Perioperative prehabilitation

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ABSTRACT
Perioperative prehabilitation has gained acclaim as a modality to improve outcomes in surgical patients, with evidence endorsing it. Although prehabilitation was originally confined to physical therapy, it now encompasses other domains of perioperative care, such as nutrition and psychology. This commentary is critical at this juncture to forge a holistic perspective on perioperative prehabilitation to guide clinical practice. The heterogeneity of currently available studies makes interpretation of the outcomes challenging, especially when further review of the literature reveals disparate findings. Studies show that benefits of preoperative physical therapy are confined to patients undergoing cardiac, thoracic and abdominal surgeries, with most studies showing no benefit in patients undergoing orthopaedic procedures. The literature implies that implementation of the domains of prehabilitation should be performed judiciously after careful selection based on patient characteristics, the nature of underlying disease and the surgery planned. Cost-benefit analysis of perioperative prehabilitation is yet to be performed.

Keywords: perioperative, physical therapy, prehabilitation, surgery

INTRODUCTION
The basic concept of prehabilitation is enhancement of an individual’s functional capacity in order to withstand an anticipated injury. It embodies the novel idea of being proactive versus the prevailing approach of rehabilitation, which is reactive. Although rehabilitation has been shown to augment fitness recovery post-surgery, the notion that deconditioning supersedes recovery\(^{(1)}\) makes perioperative prehabilitation an interesting premise to consider. Whilst the initial prehabilitation model was confined to physical training, it has now evolved into a multimodal entity that comprises nutritional optimisation, psychosocial preparedness and smoking cessation, in addition to exercise programmes. In the last decade, there has been a
heightened drive for prehabilitation to be contemporaneous with surgery, as surgery is rightfully perceived as a stressor to the human structural and physiological functions. Although in theory, the application of perioperative prehabilitation is advantageous, with studies affirming this, we must be wary in implementing it for our patients, as there have been studies showing null to nominal outcomes. We present a review of the literature on the various entities of prehabilitation, focusing on the outcomes and challenges in implementation.

**PHYSICAL THERAPY**

A generic perioperative prehabilitation exercise programme incorporates the components of warm-up, cardiovascular training, resistance training, flexibility training and practicing functional tasks. Some programmes include inspiratory muscle training.

Physical inactivity has been showed to disrupt the normal functioning of major organ systems and lead to functional decline. The benefits of exercise are improvement and maintenance of lean muscle mass, physical function, aerobic capacity, insulin sensitivity, blood pressure and lipid status, all of which – if optimised in the perioperative setting – is advantageous. Studies have shown that poor preoperative physical fitness correlates with morbidity and mortality, and that patients with better preoperative physical status had better postoperative functional status and pain scores. However, we must acknowledge that most studies on these benefits were performed in healthy subjects and those not undergoing surgery. Deciphering the current literature on preoperative physical therapy is challenging given the poor-to-moderate methodological quality and the heterogeneity of the studies. The interventions, outcome measures and results are often inconsistent, diverse and at times contradicting.

Studies involving patients undergoing cardiac, thoracic and abdominal surgeries have shown favourable results. Patients undergoing these procedures have demonstrated improved
physical activity and body strength before and after surgery in the prehabilitation group.\(^{8-11}\)
The interventions that patients were subjected to varied, comprising physical therapy, inspiratory muscle training and trimodal prehabilitation. Most of the studies also showed reduction in the rate of complications and length of stay\(^{12-16}\) by an average of 1–3 days.\(^{12,14}\)

However, some of these studies were underpowered and one study did not measure the patient outcome postoperatively.

Incongruous prescription of exercise programmes may be ineffective. Interestingly, a randomised controlled trial by Carli et al showed that patients undergoing colorectal surgery who were assigned to a sham intervention (comprising daily walks and breathing exercises) showed improvement in walking capacity at the end of prehabilitation and after surgery as opposed to the group who received intervention (comprising cycling and strength training).\(^{17}\)

This result was attributed to high dropout rates and poor adherence to exercise programmes.

