the available evidence is highly heterogeneous in terms of surgical procedures, carbohydrate formulations and doses, comparator strategies, and outcome definitions, we synthesised the literature narratively rather than attempting a unified quantitative meta-analysis across all settings[1,11,16]. Results are organized primarily by outcome domain: metabolic, patient-centered comfort, clinical recovery, and safety, followed by a dedicated section on heterogeneity of practice and specialty-specific considerations[9,10,12,14]. Within each domain, we highlight consistent patterns, areas of disagreement, and key research gaps, with particular attention to special populations such as elderly, bariatric, and diabetic patients where evidence remains limited or conflicting[15,18,21,23].

4. Results

4.1. Overview of included evidence

The current evidence base for preoperative oral carbohydrate loading comprises several classic systematic reviews and meta-analyses, including Cochrane and non-Cochrane reviews, alongside an increasing number of specialty-specific analyses[1,8,13,28,29]. More recent work includes network meta-analyses and focused systematic reviews in abdominal and colorectal surgery, major non-cardiac procedures, lower limb arthroplasty, and neurosurgery, reflecting a broader and more contemporary scope of practice[9,12,14,17,30]. Across these reviews, the bulk of primary data comes from randomized controlled trials comparing carbohydrate drinks with prolonged fasting, water, or placebo, often within ERAS-style perioperative pathways[1,2,16]. Abdominal and colorectal surgery remain the best-studied areas, but the evidence now extends to orthopedics, neurosurgery, bariatric surgery, donor hepatectomy, gynecological laparoscopy, obstetric cesarean delivery, and very elderly patients, supporting a cross-specialty appraisal of benefits and limitations[9,14,15,18,19,24]. [1,8,13,28]

4.2. Metabolic effects

Across the literature, the most consistent physiological signal associated with preoperative carbohydrate loading is attenuation of postoperative insulin resistance and a more favorable perioperative metabolic profile[2,7,8,24]. Early mechanistic trials demonstrated that carbohydrate drinks given before major surgery can halve the immediate postoperative reduction in whole-body insulin sensitivity compared with placebo or fasting, mainly by preserving non-oxidative glucose disposal and enhancing glucose oxidation[3,7,8].

Subsequent randomized trials in colorectal surgery, donor hepatectomy, and gynecological laparoscopy have reported improvements in indices such as HOMA-IR, insulin sensitivity, and perioperative glycaemic stability, although not every study has found large or sustained effects[24,31–33]. On a broader level, network meta-analyses suggest that carbohydrate loading is generally more effective than fasting or placebo in mitigating postoperative insulin resistance, particularly when administered on the morning of surgery rather than solely the night before[11,12].

4.2.1. Insulin resistance and glycaemic response

Several classic randomized trials in orthopedic and abdominal surgery showed that preoperative oral carbohydrate drinks attenuate the fall in insulin sensitivity observed immediately after surgery when compared with overnight fasting or placebo[3,7,8]. In colorectal surgery, both mechanistic and clinical trials have demonstrated lower HOMA-IR indices, improved insulin sensitivity, and better glycaemic control in patients receiving carbohydrate loading, although these benefits are not universally mirrored in every study or meta-analysis[9,17,31,34].

For example, randomized data in elective colorectal resection suggest that carbohydrate loading can reduce postoperative insulin resistance over the first three postoperative days and is associated with improved subjective well-being and certain recovery endpoints[31,34]. Network meta-analysis indicates that a single dose of carbohydrate given around three hours before surgery may be the optimal regimen for improving postoperative insulin resistance in both open and laparoscopic procedures, although effect sizes vary by surgical context[11,12].

The relationship between carbohydrate loading and perioperative blood glucose levels is more nuanced. Several meta-analyses and large trials report no major differences in average postoperative glucose concentrations between carbohydrate and control groups, despite improvements in formal insulin resistance indices[1,9,17]. In bariatric and elderly populations, carbohydrate drinks may improve glycaemic stability, with lower variability and more stable blood glucose trajectories, even if mean levels are modestly higher than with strict fasting[15,18,35].

