

BMJ Open EduCan trial: study protocol for a randomised controlled trial on the effectiveness of pain neuroscience education after breast cancer surgery on pain, physical, emotional and work-related functioning

An De Groef,^{1,2} Nele Devoogdt,^{1,2,3} Elien Van der Gucht,¹ Lore Dams,⁴ Koen Bernar,^{2,5} Lode Godderis,^{6,7} Bart Morlion,^{5,8} Niamh Moloney,^{9,10} Ann Smeets,¹¹ Paul Van Wilgen,^{12,13,14} Mira Meeus^{4,12}

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For numbered affiliations see end of article.

Correspondence to

Dr An De Groef;
an.degroef@kuleuven.be

ABSTRACT

Introduction Over the past decades, awareness on the importance of educational interventions in cancer pain management has increased. However, education is often restricted to biomedical pain management instructions. A more modern educational approach, also known as pain neuroscience education (PNE), explains pain from a biopsychosocial perspective. We hypothesise that this more comprehensive educational approach in the early treatment phase of breast cancer will lead to more beneficial effects for cancer pain management. Therefore, the aim of the present study is to investigate the effectiveness of this PNE intervention, in addition to best evidence physical therapy modalities for treatment and prevention of pain, physical, emotional and work-related functioning after breast cancer surgery, compared with a traditional biomedical educational intervention.

Methods A double-blinded randomised controlled trial has been started in November 2017 at the University Hospitals of Leuven. Immediately after breast cancer surgery, all participants (n=184) receive a 12-week intensive standard physical therapy programme. They receive three additional refresher sessions at 6, 8 and 12 months postsurgery. In addition, participants receive three educational sessions during the first-month postsurgery and three 'booster sessions' at 6, 8 and 12 months postsurgery. In the intervention group, the content of the education sessions is based on the modern PNE approach. Whereas in the control group, the education is based on the traditional biomedical approach. The primary outcome parameter is pain-related disability 1 year after surgery. Secondary outcomes related to other dimensions of pain, physical, emotional and work-related functioning at 1-week, 4, 6, 8, 12 and 18 months postsurgery.

Ethics and dissemination The study will be conducted in accordance with the Declaration of Helsinki. This protocol has been approved by the ethical committee of the University Hospitals of Leuven. Results will be disseminated via peer-reviewed scientific journals and presentations at congresses.

Strengths and limitations of this study

- This study comprises a well-powered clinical trial investigating the additional effect of an easy deliverable pain neuroscience education intervention for pain-related disability and related outcomes following breast cancer treatment.
- A strength of the trial is the pragmatic nature of the study and applicability in daily clinical practice.
- The study is powered for the primary outcome parameter 'pain-related disability' 1 year after surgery.

Trial registration number NCT03351075.

INTRODUCTION

Breast cancer is the most frequent malignancy among women worldwide.¹ Despite the high incidence, in Western countries, an increase in survival and life expectancy has been observed due to the ongoing improvement of detection method accuracy, early diagnosis and breast cancer treatment.¹ Consequently, more attention is warranted towards the debilitating problems accompanying this disease and its treatment, which can persist for months or even years after diagnosis. In addition to fatigue, pain is the most frequent and persistent symptom following cancer and cancer treatment. Between 27% and 79% of women report pain 1 month after surgery, which is often attributed to local pain mechanisms caused by a postsurgery and/or radiotherapy tissue insult at that time point.^{2–5} One would expect the prevalence rate to diminish as healing occurs, yet this does not seem to be the case. In fact, 12%–82% of women

still report persistent pain 1 year or later.⁴ This may indicate that besides local nociceptive and neuropathic pain mechanisms, a third pain mechanism characterised by altered nociceptive processing without clear evidence of persistent tissue damage causing the activation of peripheral nociceptors (ie, nociceptive pain) or evidence for disease or lesion of the somatosensory system causing the pain (ie, neuropathic pain).^{6–8} Moreover, pain interferes with pain, physical, emotional and work-related disability and therefore severely prejudices a person's quality of life and participation in society.^{9–11} Hence, adequate pain management in the early stage of breast cancer treatment is necessary to prevent and improve pain and pain-related disability, both at short and long term.