Benefits of physical therapy in patients undergoing knee and hip surgery have been largely equivocal. Most studies and reviews conducted on patients undergoing knee and hip surgery showed no benefits of prehabilitation in terms of reduction of length of stay, postoperative functional recovery and health-related quality of life.\(^{16,18-20}\) This was evident in a systematic review by Cabilan et al, which stratified the prehabilitation cohort into four groups based on total exercise duration (< 500 minutes, \(\geq 500\) minutes, \(\geq 1,000\) minutes and \(\geq 1,500\) minutes); there was no improvement across all groups. However, this review did show lower admission to rehabilitation in the intervention group,\(^{20}\) although some of the analyses suffered from low therapeutic validity, high risk of bias and possible poor compliance to prehabilitation.\(^{21}\)

In contrast, a review by Moyer et al indicated that physical therapy in patients who underwent total knee and hip replacements had a small-to-moderate effect on length of stay and physical function.\(^{22}\) Hoogeboom et al argued that the poor showing of exercise therapy in
knee and hip surgery can be attributed to the fact that subjects that were included in the studies were generally of good health. The authors opined that benefit would be seen if the studies were conducted in high-risk patients who would gain from preoperative exercise therapy.\(^{(23)}\)

There are various factors that may contribute to studies not showing benefits of preoperative exercise therapy. Most studies reported poor compliance to exercise programmes. This may be due to the current ‘one size fits all’ approach to exercise prescription, which will disadvantage the cohort of patients who are unable to adhere to the programme. This approach also fails to acknowledge the complex alterations to normal physiology caused by the diseased state and the physiological response to surgery, which may render physical therapy ill-fitted. Surgery causes activation of the sympathetic nervous system, hormonal changes (pituitary hormone secretion and insulin resistance), immunologic and haematologic alterations (cytokine production, acute phase reaction, neutrophil leukocytosis and lymphocyte proliferation),\(^{(24)}\) which culminates in a hypermetabolic and catabolic state.\(^{(25)}\)

**DIETARY MODIFICATIONS**

Malnutrition is associated with postoperative complications and increased length of stay,\(^{(26,27)}\) with perioperative nutritional optimisation shown to improve surgical outcomes and reduce infectious morbidity and mortality. An estimated 24%–48% of patients undergoing surgery are malnourished.\(^{(28)}\) Mignini et al demonstrated that well-nourished subjects had complications early (three days) in the postoperative period but had subsequent uneventful recovery as opposed to malnourished subjects, who developed post-surgery (six days) systemic and wound-related complications for a prolonged period and had poor recovery.\(^{(29)}\)

The European Society for Parenteral and Enteral Nutrition guidelines states that calorie requirement in the preoperative period should be 25–30 kcal/kg ideal body weight\(^{(30)}\) and nutritional support should ideally be started 7–14 days\(^{(31)}\) before surgery. The American
Society for Enhanced Recovery and Perioperative Quality recommends oral nutritional optimisation for those identified to be at nutritional risk for a period of at least seven days, which can be achieved by either supplementation with immunonutrition or a high-protein diet.\(^{(32)}\) In the perioperative state, protein requirements are elevated due to the synthesis of acute-phase proteins and inflammatory cytokines as well as to promote wound healing.\(^{(33)}\) Research has proven that consumption of 25–35 g of protein in a single meal maximally stimulates skeletal muscle protein synthesis in those at nutritional risk.\(^{(34)}\)

There are studies that support the use of immunonutrition (arginine, omega 3 fatty acid and antioxidants) in the perioperative setting, especially in gastrointestinal cancer surgery. Immunonutrition is postulated to prevent decrease in cellular immunity and phagocytic activity of polymorphonuclear neutrophils during the postoperative period.\(^{(35)}\) It has also been shown to reduce the rate of acquired infections, wound complications and length of stay.\(^{(36,37)}\) However, other papers showed mixed outcomes, and a systematic review by Burden et al has found potential bias in some studies.\(^{(38)}\) Also, critically ill patients may not benefit from immunonutrition.\(^{(39)}\)

Although preoperative carbohydrate loading is being advocated to mitigate the detrimental ramifications of surgery such as insulin resistance and the catabolic state,\(^{(40)}\) evidence for this modality is modest. A systematic review by Smith et al concluded that preoperative carbohydrate loading was associated with a small reduction in length of stay and no change in complication rates, as compared to patients who were fasted or given a placebo. Many studies included in the review were also subjected to possible bias due to the lack of blinding.\(^{(41)}\)

Initiating nutrition in patients who are malnourished needs to be done cautiously due to the risk of refeeding syndrome and other complications such as azotaemia, hypertonic dehydration, metabolic acidosis and hypercapnia.\(^{(42)}\) A study by van Venrooij et al interestingly
showed dietary calorie and protein supplementation in well-nourished patients did not show any benefits and was in fact associated with higher complication rates.\(^{(43)}\)