Patients with type 2 diabetes represent a special case. Prospective randomized data in arthroplasty show that preoperative carbohydrate drinks can increase glycaemic variability and calculated insulin resistance compared with standard fasting, despite no clear difference in gastric volume[21,36]. By contrast, other studies in

non-insulin-dependent diabetic patients undergoing total knee arthroplasty suggest that carefully timed carbohydrate loading two to four hours before surgery may improve insulin resistance and reduce postoperative hyperglycaemia compared with a carbohydrate-free placebo, highlighting the importance of regimen design[11,22].

Taken together, these findings indicate that while carbohydrate loading generally attenuates surgical insulin resistance in non-diabetic adults, its metabolic effects in diabetic patients are more variable and highly dependent on timing, dose, and background glycaemic control[11,21,22].

4.2.2. Inflammatory markers and stress response

Beyond glucose and insulin metrics, several trials have evaluated the impact of preoperative carbohydrate loading on inflammatory markers and broader stress responses. In colorectal surgery, randomized data suggest that carbohydrate loading can reduce postoperative C-reactive protein concentrations and improve composite inflammatory scores over the first few postoperative days compared with conventional fasting[31,34]. Similarly, in elderly patients undergoing hepatectomy, a protocol combining preoperative carbohydrate drinks with early postoperative oral intake has been associated with lower acute-phase inflammatory markers and a more favorable postoperative inflammatory profile than traditional fasting, although differences in complications were less pronounced[33].

Network meta-analyses and broader abdominal surgery reviews support the concept that carbohydrate loading, particularly in enriched formulations, tends to be associated with more favorable postoperative C-reactive protein and insulin resistance profiles than fasting, whereas clear water alone appears metabolically neutral but still preferable to complete fasting[2,12,17]. However, these effects are not uniform across all studies, and some meta-analyses emphasize that differences in inflammatory markers, while statistically significant, may be modest and clinically difficult to interpret in isolation[1,16,17].

Overall, current evidence suggests that preoperative carbohydrate loading can modulate elements of the surgical stress response, particularly inflammatory markers and acute-phase scores, but the strength and consistency of this signal are weaker than for insulin resistance, and its independent impact on major postoperative outcomes remains uncertain[12,33,34].

4.3. Patient-centered outcomes

Patient-reported outcomes are among the most consistently improved domains following preoperative carbohydrate loading across different surgical settings[5,26,29]. Meta-analytic data and multiple randomized trials show that carbohydrate drinks reduce preoperative thirst, hunger, and mouth dryness, and often improve subjective well-being and fatigue compared with traditional fasting[5,25,26,33]. These benefits are observed not only in major abdominal or colorectal surgery but also in orthopedic procedures, short-stay laparoscopy, and very elderly patients, suggesting that comfort improvements are robust across a wide perioperative spectrum[10,18,25,32]. In some trials, better patient comfort is accompanied by higher quality-of-recovery scores and improved early functional measures, reinforcing the clinical relevance of these subjective outcomes[34,37,38].

4.3.1. Thirst, hunger, and dry mouth

Evidence for reduced thirst and hunger is particularly robust and may represent one of the most clinically immediate benefits of preoperative carbohydrate drinks[5,10,29]. A meta-analysis of randomized trials found that preoperative oral carbohydrates significantly lowered postoperative discomfort scores, driven largely by reductions in thirst, hunger, and dry mouth when compared with overnight fasting or placebo beverages[5,29].

In perioperative nursing studies, small-volume carbohydrate solutions or popsicles administered two to three hours before surgery markedly reduced preoperative thirst intensity and thirst-related discomfort versus standard fasting, with large effect sizes[26,39]. Similar patterns have been reported in arthroscopic and orthopedic surgery, where patients receiving carbohydrate drinks report lower thirst scores and less perceived fasting burden than those kept nil by mouth after midnight[10,25,40].

In colorectal and liver surgery, carbohydrate loading has also been associated with lower perioperative thirst and hunger scores and reduced subjective weakness, even when differences in hard endpoints are modest[33,34,38]. Extremely elderly patients randomized to receive a carbohydrate-containing drink two hours before surgery reported significantly better subjective perceptions of preparation, including thirst and mouth dryness, without adverse effects on gastric volume[18].

Taken together, these findings suggest that replacing prolonged fasting with a structured carbohydrate drink regimen reliably improves basic comfort parameters, which may be particularly relevant in frail, anxious, or day-case populations[5,10,26].

