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British Journal of Anaesthesia, 125 (5): 646–649 (2020)
doi: 10.1016/j.bja.2020.06.050
Advance Access Publication Date: 15 July 2020

Evidence on technology-driven preoperative exercise interventions: are we there yet?

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Keywords: cancer; exercise; morbidity; prehabilitation; preoperative; postoperative outcomes; technology

A number of RCTs have been published in the past few years investigating the effectiveness of a wide range of preoperative exercise interventions on postoperative surgical outcomes, quality of life, and health service costs in patients undergoing cancer surgery.[1–3] Thus far, the most compelling evidence is reported in lung cancer patients, where preoperative exercise was shown to be effective in reducing the rate of postoperative complications and length of hospital stay.[4–6] For other groups of patients undergoing oncological surgery, the evidence is mostly derived from small individual trials reporting a trend towards preoperative exercise as an effective intervention to reduce postoperative morbidity.[7–10]

Many of these programmes are delivered face to face in centralised rehabilitation centres; however, this might not be suitable for patients who live in regional or remote areas, are of low socioeconomic status, or are juggling full-time work, family responsibilities, and medical appointments in the weeks before a surgery. Home-based exercise prescription may help, although poor exercise fidelity and poor adherence to the exercise programme are commonly reported. A potential solution to these limitations would be implementation of a technology-based preoperative exercise intervention, in which patients could perform individualised and unsupervised preoperative exercises, delivered online at home.

Our group recently conducted a systematic review to evaluate the evidence for technology-based preoperative exercise in patients undergoing cancer surgery.[11] For this purpose, technology-driven preoperative exercise interventions were defined as app-based, web-based, video-game, or virtual reality exercise programmes aimed to maintain or increase muscle strength, endurance, respiratory function, or all three. This review aimed to describe the current evidence of efficacy in technology-driven preoperative exercise on postoperative complication rate, length of hospital stay, and quality of life outcomes in patients undergoing cancer surgery. Of the 321 individual articles found in the search, none met the inclusion criteria. This was somewhat surprising, as there are >1000 exercise applications available from App stores. Although clearly not evidenced-based for patients undergoing cancer surgery, we found four studies – three that were originally excluded from our review for reporting on a single arm only (no control)[12–14] and one abstract that was published in a conference proceeding.[15] The characteristics of the four studies are described in Table 1.

The limited literature on this topic highlights that more research is warranted. Recent research has shown that the majority of patients (72%, 74/103) awaiting major gastrointestinal and urological cancer surgeries would prefer to do a preoperative exercise programme at home.[16] Therefore, there is a need to develop an evidence-based technology to deliver a preoperative exercise programme to patients undergoing surgery that can improve exercise fidelity and patient adherence to exercise regimens when performed at home. We have developed a set of recommendations that we consider

Table 1 Characteristics of technology-based preoperative exercise interventions. -a Preoperative and postoperative intervention. NA, not applicable; NR, not reported; IQR, inter-quartile range.

Authors, year	Characteristics	Technology-based intervention						
		Technology	Intervention type	Frequency	Intensity	Session time	Programme duration	Adherence (%)
Bruns and colleagues, 2019[13]	Design: single arm cohort Sample size: 14 Median age (IQR): 79 (74–86) Male sex (%): 5 (36%) Cancer type: colorectal	Digital TV (not commercially available)	Physical: strengthening exercises using body weight	Daily	NR	7 min	18–32 days	86
			Nutritional: protein-rich meals	Daily	NA	NA	18–32 days	71
Olivero and colleagues, 2019[15]	Design: prospective cohort Sample size: 182 Age: NR Male sex (%): NR (NR) Cancer type: lung	Mobile Application[a] (n=68)	Physical: aerobic, inspiratory, muscle strength	NR	NR	NR	NR	NR
			Education: smoking advice, mouth health, early mobilisation, and pain control	NR	NR	NR	NR	NR
		Control (n=114)	Education: information and education by the department of physical medicine	NR	NR	NR	NR	NR
Hillen and colleagues, 2019[14]	Design: case report Sample size: 1 Age: 56 yr Male sex (%): 1 (100%) Cancer type: oesophagus	Web-based programme (individualised)a	Physical: endurance and resistance exercises using resistance bands	6 days/ week	NR	NR	10 weeks	95
Kadiri and colleagues, 2019[12]	Design: single arm cohort Sample size: 31 Mean age (SD): 64 (12) yr Male sex (%): NR (NR) Cancer type: lung	Mobile Application (iOS 11) incorporated with pulse oximeter	Physical: aerobic and strengthening training consisted of 10 exercises	NR	Target heart rate ≥60% of maximum heart rate based on their age	NR	NR	NR
			Education: importance of exercise, information about their surgery, patient pathway	NR	NR	NR	NR	NR

important based on our collective experience in preoperative group exercise programmes and technology-based exercise programme design.

The exercise programme should be tailored to the individual and increase in intensity and dose as the performance improves. Integration of a heart rate monitor and self-report feedback (e.g. Borg scale) can be used for ongoing tailoring of exercise intensity. A daily exercise routine including a combination of aerobic exercises, strength exercises, or both may be important to maximise the effectiveness of the programme on postoperative recovery. We propose a range of strategies to encourage patients to reach this dose, including push notifications to remind participants about daily exercises, feedback on performance for self-monitoring, health education on the benefits of preoperative exercise, personal online coaching, and providing personalised messages of encouragement and a 'reward' or 'gamification' system. In addition, integration of other smart devices such as smart watches or other activity trackers that patients already use might increase usability of the preoperative exercise programme. Integration of other potential preoperative interventions tailored to the patient, such as specific multidisciplinary videos that cover psychological and nutritional education and advice, might further increase overall effectiveness of the programme.

