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Toward surgical resilience

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Prehabilitation consists of planned interventions implemented prior to surgery with the aim of increasing functional reserve and creating surgical resilience to positively impact a patient's surgical outcome.

Keywords: surgical resilience, planned interventions, increasing functional reserve, prehabilitation

Introduction

The definition of resilience is the ability to be successful or happy again after experiencing something bad or difficult. Over 200 million surgeries take place every year worldwide, and, for most patients, having an operation is a significant event with far-reaching after effects.[1] Surgical trauma is an injury to the patient that leads to a physiological stress response aimed at re-establishing homeostasis.[2] Resilience to this stress response depends on both set and adjustable patient factors including age, sex, malignancy, comorbidities, recreational habits, nutritional and physical status.[3] Anaesthetists act as perioperative physicians and the preoperative time can be used to increase the patients' physiological reserve to have a positive effect on surgical outcome.[4]

Definitions

Prehabilitation is planned interventions that take place prior to surgery to increase a patient's functional reserve. It consists of physical, nutritional and psychological components, together with smoking/alcohol cessation all aimed at improving perioperative clinical outcome.[3-5] This is in contrast to rehabilitation which aims to improve functional capacity after surgery has taken place.[6] The patient's ability to perform activities of daily living requiring integration of the cardiorespiratory and skeletal muscular systems is known as functional capacity and is a commonly reported outcome in prehabilitation research. Exercise capacity measures oxygen uptake at increasing levels of physical work and is used to predict the ability of the cardiorespiratory system to increase cardiac output to meet the increased postoperative oxygen demand. This adds a margin of safety to protect against the development of postoperative complications.[2]

Factors that contribute to poor physiological reserve include reduced exercise tolerance, malnutrition, sarcopaenia and frailty. These factors predict poor postoperative outcomes both independently and combined, yet they are potentially modifiable.[7]

Frailty can be described as a multi-system reduction in physiological reserve, promoting vulnerability and rendering a frail patient at increased risk of morbidity and mortality following a stress response.[6] Malnutrition leads to depleted energy reserves and a blunted inflammatory response to injury that contributes to postoperative complications. Patients with reduced skeletal muscle mass, as seen in sarcopaenia, are more susceptible to complications associated with postoperative catabolism evident as reduced strength, impaired ability to cough and an impaired gut mucosal barrier. Malnutrition and sarcopaenia often lead to frailty.[2]

Physiology

Surgical insult heralds a surgical stress response mediated by afferent nerves and humoral factors including pro- and anti-inflammatory cytokines released from the site of injury. This, in turn, activates the hypothalamic-pituitary-adrenal axis and sympathetic nervous system. The result includes:

- Whole body protein catabolism
- Inflammatory protein synthesis
- Hyperglycaemia
- Insulin resistance
- Hypertension
- Tachycardia
- Urinary retention
- Oedema

Preoperative fasting and comorbidities including obesity, metabolic syndrome, frailty, sarcopaenia, cancer and diabetes contribute to the insulin-resistant state. Postoperatively this state can last for up to three weeks with a reduction in insulin-mediated glucose uptake by muscle and fat. Proteolysis and lipolysis provide precursors for gluconeogenesis and the amino acids released are also used in the synthesis of acute phase proteins. A negative whole-body protein balance ensues with reduced lean mass and function, causing a catabolic disaster.[2,6]