Despite the effectiveness of currently applied physical therapy modalities after breast cancer surgery (such as manual techniques, specific exercises and general exercises), up to 72% of women still experience pain and the resulting disabilities after finishing breast cancer treatment.¹² Over the past decades, awareness on the important role of educational interventions in the management of cancer pain has increased.^{13–15} These general educational interventions have been shown to be effective for improving pain severity, self-efficacy and knowledge and attitude to pain and analgesia in patients with cancer. However, effect sizes are only moderate and of limited clinical relevance.¹³ This can be explained by the fact that these educational interventions mainly focus on tissue and tissue injury as the source of pain and are often restricted to biomedical pain management instructions and general advice on physical activity and analgesics.^{13–15} They focus on explaining treatment side effects and improving patients' coping strategies. Recently, increased knowledge on pain mechanisms has led to a more modern educational approach, also known as pain neuroscience education (PNE).^{16–19} This explains the neurophysiology of chronic pain and the ability of the nervous system to modulate pain experience, as well as the potential influences of sleep, thoughts, feelings and culture, among others, on pain. Thereby, it targets a reconceptualisation from a biomedical or structural model to an actual biopsychosocial model of pain. Through the knowledge that pain is often an unreliable indicator of the presence or extent of tissue damage and if patients may become open to exploring broader contributions to pain, pain-related behaviour might change by shifting from passive therapy receiving to active self-management. Increased knowledge of the broad contributions to pain,⁴ as well as awareness of different pain mechanisms following breast cancer treatment^{6–8} provides justification for the integration of PNE in this population. Applying PNE could enhance the effectiveness of the currently applied physical therapy modalities for prevention and treatment of pain and related disabilities after breast cancer treatment, compared with a traditional biomedical educational intervention. Indeed, encouraging people to address emotional, cognitive and broader health-related factors in the early stage of cancer

treatment may enhance recovery during and after the treatment. To our knowledge, only one controlled trial investigated the effectiveness of PNE in the early stage of breast cancer treatment.²⁰ Although the results were very promising for shoulder function, only short-term effects were examined, no randomisation was performed and no pain-related or other health-related outcomes were evaluated.

Objectives

The main scientific objective is to examine the effectiveness of PNE, in addition to a standard best evidence physical therapy programme, on pain, physical, emotional and work-related functioning in the early stage of breast cancer treatment, compared with a traditional biomedical educational intervention, up to 1.5 years after surgery (EduCan Trial). This will be performed through a double-blinded randomised controlled trial.

METHODS AND ANALYSIS

Described according to the Standard Protocol Items: Recommendations for Interventional Trials guidelines (<http://www.spirit-statement.org/protocol-version/>).

Trial design and study setting

A parallel, two-arm randomised controlled trial with blinding of assessors and physical therapists providing the standard physical therapy programme in both arms and masking of the participants. The trial started in November 2017 at the Department of Physical Medicine and Rehabilitation of the University Hospitals in Leuven (Belgium). A schedule of the EduCan Trial is provided in [table 1](#).

Patient and public involvement in the trial design

One female patient with breast cancer and a representative of the National Health Service were consulted during the initial grant preparation and trial set-up. The patient representative provided valuable insight into the worries and concerns experienced during cancer treatment. The representative of the National Health service contributed to the design of the study and advised on assessment of work-related functioning outcomes.

Eligibility criteria

Women are eligible to participate in the EduCan Trial if they are scheduled for surgery for breast cancer at the Multidisciplinary Breast Centre of the University Hospitals of Leuven. Patients with increased risk of developing pain after breast cancer surgery are included.^{21–23} Therefore, inclusion criteria are: (1) diagnosed with histologically confirmed invasive or non-invasive primary breast cancer, (2) scheduled for surgical excision including either axillary lymph node dissection and mastectomy (whether or not in combination with reconstructive surgery) or breast conserving; or either sentinel node biopsy and mastectomy (whether or not in combination with reconstructive surgery); (3) aged 18 years or older;