The system must be designed in ways that are accessible to all patients regardless of their previous technology exposure, and access to technology, wireless internet, or both. For example when designing the programme, it is important to aim for an inclusive system that works on both Android and iOS operating systems, smartphones, computers, tablets, smart TVs, and other smart devices. In addition, the exercises should be accessible offline in written or pamphlet form and involve patient co-design principles. The exercise equipment should be readily available and inexpensive, with a preference on using body weight or readily available equipment (e.g. can, milk bottle filled with water). Safety is paramount and should be considered throughout the design and set-up processes, with an option for ongoing support from experienced physiotherapists, exercise physiologists, or other exercise specialists, and technical support. Finally, in order to allow monitoring by healthcare professionals and researchers, it is important that the system capture and communicate data on compliance to a secure back end. This may include the exercises performed, time spent reading educational materials, and completing patient-reported outcomes.

Although previous research has suggested that preoperative exercise reduces postoperative complications and length of hospital stay for patients undergoing cancer surgery, there are several limitations with the current trials, especially related to accessibility. The opportunity for all appropriate cancer patients to undergo a preoperative exercise programme using a technology-based programme will improve treatment equity, although in order to confirm the effectiveness and safety of such interventions, they must first be tested in high-quality trials. The evolving coronavirus disease 2019 (COVID-19) pandemic may have fast-tracked the upsurge in technology-driven exercise participation, potentially providing new pragmatic evidence that these methodologies are indeed possible for patients having cancer surgery.

Declaration of interest

The authors declare that they have no conflict of interest.

Authors' contributions

Drafting of manuscript: DS, KD, LD.
All authors were involved in concept and design of the manuscript. All authors reviewed and revised drafts of the manuscript and approved the final version.

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British Journal of Anaesthesia, 125 (5): 649–651 (2020)
doi: 10.1016/j.bja.2020.08.013
Advance Access Publication Date: 28 September 2020

Fascial plane blocks in regional anaesthesia: how problematic is simplification?

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This editorial accompanies: Comparing erector spinae plane block with serratus anterior plane block for minimally invasive thoracic surgery: a randomised clinical trial by Finnerty et al., *Br J Anaesth* 2020:125: 802–810, doi: 10.1016/j.bja.2020.06.020

Keywords: anatomy; facial plane block; local anaesthesia; nerve block; regional anaesthesia

Introduction of ultrasound guidance into the clinical practice of regional anaesthesia was revolutionary and brought the potential for superior efficacy and safety compared with pre-ultrasound practice.[1] Fulfilling this potential demands acquisition of new knowledge (sonographic anatomy and physical principles of ultrasound) and technical skills.[2] The transition of non-neuraxial regional anaesthesia from a 'hit or miss' approach to a precision image-guided approach has led to an increasingly important role in perioperative medicine. The strength of ultrasound-guided techniques in experienced hands is that local anaesthetics can be administered as close as possible to nerve structures while damage to the nerve and adjacent anatomical structures can be avoided.[3] The fact that so many anaesthesiologists around the world have undertaken the necessary learning and training to expand their clinical repertoire to encompass ultrasound-guided regional anaesthesia represents a real triumph for our specialty.

The earliest applications of ultrasound-guided regional anaesthesia were for plexus and peripheral nerve blocks of the limbs.[4,5] The availability of point-of-care ultrasound machines and sonographic skills soon led to an expanding number of approaches to providing regional anaesthesia of the trunk using fascial plane blocks. The underlying aims of these techniques were to provide peripheral regional anaesthesia of the trunk, thereby replicating the advantages seen with widespread adoption of ultrasound-guided regional anaesthesia of the limbs, while avoiding the side-effects and complications of neuraxial anaesthesia. Their uptake was fuelled in part by the enthusiasm of anaesthesiologists to broaden use of their newly acquired sonographic skills. The partial list of fascial plane blocks includes transversus abdominis plane,[6] pectoral I and II,[7] serratus anterior plane,[8,9] erector spinae plane,[10] rectus sheath,[11] quadratus lumborum,[12] and transversalis fascia blocks.[13] The fundamental problem, however, is that the notion that truncal blocks can achieve the same reliable efficacy as ultrasound-guided regional anaesthesia of the limbs neglects the essence of the latter's success: the precise administration of local anaesthetics as close as possible to the relevant nerve structures. Although some blocks of the trunk do involve nerves coming into direct contact with the local anaesthetic (e.g. rectus sheath block), most do not have a clear anatomical rationale to predict success and efficacy even if local anaesthetic is deposited at the intended landmark.

The current issue of *British Journal of Anaesthesia* includes a comparative study of the perioperative impact of erector spinae *vs* serratus anterior plane blocks for minimally invasive thoracic surgery.[14] Finnerty and colleagues[14] treated 60 patients undergoing thoracoscopic surgery with one of the two regional techniques and compared the quality of recovery and overall morbidity. Their results suggest that the erector spinae plane block was superior in all outcomes. In evaluating this study, it is first necessary to appreciate that pain after so-called 'minimally invasive surgery' is a clinical problem worthy of investigation. Contrary to widespread belief, the

DOI of original article: 10.1016/j.bja.2020.06.020.