4.3.2. Anxiety, subjective well-being, and quality of recovery

Several studies suggest that preoperative carbohydrate loading can favorably influence broader patient-reported measures such as anxiety, subjective well-being, and quality of recovery, although results are more heterogeneous than for thirst and hunger[5,34,38]. Randomized colorectal trials report that patients receiving carbohydrate drinks experience lower perioperative anxiety and weakness scores and higher ratings of overall well-being than fasted controls, alongside improvements in physical recovery measures[34,38]. In elderly hepatectomy patients, combining preoperative carbohydrates with early oral intake has been associated with lower self-reported symptom burdens, including anxiety and nausea, and with better perceived postoperative recovery[33].

In orthopedic settings, carbohydrate loading has been linked to reductions in fatigue and better early quality-of-recovery scores, although the magnitude of improvement sometimes falls below thresholds considered clinically important[25,36,41]. Day-case laparoscopic cholecystectomy data suggest that preoperative carbohydrate drinks, combined with simple adjuncts such as chewing gum, can improve global quality-of-recovery scores and reduce the severity of postoperative nausea and vomiting-related discomfort, even when differences in nausea and vomiting incidence are small[37]. Conversely, some trials in obstetric and diabetic arthroplasty populations report minimal or equivocal differences in anxiety or quality-of-recovery scales between carbohydrate and water or intravenous dextrose, underscoring that these outcomes are sensitive to context, baseline expectations, and measurement tools[19,36,42].

Overall, the available evidence indicates that preoperative carbohydrate loading often, but not invariably, improves subjective well-being and quality-of-recovery indices, with the most consistent benefits observed when thirst and hunger are prominent drivers of preoperative distress[5,34,38].

4.4. Clinical outcomes

Compared with metabolic and comfort outcomes, clinical endpoints such as length of stay, gastrointestinal recovery, postoperative nausea and vomiting, and complications show

more heterogeneous and generally more modest effects of preoperative carbohydrate loading[1,8,12,17]. Several recent meta-analyses and specialty-specific trials suggest that carbohydrate drinks can shorten hospital stay and accelerate selected aspects of postoperative recovery, particularly in major abdominal, colorectal, orthopedic, and neurosurgical procedures, but the magnitude of benefit is typically small and not universal[9,10,12,14,17]. Moreover, many studies embed carbohydrate loading within broader ERAS pathways, making it difficult to disentangle the specific contribution of the drink from other perioperative co-interventions[1,2,16].

4.4.1. Length of stay

Length of hospital stay is one of the most frequently reported clinical endpoints in the carbohydrate-loading literature and one of the more reproducibly favorable signals, albeit with modest effect sizes[1,8,9,17]. Some systematic reviews have found that patients receiving preoperative carbohydrates are discharged approximately half a day earlier than those given placebo or kept fasting, although the quality of evidence is generally low and benefits diminish when analyses are restricted to higher-quality trials[1].

A meta-analysis of randomized trials in elective major non-cardiac surgery reported that carbohydrate loading, compared with fasting or placebo, shortened length of stay by about half a day on average, without clear differences in postoperative glucose, insulin, or C-reactive protein levels[17]. Similarly, colorectal-specific meta-analysis has shown shorter hospitalisation in carbohydrate groups, consistent with faster return of bowel function and earlier oral intake[9,34]. Beyond abdominal surgery, reductions in length of stay have also been reported in neurosurgical and orthopedic procedures, although the absolute differences are small and may be particularly influenced by baseline ERAS implementation and discharge criteria[10,14,41].

Taken together, the evidence suggests that preoperative carbohydrate loading can contribute to a modest shortening of hospital stay in selected elective surgical populations, especially in major abdominal and neurosurgical settings, but it is unlikely to be the sole driver of early discharge[1,8,14,17].

4.4.2. Gastrointestinal recovery

Gastrointestinal recovery appears to be another domain in which preoperative carbohydrate loading may confer clinically relevant, though variable, benefits[9,34,39].