Table 1 Schedule of enrolment, interventions and assessments of the EduCan Trial

	Study period							
	Enrolment		Allocation	Postallocation				
Time point	-t ₂	-t ₁	0	t ₁	t ₂	t ₃	t ₄	t ₅
	preop consult	postop consult		4 mo	6 mo	8 mo	12 mo	18 mo
Enrolment								
Eligibility screen	X							
Informed consent	X							
Randomisation			X					
Allocation			X					
Interventions								
				Intensive phase	Maintenance phase			
Standard PT programme (All)		n=184		1–2 sessions/week	1 session	1 session	1 session	
Pain neuroscience education (IG)		n=92		3 sessions	1 session	1 session	1 session	
Biomedical education (CG)		n=92		3 sessions	1 session	1 session	1 session	
Assessments								
Pain-related functioning (primary outcome)*	X	X		X	X	X	X	X
Pain-related outcomes*	X	X		X	X	X	X	X
Emotional functioning	X	X		X	X	X	X	X
Physical functioning*		X		X			X	X
Work-related functioning*				X	X	X	X	X

*See table 2 for details on the content of the different assessments at each point in time. CG, control group; IG, intervention group; Mo, months.

(4) can comply with the study protocol. Patients with active metastasis are excluded because of the higher risk of mortality.

Participant screening, recruitment and consent

Participants are identified from scheduled operation lists and screened for eligibility criteria. The initial screening process is undertaken by a member of the research team. Potentially eligible participants are approached and recruited during the preoperative consult at the Multi-disciplinary Breast Centre of the University Hospitals of Leuven. All eligible patients receive an information sheet and the explanation of the study during the preoperative consult. Next, they are asked to have a preoperative baseline measurement for which a separate informed consent exists. Because of ethical and deontological reason, patients will not be forced to decide on participation in the complete EduCan Trial at this moment, but initially only for the baseline measurements.

During their postoperative hospital stay, a member of the research team will meet the eligible participants again, answer further questions and include them in the further trial if wanted. Then, a second informed consent is signed for participating in the complete EduCan Trial. The preoperative baseline measurement of non-participating patients will be stored in the medical file of

the patient and can be consulted on clinical follow-up appointments to evaluate the recovery of the patient but is not used for research purpose. The participants' flow is summarised in figure 1.

Allocation and randomisation

Therapists and assessors are blinded to the allocation of the treatment groups. The therapists providing the standard physical therapy programme will be unaware of the type of education received by the patient (PNE in the intervention group and biomedically focused education in the control group). Consequently, they give therapy in both groups. Assessors are blinded to the maximal extent possible. With regard to this, patients are asked not to communicate with the assessors about the intervention received. Patients are masked for the allocation to the intervention/control group; they do not know which one is the experimental intervention and which one is the control intervention, however, they will, of course, be aware of the intervention received. To reduce bias, within one participant, therapists giving the standard physical therapy programme, therapists given the educational intervention and the assessors are all different persons.

At the end of the trial, the success of assessor blinding will be examined by asking whether the assessor thought the participant had received the experimental or control