**PSYCHOSOCIAL OPTIMISATION**

Psychological distress in the form of anxiety and depression have been shown to influence wound healing, medication compliance and postoperative pain relief, leading to increased length of stay and functional limitations.\(^{(44,45)}\) Psychological distress is prevalent, particularly in cancer patients. A study by Parker et al conducted in patients with prostate cancer found that presurgical stress management leads to less mood disturbance and higher quality of life in the immediate postoperative period, as compared to patients who did not undergo stress management. These patients also had a significantly higher physical summary score one year after surgery.\(^{(46)}\) A systematic review by Tsimopoulou et al found that patients who were subjected to psychological intervention before cancer surgery had better immune function, self-reported psychological outcomes, quality of life and somatic symptoms. Unfortunately, intervention did not impact other outcomes such as length of stay, analgesia use, complication and mortality rate.\(^{(47)}\)

**SMOKING CESSATION**

Smoking is known to have detrimental effects on patients undergoing surgery, with increased pulmonary complications, wound infections and delayed wound healing,\(^{(48)}\) leading to increased length of stay and hospital mortality.\(^{(49)}\) Surgery is considered a ‘teachable moment’ to promote long-term smoking cessation, as smokers are more receptive to interventions to quit,\(^{(50)}\) with studies showing abstinence in 25\%–36\% of individuals at 12 months after perioperative smoking cessation interventions.\(^{(51,52)}\)
The timing of smoking cessation has been a subject of debate. Warner et al found that patients who stopped smoking less than two months prior to surgery were at an increased risk of pulmonary complications.\(^{(53)}\) The authors concluded that decreased coughing and increased sputum production after smoking cessation led to this finding. This was later discredited by a meta-analysis by Myers et al, which found no increase in rates of complications even when smoking cessation occurred within eight weeks of surgery.\(^{(54)}\) Studies indicate a positive linear correlation between the duration of smoking cessation before surgery and improvement in outcomes. Studies with shorter pre-surgery smoke-free periods showed no or minimal reduction in adverse events\(^{(55,56)}\) as opposed to studies with longer periods of smoking cessation.\(^{(57)}\) Based on the current evidence, intervention of at least 4–8 weeks prior to surgery, with a strategy to combine behavioural therapy with nicotine replacement, is likely to have a positive impact on complications and long-term smoking cessation.\(^{(58)}\)

**COST**

One major factor that has yet to be addressed by studies is cost, with no studies showing convincing cost benefit of perioperative prehabilitation. In the current climate, prehabilitation ostensibly can only be enforced in healthcare systems that are well-heeled. With healthcare funding being a hotly debated subject, the justification of implementing perioperative prehabilitation depends greatly on the cost incurred versus the benefits to patients and the healthcare system. Also, as insurance claims may not cover the costs of prehabilitation, patients will need to bear the expenses, and this may affect interest in and compliance to prehabilitation programmes. An ongoing study by van Rooijen et al, which analyses the cost-effectiveness ratio of perioperative prehabilitation, will hopefully shed light on its economic viability.\(^{(59)}\)
CONCLUSION

Multimodal perioperative prehabilitation is applicable only in elective surgery, as patients who need urgent or semi-urgent surgeries do not have the leverage of time to benefit from the interventions. Although this topic has been researched to a reasonable extent, the results are polarising, especially the outcomes of preoperative physical therapy. As discussed in this commentary, studies and reviews conducted thus far are vastly heterogeneous in terms of patient selection, underlying disease, delivery of prehabilitation and measure of outcomes. Studies suffer from small sample sizes, inadequate description of the exercise programmes and poor compliance to exercise regimes, which subject these studies to a high risk of bias. The lack of control groups and placebo interventions in many studies also predisposes the outcomes to the Hawthorne effect. As such, implementing prehabilitation across the board in its current state is controversial, especially in the absence of any cost-benefit analyses.

Preoperative exercise therapy should not be implemented *en masse*. Patients at either ends of the fitness spectrum (the patients already actively exercising and those who are unfit to exercise) may not benefit from exercise therapy. The components of exercise therapy prescribed need to be carefully selected. Based on current evidence, the benefit for physical therapy seems to be most evident in patients undergoing cardiac, thoracic and abdominal surgeries.

A prehabilitation team should ideally consist of a robust multidisciplinary team, comprising surgeons, anaesthetists, perioperative physicians, physiotherapists, dietitians, psychologists and specially trained nurses, working in tandem to form a sturdy system that provides patient support both in the community and hospital.

If perioperative prehabilitation is to be actualised, the domains offered need to be tailored to the local setting, taking into consideration the resources available, the patient and disease profile, and the cultural outlook on surgery. Failure to modify prehabilitation based
on the patient characteristics or inappropriate enforcement of preoperative optimisation measures may be counterproductive\(^\text{(21)}\) and may incur unnecessary costs to both the patient and the healthcare system.

**REFERENCES**