In colorectal surgery, meta-analysis of randomized trials has shown that patients receiving carbohydrate drinks experience shorter times to first flatus and first stool compared with controls with differences on the order of several hours to roughly half a day[9,34]. The same studies often report earlier tolerance of oral intake and advancement of diet, which may contribute to reduced length of stay and perceived recovery[9,34,38].

In donor hepatectomy, preoperative carbohydrate loading combined with early postoperative feeding has been associated with earlier return of bowel function and faster achievement of predefined functional recovery milestones, even though global complication rates remain similar between groups[33,34]. By contrast, a trial of potassium-containing carbohydrate drinks in laparoscopic colorectal resection reduced preoperative hypokalaemia and improved thirst and hunger but did not significantly change time to first flatus or stool, or length of stay compared with fasting or carbohydrate-only beverages[39].

Overall, carbohydrate loading seems most likely to accelerate gastrointestinal recovery in major colorectal and hepatobiliary surgery, whereas effects in shorter or minimally invasive procedures are smaller and less consistent[9,33,34].

4.4.3. Postoperative nausea and vomiting, pain, and ambulation

The impact of preoperative carbohydrate loading on postoperative nausea and vomiting is mixed but generally favorable in selected contexts[8,10,12]. Some analyses in abdominal surgery suggest that carbohydrate drinks and clear water both reduce postoperative nausea and vomiting compared with prolonged fasting, with carbohydrate loading providing a slight additional advantage in some models[12]. Specialty-specific reviews in neurosurgery and orthopedics report trends toward lower rates or severity of postoperative nausea and vomiting in carbohydrate groups, although not all comparisons reach statistical significance[10,14,43].

A recent systematic review specifically examining anesthetic technique found that preoperative carbohydrate loading reduced postoperative nausea and vomiting compared with fasting in adults receiving inhalational anesthesia, whereas the incremental benefit under total intravenous anesthesia appeared attenuated, underscoring the importance of background antiemetic strategies[27]. Some trials in donor hepatectomy and colorectal surgery have also reported reduced early postoperative nausea and vomiting scores in carbohydrate groups, often alongside earlier diet progression and improved comfort[33,34].

Effects on pain and early mobilisation are more variable. In neurosurgery, pooled data indicate that patients receiving preoperative carbohydrate drinks have higher odds of ambulation on postoperative day one and lower odds of moderate-to-severe pain than controls, suggesting a potential functional benefit[14].

In arthroplasty and other orthopedic procedures, carbohydrate loading has been associated with small reductions in early pain scores and improved mobilisation metrics in some studies, particularly when embedded in comprehensive ERAS protocols, but results are not uniform across all trials[10,25,41].

In general, while carbohydrate loading may modestly reduce postoperative nausea and vomiting and facilitate early mobilisation in certain settings, these effects appear context-dependent and interact with anesthetic technique, analgesic regimens, and the broader perioperative care bundle[12,14,27].

4.4.4. Complications

In contrast to metabolic and comfort endpoints, evidence for a reduction in overall postoperative complications with preoperative carbohydrate loading is less convincing[1,8,12,17].

Systematic reviews and meta-analyses have generally found little or no effect of carbohydrate drinks on composite in-hospital morbidity when compared with fasting or placebo, despite favorable trends in length of stay and insulin resistance[1,8].

In abdominal network meta-analysis, carbohydrate loading and clear water showed similar probabilities of being associated with lower morbidity, both clearly outperforming prolonged fasting, suggesting that avoiding strict fasting may be more important than carbohydrate content alone for this endpoint[12].

More recent neurosurgical and orthopedic analyses report either neutral or modestly favorable complication profiles with carbohydrate loading, but heterogeneity, small sample sizes, and event rarity limit the certainty of these findings[10,14,30]. Specialty-specific trials occasionally show reduced rates of selected complications, such as wound infections or cardiopulmonary events, yet these signals are inconsistent and often confounded by concurrent ERAS measures and perioperative optimisation strategies[2,12,17].

In general, current data do not support preoperative carbohydrate loading as a stand-alone intervention that reliably lowers major postoperative morbidity, even though it

may contribute to improved recovery and patient experience as part of a multimodal ERAS framework.