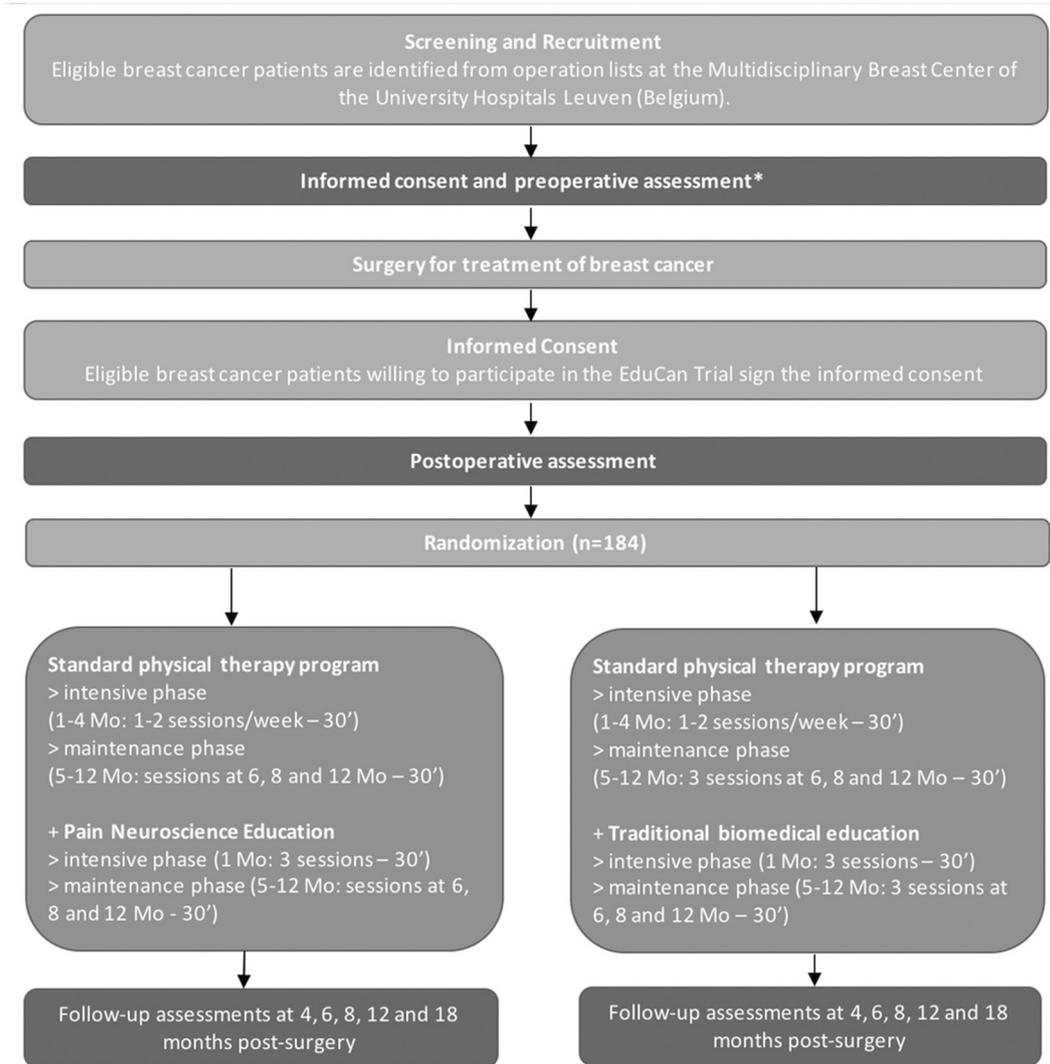


Figure 1 Flow diagram of the EduCan Trial. *A separate informed consent is available for the preoperative assessment. Mo, months.

intervention, including the percentage of certainty (ie, 50% certainty means a pure guess). The same will be done for patient masking. The research members performing statistical analysis will be blinded as well.

The randomisation is computer generated and is performed by using permuted blocks (size=4). An independent coworker at the department carries out the randomisation to ensure blinding of the research team. The sequence of randomisation is determined by the patient's identification number, which she receives after signing informed consent. Participants are randomised in a 1:1 ratio between intervention and control arms.

Interventions

Standard physical therapy programme

All participants in the EduCan Trial attend a standard physical therapy programme. The standard physical therapy programme is based on currently available evidence and clinical experience of the research team and will include three physical therapy modalities. Additionally, to avoid conflicts with the information given

during the educational interventions, a communication sheet had been made. This document contains guidelines on which information the physical therapists can provide on common topics discussed during the standard physical therapy sessions. First, manual techniques including (1) passive mobilisations to restore shoulder range of motion, (2) stretching of the pectoral muscles to improve muscle flexibility and (3) scar tissue massage to improve flexibility of the scar(s) will be implemented.^{12 24 25} Second, specific exercises to improve shoulder range of motion and upper limb strength have been proven to be effective for the treatment of upper limb problems after breast cancer and will start immediately after surgery as well.^{12 26} Specific exercises are instructed during the individual session and continued at home. Third, patients are advised on general exercises. General exercises should be implemented to increase the patient's physical activity level. In general, these recommendations consist of physical activity at a minimum level of moderate intensity over an extended

period and can include, for example, running, walking, cycling, swimming.^{27 28}

During month 1–4, an intensive physical therapy programme is implemented because of the postoperative side effects. Patients will attend 1–2 individual sessions of 30 min per week during the intensive phase, starting 1-week postsurgery. All patients start with a frequency of two sessions per week, decreasing to once every 2 weeks. The decrease in the frequency of the sessions is pragmatically chosen based on the individual progression and need of the patient.