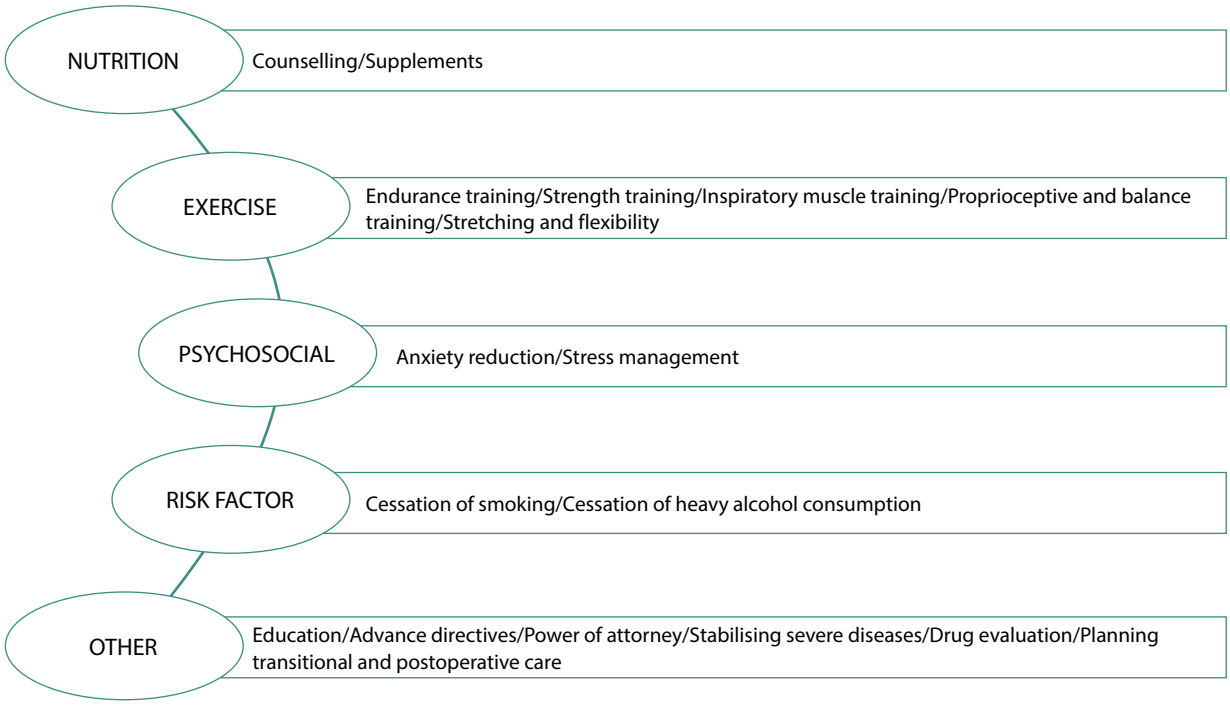

Figure 1: Elements of prehabilitation[9]

Components

Prehabilitation evolved from unimodal components (either nutritional or exercise alone) to a multimodal approach that incorporates two or more synergistically acting interventions (Figure 1) aimed at improving health outcome by enhancing fitness, nutrition and psychological resilience.[3]

Nutrition

Nutritional management of the surgical patient requires a multidisciplinary approach. The aim is to attenuate risk by identifying the patient with malnutrition and addressing severe risk, for example, even delaying cancer surgery by 7–14 days may be appropriate.[8]

Ultimately, the goal of a nutritional intervention is to optimise a patient's nutrient stores and metabolic reserve, buffering surgery-induced catabolism and enhancing the immune response. Body mass index (BMI) and weight does not provide enough information in the perioperative period, hence a screening tool such as the Perioperative Nutrition Screen (PONS) score can be used (Figure 2). A positive response to any question in the PONS score requires a formal nutritional assessment and/or intervention.[7]

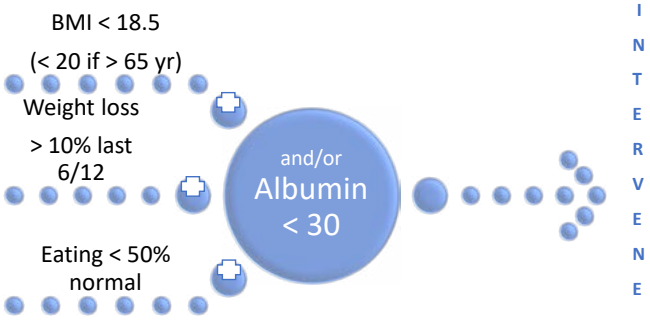

Figure 2: PONS score for preoperative nutrition screening[7]

Hypoalbuminaemia reflects disease severity with associated catabolism and is a recognised surgical risk factor. Undernutrition is also recognised as an independent risk factor for the incidence of complications, increased mortality, length of stay (LOS), and costs.[8]

General preoperative guidelines[8,10] include the following:

- A recommended protein intake goal of 1.2 g/kg/day pre-operatively is of more benefit than a total calorie intake goal.
- Nutritional therapy should ideally be administered orally before enterally before parentally.
- When normal food does not deliver the patient's energy needs, then oral nutritional supplements (ONS) should be used. ONS can be used as the sole source of nutrition if it is a standard, fully balanced, non-disease-specific formula.
- ONS is initiated if the patient will be unable to eat for more than five days perioperatively or if patients cannot maintain more than 50% of their recommended intake for more than seven days.
- ONS is also indicated in malnourished cancer patients, high-risk patients undergoing major abdominal surgery and the elderly with sarcopaenia. This should ideally happen as an outpatient to minimise the risk of unnecessary hospitalisation and nosocomial infections. Use high protein ONS (2–3 times a day, minimum of 18 g protein/dose) for at least seven days preoperatively.
- Preoperative parental nutrition for 7–14 days benefits patients with severe malnutrition evidenced by weight loss of 10–15% presenting for major gastrointestinal surgery. Continued

postoperatively, this can lead to reduced complications and mortality.

- Immune-modulating substrates such as arginine, omega-3 fatty acids, and nucleotides are controversial, although a postoperative morbidity and LOS benefit after major abdominal cancer surgery in malnourished patients have been shown. Currently no clear evidence exists for the sole use of immunonutrition (IMN) versus standard ONS in the preoperative period.
- Traditional preoperative fasting from midnight is not recommended.
- Clear fluids are allowed up to two hours before surgery in patients with no specific aspiration risk, and solids up to six hours before.
- Oral preoperative carbohydrate drinks can be administered up to two hours before surgery to reduce perioperative discomfort, anxiety and postoperative insulin resistance. The drink should ideally contain 45 g of a complex carbohydrate like maltodextrin. In diabetics, this should be individualised according to severity and type of diabetes.

Exercise

Health is affected by physical fitness and fitter patients tend to have better outcomes. Inactivity has become more prevalent and patients with decreased exercise capacity have an established risk factor for developing complications perioperatively. Low perioperative activity levels are further augmented by underlying disease processes and treatment side effects if, for instance, neoadjuvant radiation or chemotherapy is used. A reduced anaerobic threshold has a strong association with surgical outcome. Exercise aims to prepare the patient to compensate physiologically for a major stressor by optimising the delivery of oxygen and using energy efficiently, essentially enhancing the physiological reserve. Improvement in overall and cardiovascular function can happen within three weeks.[7]

Traditionally patients were encouraged to rest before upcoming surgery and start exercising postoperatively for rehabilitation, however bed rest has detrimental effects on aerobic capacity, muscle mass and strength. Exercise prehabilitation results in improved functional walking capacity throughout the whole perioperative period.[11]

An exercise programme should ideally consist of aerobic, strength, flexibility and balance exercises. The America College of Sports Medicine proposes using the FITT-principle when prescribing a patient-tailored exercise programme.[7,11]

- **F**requency – aerobic training 3–5 days per week, strength training 2–3 days per week, and flexibility/balance training most days of the week.
- **I**ntensity – refers to levels of exertion experienced during exercise, which can be monitored using the modified BORG scale or by tracking heart rate. Moderate intensity is recommended for aerobic exercise which measures between 5 and 7 (out of breath to trouble breathing) on the modified BORG scale. Strength exercise should measure between 6–8 (somewhat hard to hard) and once the perceived exertion falls below 6, the weight can be progressed.[4]
- **T**ime – duration of the exercise should be between 20 and 60 minutes for aerobic training and 1–2 sets of 8–15 repetitions for strength training. For balance and flexibility training, each stretch should be held for 20–30 seconds and repeated 2–3 times.[4]
- **T**ype – refers to all four types of exercise mentioned above.

Once a patient becomes fitter, the exercises can progress to ensure that there is optimal improvement. This is achieved by increasing the frequency or duration of exercise and lastly the intensity.[11]

The goal of the exercise intervention is to increase aerobic capacity meaningfully but at the same time be safe, cost-effective, time-efficient and above all, acceptable to the patient.[7] Programmes can only be effective if adhered to and non-adherence can present as misunderstanding the advice or reason for participating, doing the exercises wrong or even ignoring it altogether. Patients need to understand the purpose of the programme and they should be able to apply the intervention once home.[4,11] Supervised programmes add an extra safety benefit with high-intensity interval training increasing a patient's aerobic capacity within a short time frame. A walking-based intervention, more easily performed at home, may not create the aerobic improvements needed within the short preoperative time frame.[3]