4.5. Safety and subgroup considerations

Preoperative carbohydrate loading appears to be safe in appropriately selected adult elective surgical patients when administered in accordance with modern fasting intervals[1,2,12,15]. Nevertheless, safety and metabolic responses may differ in specific subgroups, particularly those with elevated aspiration risk, advanced age, obesity and bariatric surgery, or diabetes, where individualized assessment is warranted[9,15,18,20,22].

4.5.1. Aspiration risk and gastric emptying

Despite longstanding concerns that recent oral intake might increase aspiration risk, current evidence does not suggest a clinically meaningful increase in aspiration events when carbohydrate drinks are given 2-4 hours before anesthesia in selected patients[12,15,20]. Network meta-analysis in elective abdominal surgery indicates that aspiration or regurgitation events are very rare and do not differ meaningfully between fasting, water, and carbohydrate-loading strategies[12].

Prospective bariatric data using intraoperative esophagogastroduodenoscopy show that patients who received a carbohydrate drink two to four hours before surgery had similar gastric volumes and higher gastric pH compared with traditional fasting, with no aspiration events observed[15]. In elderly patients, randomized trials using gastric ultrasonography report no significant differences in residual gastric volume or high-risk antral grades between carbohydrate and fasting groups when drinks are given two hours preoperatively[18,20]. Across multiple specialties, including colorectal laparoscopy and c-section, no regurgitation or aspiration events have been reported in trials that adhered to guideline-based fasting intervals for carbohydrate drinks[19,39].

Taken together, these findings support the view that preoperative carbohydrate drinks can be used safely with respect to aspiration risk in carefully selected elective patients, provided that standard fasting guidelines and exclusion criteria for delayed gastric emptying are respected[2,12,15].

4.5.2. Elderly and frail populations

Evidence in elderly and frail patients remains limited but generally reassuring. Randomized data in patients aged 65 years and above show that ingestion of a carbohydrate

drink two hours before surgery does not increase high-risk gastric ultrasound grades or aspirated gastric volume compared with nil-by-mouth from midnight[20]. In extremely elderly patients aged 80 years or older scheduled for orthopedic procedures, carbohydrate drinks given two hours preoperatively have been associated with similar gastric antral cross-sectional areas and ultrasound risk grades to fasting, indicating acceptable gastric emptying[18]. At the same time, extremely elderly patients in these trials reported improved subjective comfort and more stable perioperative glycaemic trajectories with carbohydrate drinks, although absolute glucose levels were slightly higher than with strict fasting[18].

On balance, current data suggest that preoperative carbohydrate loading can be feasible and safe in carefully chosen elderly patients, but cautious extrapolation and close monitoring are advisable in the very frail or those with suspected delayed gastric emptying[2,18,20].

4.5.3. Diabetes

The diabetic population deserves particular caution, as metabolic responses to preoperative carbohydrate loading appear more variable than in non-diabetic cohorts[21–23,36]. In type 2 diabetes patients undergoing total hip or knee arthroplasty, carbohydrate drinks given two to three hours before anesthesia have been associated with increased perioperative glycaemic variability and calculated insulin resistance compared with standard fasting, despite no clear difference in gastric volume[21]. Other trials in diabetic arthroplasty populations have reported minimal differences in postoperative nausea and vomiting and only small, possibly clinically marginal improvements in quality-of-recovery scores[36].

By contrast, more recent randomized data in non–insulin-dependent type 2 diabetes patients undergoing total knee arthroplasty indicate that carefully timed carbohydrate loading two or four hours before surgery can reduce postoperative insulin resistance, improve glycaemic control on the first postoperative day, and alleviate preoperative hunger compared with a carbohydrate-free placebo[22]. Guideline-based evidence reviews suggest that caloric oral fluids before surgery in adults with diabetes do not clearly worsen key outcomes, but the certainty of evidence is low and heterogeneity substantial[23].

Taken together, these findings imply that preoperative carbohydrate drinks cannot simply be extrapolated from non-diabetic to diabetic populations without adjustment[21,22,36].

In patients with type 2 diabetes, decisions about carbohydrate loading should consider baseline glycaemic control, concomitant therapies, potential gastroparesis, and the ability to

monitor and manage perioperative glucose closely, and may favor lower-volume, well-timed regimens within structured protocols rather than routine, protocol-free use[2,22,23].