Up to 1 year after surgery, a maintenance physical therapy programme is implemented to follow up on the exercises performed at home and to treat possible additional/new side effects of other adjuvant treatment modalities such as radiotherapy, chemotherapy and hormone therapy. An individual maintenance session of 30 min is scheduled 6, 8 and 12 months postsurgery.

Additionally, information about prevention of lymphoedema is given by a specialised physical therapist: about normal use of the upper limb, avoiding pinching off the arm, skin care and control of body weight.²⁹ One group information sessions of 60 min on this topic is organised each month which should be attended once by every participant (both patients from the intervention and control group together) and this as soon as possible after surgery. Patients also receive a brochure with this information. If patients develop lymphoedema, they are additionally referred to the Lymphovenous Center of the University Hospitals of Leuven for further treatment of the lymphoedema.

Educational intervention

The educational sessions are individual and last for 30 min. The first PNE session is given within the first postoperative week before the start of the standard physical therapy programme to prepare the patient for the physical therapy sessions. Information is presented verbally (explanation by the therapist) and in multimedia forms (power point presentation with summaries, pictures, metaphors and diagrams on a computer). After the first session, patients also receive an information leaflet on paper and are asked to read it carefully at home. They also receive a web-link to an online presentation that summarises the provided information. Additional written information that can be read afterwards is a valuable and essential part of the educational intervention. In the following 4 weeks after surgery, two additional PNE sessions are provided to ensure that the patient understands the pain physiology and principles of activity management and can relate this to the physical therapy programme and his/her pain complaint. However, education is a continuous process initiated at the start and continuing into and followed up during the longer term rehabilitation programme. Therefore, three additional booster sessions are organised at 6, 8 and 12 months postsurgery. During the booster sessions, the information given postoperatively will be rehearsed and application of the information into future stages of

the recovery process will be discussed. Special attention is given to return to preoperative activities and return to work (if applicable). Regarding this, a second information leaflet on paper will be given to the patient. Patients in the control arm and intervention arm will have the same schedule of educational sessions, only the content of the education differs from the intervention arm.

Intervention arm: PNE

Based on the available literature, a modern PNE programme has been established to explain pain specifically for this population.^{13 15 20} The content and pictures of the educational sessions are based on the book 'Explain Pain',³⁰ 'Pijneducatie een praktische handleiding voor (para)medici' (Van Wilgen and Nijs, 2011) and the 'The Pain Toolkit',³¹ as used in earlier studies.^{32 33} Topics addressed during the PNE sessions will include: the characteristics of acute versus chronic pain; specific side effects of the different breast cancer treatment modalities in relation to pain; how pain is a product of the brain; how pain becomes chronic (plasticity of the nervous system, modulation, modification, central sensitisation); potential sustaining factors of pain such as emotions, stress, pain cognitions and pain behaviour.

Additionally, this PNE intervention includes advice for activity management, while experiencing pain and other symptoms. In addition to the general recommendations for general exercise and advice to stay active in the standard physical therapy programme, the PNE guides patients in performing general exercises and activities according to the graded activity principle. Graded activity is applied according to the guidelines reported by the International Association for the Study of Pain.³⁴ This includes general exercise activities according to pacing strategies for 'persisters' (ie, restructuring the activity pattern to avoid peaks of overactivity and exacerbations of their pain) and graded activity for 'avoiders' (ie, time-contingent increase of physical activity). PNE is crucial here to help patients interpret pain during exercise in the correct context. Finally, advice on returning to work in the context of present pain complaints and how to apply the principles described above for activity management can be applied in the working situation will be provided.