Psychological

Awaiting surgery is a stressful time in a patient's life.[12] Evidence suggests that psychological factors such as depression, anxiety and low self-efficacy impact physiological and psychological surgical outcomes, including LOS and quality of life.[2,5,13] The presence of preoperative pain, anxiety, together with the patient's age and type of surgery are factors predictable of developing acute postoperative pain. Patients with psychological vulnerability, depression, anxiety, chronic stress and pain catastrophising are at risk of developing postsurgical chronic pain.[13]

Psychological interventions studied in 10 302 patients undergoing elective surgery reported lower postoperative pain, LOS and negative affect. Although evidence was of low quality, there was no report of harm. Interventions reported includes:[2,13]

- Information about the surgery – what, when and how.
- Sensory information on what the experience will feel like.
- Behavioural instruction – telling the patient what they need to do.
- Cognitive therapy to change how patients think.
- Relaxation techniques.
- Hypnosis therapy.
- Techniques to manage patients' emotions.

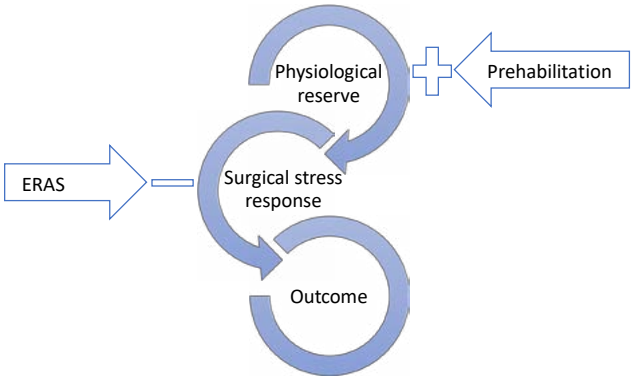

Figure 3: Complementary effects of prehabilitation and ERAS[2]

Mental preparedness and social support from peers, family and healthcare providers are important for psychological wellbeing during the postoperative period.[12]

Smoking

Preoperative interventions for smoking cessation often lead to long-term abstinence. Smoking is a known risk factor for postoperative complications and anaesthetists are ideally positioned to assist in short-term outcome but also improve a patient's long-term health outcome.[14]

Enhanced recovery after surgery

Enhanced recovery after surgery (ERAS) is a multidisciplinary approach to perioperative care that is constantly evolving and based on current best evidence. ERAS is implemented in more than 25 countries and leads to fewer complications, and a reduction in the cost of care.[15] Recovery from surgery is not a passive process and ERAS aims to enhance postsurgical recovery by decreasing organ dysfunction perioperatively. It consists of interventions that attenuate the surgical stress response. Prehabilitation complements ERAS by enhancing a patient's physiological reserve and functional capacity as seen in Figure 3.[2] Patients awaiting surgery may be more receptive to measures to improve their health.[15] Prehabilitation programmes need to be tailored to the individual patient and surgery, understanding their needs, preferences and potential barriers to engagement as changing health behaviour is a complex process.[13]

Since the inception of fast-track surgery or ERAS more than 20 years ago, implementation has been slow due to complicated guidelines, interdisciplinary disagreement, lack of knowledge and leadership, as well as lack of procedure-specific guidelines.[1]

Some critics view ERAS as good clinical practice tailored to individual patient needs, that has evolved from traditional practice and which should be available to all patients.[16] Implementing ERAS in low- and middle-income countries (LMIC) faces many challenges including existing healthcare issues such as malnutrition, HIV and obesity that impact on the complexity of surgery, complications and LOS. It is estimated that LMICs have around 143 million surgeries per year that are unfulfilled.[15] There is very little high-quality evidence on preoperative optimisation from these countries, yet the impact is likely to be the greatest.[17]

Conclusion

A recent systematic review focussed on all types of prehabilitation interventions across all surgical specialties and reported that exercise, inspiratory muscle training, immunonutrition and multimodal prehabilitation reduced postoperative complications and/or LOS.[18] This was echoed in a review of prehabilitation in patients undergoing major abdominal and cardiothoracic surgery reporting a lower overall, pulmonary and cardiac complication rate. Due to the heterogeneous data currently available, more high quality information is required to tailor the optimum prehabilitation programme required for individual patients and specific surgeries.[15] The components, duration, supervision, intensity, outcomes measured and cost of the programme need to clear.[4]

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