4.5.4. Surgical specialty differences

The magnitude and profile of benefits associated with preoperative carbohydrate loading are not uniform across surgical specialties[9,10,12,14,15,17,19].

Abdominal and colorectal surgery remain the most extensively studied areas, with relatively consistent signals for improved metabolic profiles, faster gastrointestinal recovery, shortened length of stay, and better patient comfort, albeit with limited impact on major complications[1,8,9,17,34].

In neurosurgery, a recent systematic review and meta-analysis reported that carbohydrate loading was associated with shorter total and postoperative length of stay, higher rates of ambulation on postoperative day one, and lower odds of pain and postoperative nausea and vomiting, supporting its integration into neuro-ERAS pathways[14].

Orthopedic evidence, including arthroplasty and fast-track knee arthroplasty, points to reduced thirst and modest reductions in length of stay, with variable effects on pain and postoperative nausea and vomiting, and particular complexity in patients with diabetes[10,21,22,30,40].

In bariatric surgery, the main emphasis has been on safety, with studies suggesting that carbohydrate drinks given two to four hours before surgery do not increase gastric volume or aspiration risk when embedded in structured ERAS protocols, and may influence stress hyperglycaemia depending on drink composition[15,35].

Obstetric data in elective cesarean section show that preoperative carbohydrates can shorten time to colostrum and reduce vaginal bleeding, but evidence remains limited and highly context-specific[19].

These specialty differences reinforce the need to interpret carbohydrate loading within the clinical and organisational context of each surgical field rather than assuming a uniform effect across all procedures[9,10,12,14,15].

4.6. Practice heterogeneity

One of the most striking findings across the literature is the lack of standardisation in preoperative carbohydrate loading protocols[2,11,16].

A systematic review of dozens of trials reported that roughly half prescribed carbohydrate drinks both the night before and the morning of surgery, whereas almost as many used morning-only regimens, with typical carbohydrate concentrations around 13–14% and total volumes ranging widely[16].

Network meta-analysis further highlighted that regimens differ not only in volume and timing, but also in comparator strategies: fasting, water, placebo, or alternative carbohydrate formulations, making direct pooling of outcomes difficult[11,12].

In addition, co-interventions such as broader ERAS implementation, early feeding, opioid-sparing analgesia, and glycaemic management protocols frequently differ between studies and are not always balanced across groups[1,2,17].

This considerable practice heterogeneity likely contributes to the variability in reported clinical effects and underscores the need for more standardized and clearly reported carbohydrate-loading prescriptions in future trials and guidelines[11,12,16].

5. Discussion

5.1. Main interpretation

Taken together, the available literature suggests that preoperative carbohydrate loading is most convincingly associated with attenuation of perioperative metabolic stress and improvements in patient comfort, whereas effects on hard clinical endpoints are more modest and variable across settings[2,5,8,17]. Meta-analyses and specialty-specific reviews consistently demonstrate reductions in postoperative insulin resistance and favorable changes in inflammatory markers in major abdominal and colorectal surgery, particularly when carbohydrate is given on the morning of surgery[2,8,11,12,34]. At the same time, multiple randomized trials and meta-analyses show robust improvements in basic comfort outcomes such as thirst, hunger, dry mouth, and subjective well-being, even when differences in complications or length of stay are small[5,10,26,29].

By contrast, the signal for major recovery endpoints: length of stay, gastrointestinal recovery, postoperative nausea and vomiting, and overall morbidity is more procedure-dependent and sensitive to study design and baseline care pathways[1,9,13,14,17]. Recent meta-analyses suggest that preoperative carbohydrate drinks can shorten hospital stay by roughly half a day and accelerate bowel recovery in selected populations, but these effects are not universal and often attenuate in well-conducted, ERAS-based trials[1,9,17,44].

Overall, the physiological and patient-centered benefits of carbohydrate loading appear stronger and more consistent than any measurable impact on complications or long-term outcomes, supporting its role as a supportive component of modern ERAS protocols rather than a stand-alone transformative intervention[2,4,17,45].

5.2. Why the findings are inconsistent

The inconsistency in reported clinical effects likely reflects a combination of methodological and clinical heterogeneity rather than a simple absence of benefit[1,11,13,16].