Control arm: traditional biomedical education

Traditional biomedical educational interventions consist of explaining patient's pain experience in relation to the therapeutic procedures from a tissue and biomechanical perspective.^{35 36} Information on the different side effects of surgery, radiotherapy, chemotherapy, hormone therapy and target therapy is given. The role of different structures and injured versus healthy tissue in acute and persistent pain is discussed. Pain is explained from a biomechanical point of view, for example, deviance from normal expected movement patterns and postures. Additionally, during the educational sessions and rehabilitation program, patients receive advice on activity

management. This advice is to stay active as minimally possible during treatment and increase their physical activity level according to current recommendations for general exercises after treatment. Based on the American Cancer Society Guidelines on Physical Activity at least 150 min of moderate intensity (heart rate 50%–70% of the maximum heart rate or a score of 12–14 on Borg Rating of Perceived Exertion (RPE)) or 75 min of vigorous intensity activity (70%–85% of the maximum heart rate or RPE of >15) each week (or a combination of these), preferably spread throughout the week is recommended. Finally, advice on returning to work in the context of the different (persistent) side effects of the treatments will be provided.

Outcomes

The outcome measures were chosen in accordance with the guideline for core outcome domains to be used in clinical trials on multimodal treatment approaches for pain as advocated by an international steering committee (VAPAIN (Validation and Application of a patient-relevant core set of outcome domains to assess multimodal PAIN therapy) recommendations)³⁷ and the

IMMPACT (Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials) recommendations for the outcome measures in pain clinical trials.³⁸

The primary outcome is pain-related functioning at 12 months measured using the Pain Disability Index (PDI). Secondary outcomes are other pain symptoms and characteristics, physical functioning, emotional functioning and work-related functioning. Additionally, a number of visits are recorded. Assessments are performed within 1-week preoperatively, within 1-week postoperatively and then at 4, 6, 8, 12 and 18 months after surgery. However, because of feasibility limitations, not all outcome parameters are assessed at each assessment time point. Tables 1 and 2 present the study outcome measures by assessment time point. In table 3, the outcome measures are described in more detail.

Sample size

A power calculation was performed by the Leuven Biostatistics and statistical bioinformatics Centre of KU Leuven (Katholieke Universiteit Leuven) for the primary outcome parameter 'PDI after 1 year'. Sample size calculation was based on data available in the literature for the

Table 2 Study outcome measures by assessment time point

Domain	Scale/measure	T ₋₂ 1 W preoperative	T ₋₁ 1 W postoperative	T ₁ 4 months	T ₂ 6 months	T ₃ 8 months	T ₄ 12 months	T ₅ 18 months
Pain-related functioning (primary outcome)	Pain Disability Index	x	x	x	x	x	x	x
Pain symptoms and characteristics	Pain intensity (Visual Analogue Scale)	x	x	x	x	x	x	x
	Brief Pain Inventory	x	x	x	x	x	x	x
	Douleur Neuropathique in 4 questions	x	x	x	x	x	x	x
	Central Sensitisation Questionnaire	x	x	x	x	x	x	x
	Pain sensitivity testing	x	x	x	x	x	x	x
Physical functioning	General physical activity level (accelerometry)		x	x			x	x
	Upper limb performance (accelerometry)		x	x			x	x
	Upper limb function (Disability of Arm, Shoulder and Hand)	x	x	x	x	x	x	x
Emotional functioning	Pain Catastrophising Scale	x	x	x	x	x	x	x
	Depression, Anxiety and Stress Scale 21	x	x	x	x	x	x	x
	Health-related quality of life (McGill Quality of Life Questionnaire)	x	x	x	x	x	x	x
Social functioning	Return to work rate			x	x	x	x	x
	QuickScan			x	x	x	x	x
	19-items Return-to-work self-efficacy			x	x	x	x	x