First, surgical populations range from major open colorectal and hepatobiliary procedures to short-stay arthroscopy, neurosurgery, bariatric surgery, and elective cesarean delivery, each with different baseline risks, recovery trajectories, and discharge practices[1,9,10,14,15,19].

Second, comparator regimens vary widely: some trials compare carbohydrate drinks with prolonged nil-by-mouth fasting, whereas others use water, placebo beverages, or already liberal clear-fluid policies, which naturally reduces the incremental effect attributable to the carbohydrate component[12,29,46].

Third, there is substantial variation in carbohydrate formulation, concentration, volume, timing, and dosing schedule, as highlighted by systematic cataloguing of protocols across multiple trials[11,16]. Studies that administer a morning-of-surgery drink around three hours before induction tend to show more consistent metabolic benefits than those relying predominantly on night-before dosing or less clearly defined regimens[8,11,34].

Fourth, many trials embed carbohydrate loading into broader ERAS bundles that include early feeding, opioid-sparing analgesia, and protocolized mobilisation, making it difficult to isolate the independent contribution of the drink to clinical outcomes[2,14,17,45].

Finally, numerous randomized studies are small, with limited power for complications, and use differing or incompletely reported outcome definitions, which further weakens the ability of meta-analyses to detect consistent effects on hard endpoints[1,10,13,16]. These sources of heterogeneity do not negate the observed metabolic and comfort benefits but do caution against overgeneralising specific effect sizes across all surgical contexts[1,11,16].

5.3. Implications for practice

For adult elective surgical patients without major contraindications, preoperative carbohydrate loading can reasonably be considered a useful component of multimodal ERAS strategies, particularly when the goals are to reduce fasting-related discomfort and attenuate perioperative metabolic stress[2,4,5,17].

Meta-analyses and larger randomized trials support its ability to reduce postoperative insulin resistance, improve inflammatory profiles in selected settings, and consistently improve thirst, hunger, and overall patient experience, with a favorable safety profile when modern fasting intervals are respected[8,12,15,34].

In many ERAS pathways, carbohydrate drinks are best viewed as part of a coherent bundle that includes shortened fasting, early feeding, effective analgesia, and mobilisation rather than as a single intervention expected to transform length of stay or morbidity in isolation[2,14,17,45].

Implementation should therefore prioritize procedure types and patient groups where the evidence base is strongest, such as major abdominal, colorectal, and increasingly neurosurgical and orthopedic procedures, while acknowledging that benefits for complications are likely to be incremental rather than dramatic[1,9,10,14].

In practical terms, adopting a simple, standardized regimen, typically a clear carbohydrate drink of defined concentration, given two to three hours before anesthesia in eligible patients, may maximize feasibility and adherence while aligning with current guideline recommendations[2,11,16].

As with other ERAS elements, local protocols should incorporate clear inclusion and exclusion criteria, staff education, and monitoring of outcomes to ensure safe and context-appropriate use rather than universal, protocol-free adoption[2,16,46].

5.4. High-risk or uncertain groups

Special caution is warranted in higher-risk or less well-studied groups, particularly patients with diabetes, suspected delayed gastric emptying, severe obesity outside structured bariatric ERAS programmes, and those with advanced frailty[15,18,21,23].

In type 2 diabetes, trials have reported divergent metabolic responses to carbohydrate drinks, ranging from worsened glycaemic variability and insulin resistance in some orthopedic

cohorts to improved insulin sensitivity and glucose control under carefully timed and protocolized regimens[21,22,36]. Similarly, while bariatric data indicate that carbohydrate drinks given two to four hours preoperatively do not increase gastric volume or aspiration risk when combined with proton pump inhibition and structured ERAS care, these findings may not be generalisable to all obese patients in all settings[15,35].

Very elderly patients appear to tolerate moderate-volume carbohydrate drinks without excess gastric retention in small trials, but evidence remains sparse and largely restricted to relatively selected cohorts[18,20,33]. In these higher-risk or uncertain populations, individualized perioperative strategies-including consideration of lower volumes, closer glycaemic monitoring, and, where appropriate, alternative regimens such as non-caloric clear fluids-may be preferable to routine use of standard carbohydrate drinks[2,22,23].

Clinicians should therefore interpret the general carbohydrate-loading evidence with caution in these groups and verify details in the original trials before extrapolating protocols to their own practice[15,18,21].

5.5. Strengths and limitations of the evidence base

The evidence base for preoperative carbohydrate loading is strengthened by the availability of multiple systematic reviews, network meta-analyses, and randomized trials across a broad range of surgical specialties[1,8–10,12–14,17]. These studies consistently support favorable effects on metabolic parameters and patient comfort, and more recent work has expanded the scope to neurosurgery, orthopedics, bariatric surgery, obstetrics, and very elderly patients, improving external validity compared with earlier abdominal-only data[2,15,18,19,34].

However, confidence in the overall body of evidence is limited by substantial heterogeneity in interventions, comparators, and outcome definitions, as well as by small sample sizes and variable methodological quality in many randomized trials[1,8,10,16]. Some meta-analyses have identified possible publication bias and noted that benefits for length of stay diminish when analyses are restricted to higher-quality studies, suggesting that early enthusiasm may overestimate the true effect size[1,8,17]. Furthermore, many trials do not adequately report adherence to carbohydrate protocols, details of co-interventions, or subgroup analyses by risk profile, which complicates the translation of findings into precise, patient-level recommendations[11,12,16,45].

In this narrative review, key messages are synthesised from aggregated and sometimes heterogeneous data, and readers are encouraged to consult original publications, especially pivotal randomized trials and meta-analyses, when applying these findings to individual patients or local protocols[1,12,17].

5.6. Research gaps

Future research on preoperative carbohydrate loading should prioritize more standardized and clearly reported intervention protocols, including defined carbohydrate formulations, concentrations, volumes, and timing relative to anesthesia[11,16,45]. Harmonised outcome sets that capture metabolic markers, patient-reported comfort, and clinically meaningful endpoints such as length of stay, complications, and readmissions would facilitate more robust comparisons and meta-analyses across studies and specialties[5,9,12,17].

There is a particular need for larger, high-quality trials in high-risk groups including patients with diabetes, frailty, and complex obesity where current data are limited and sometimes conflicting[15,18,21,23]. Studies explicitly designed to disentangle the effects of carbohydrate content from those of shortened fasting and other ERAS components, for example by comparing carbohydrate drinks with water or non-caloric fluids on a background of optimized care, would help clarify the specific added value of carbohydrate loading[12,29,46].

Emerging approaches such as continuous glucose monitoring, perioperative digital symptom tracking, and large-scale registry data could provide more granular insight into individual responses and support more personalized carbohydrate-loading strategies in the future[23,45]. Until such data are available, clinicians should continue to interpret existing evidence cautiously, recognising that final responsibility for data interpretation and protocol design rests with the treating team[1,2,16].

6. Conclusions

6.1. Main conclusion

Preoperative carbohydrate loading appears to be a safe and clinically useful component of modern perioperative care in appropriately selected adult patients undergoing elective surgery.

Across multiple trials and meta-analyses, the most consistent benefits concern attenuation of perioperative insulin resistance and inflammatory responses, together with

marked improvements in patient comfort, including reduced thirst, hunger, and subjective symptom burden.

Effects on length of stay, gastrointestinal recovery, pain, postoperative nausea and vomiting, and complications are generally favorable but modest, procedure-dependent, and sensitive to study design and baseline ERAS implementation, rather than uniformly transformative.

Overall, the physiological and patient-centered signals supporting preoperative carbohydrate drinks are stronger and more consistent than the signal for major postoperative morbidity or mortality, which remains relatively limited and heterogeneous.

6.2. Practical conclusion

At present, the evidence supports integrating preoperative carbohydrate drinks into appropriately selected ERAS pathways for adult elective surgical patients, particularly when the aim is to reduce fasting-related discomfort and blunt perioperative metabolic stress.

Clinical implementation should take into account procedure type, patient risk profile, and local perioperative practice, with particular caution in higher-risk groups such as patients with diabetes, suspected delayed gastric emptying, or advanced frailty.

Rather than universal, protocol-free adoption, preoperative carbohydrate loading is best used as a standardized, guideline-based element of multimodal perioperative optimisation, monitored and adapted over time as new evidence emerges.

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