Table 3 Outcome measures of the EduCan Trial

Outcome	Assessment method
Pain-related functioning (primary outcome)	
Pain-related functioning	Pain Disability Index (PDI). The PDI is a short, self-reported questionnaire for measuring the degree of interference of pain with normal role functioning (family/home responsibilities, recreation, social activity, occupation, sexual behaviour, self-care, and life-support activity). ^{39 40}
Pain symptoms and characteristics	
Pain intensity	Visual Analogue Scale. Present pain intensity and mean pain intensity during the past week for pain at the upper limb region (ie, shoulder-neck region, arm, axilla, trunk side and breast region).
Brief pain inventory	Medication use, pain quality, pain location, pain severity and response to treatment. ⁴¹
Presence of neuropathic pain	Douleur Neuropathique in 4 questions (DN4). The DN4 a questionnaire generating reliable and valid data for identifying pain of predominantly neuropathic origin. ⁴²
Presence of hypersensitivity of the central nervous system	Central Sensitisation Inventory (CSI). The CSI is a questionnaire generating reliable and valid data to assess symptoms related to central sensitisation mechanisms. ⁴³
Pain sensitivity testing	
Quantitative sensory testing: mechanical detection and pain thresholds*	Twelve monofilaments (MARSTOCK nerve test—Optihair2, Schriesheim, Germany) with a force from 0.25 to 512 mN are used. The mechanical detection threshold is defined as the lowest mechanical force that the participant can detect. The mechanical pain threshold is defined as the lowest mechanical force that the participant perceives as painful or unpleasant. Monofilaments are applied with a rate of 2 s 'on' and 2 s 'off' at the inner side of the upper arm and lateral trunk side.
Quantitative sensory testing: temperature detection and pain thresholds*	The computerised thermotest device TSA-II-NeuroSensory Analyser is used. The method of limits is used. The detection and pain thresholds are measured as the first identified stimulus under increasing stimulus intensities. The participant has to push the button once the stimulus is detected or perceived as painful or unpleasant. This is repeated three times for each threshold. The mean of three stimuli for each threshold is calculated and used for analysis. ⁴⁴
Quantitative sensory testing: pressure pain thresholds*	Measured by a digital Wagner FPX algometer. Points of measurement are defined by palpation for most tender muscle points (one per muscle) at the major pectoral muscle region, the lateral trunk side and upper trapezius muscle region. The participant is asked to say 'stop' when the sensation of pressure first changes to pain. The mean value of the two measurements is calculated and used for analysis. ⁴⁵
Presence of widespread pain/secondary hyperalgesia	Quantitative sensory testing is performed both at the local painful area as at remote body parts (ie, quadriceps muscle at the non-affected side) and pain distribution is displayed on a body diagram.
Presence and degree of impaired nociceptive inhibitory mechanisms (ie, conditioned pain modulation (CPM))	Assessment of conditioned pain modulation will be done using the Medoc two thermode Q-Sense CPM system. This system involves a 'test' stimulus and a 'conditioning' stimulus applied on the ulnar side of the forearms. The test stimulus (at the affected side) is used to assess pain sensitivity to a warmth stimulus pre and post the noxious conditioning stimulus and the difference is calculated between premeasures and postmeasures. When the second pressure pain threshold (ie, test stimulus) is similar or lower than the first, dysfunctional inhibitory pain mechanisms are present. ^{46 47}
Presence and degree of enhanced facilitation mechanisms (ie, wind-up)	Wind-up of pain or temporal summation will be assessed by applying repetitive nociceptive stimulation with a 26 g nylon monofilament at the major pectoral muscle at the affected side. The perceived intensity of the stimulus (the first, the last and aftersensations) are reported by using a Numeric Rating Scale. The temporal summation value is calculated as the difference between the first and the last stimuli or the slope of the increase in pain intensity. A response for enhanced temporal summation is deemed positive if participants perceive the initial stimulus as non-noxious, but it becomes noxious, increasing by at least two points on a Numeric Rating Scale, or if baseline pain intensity increases by at least two points. ⁴⁶⁻⁴⁸
Presence and degree of hypersensitivity to non-mechanical stimuli	The Central Sensitisation Inventory, a questionnaire generating reliable and valid data to assess symptoms related to central sensitisation mechanisms. ⁴⁹⁻⁵¹
Physical functioning	
General physical activity and upper limb performance	Three ActiLife accelerometers, one on the pelvis (seven consecutive days) and one on each wrist (three consecutive days), will be worn during waking hours. Outcome parameters are general activity level, unimanual/bimanual time and intensity of both unimanual/bimanual use. The ActiLife V.6.9.5 Firmware V.2.2.1 will be used to save raw data. Data will be further processed with Matlab, using custom-written routines. ^{52 53}
Upper limb function	DASH questionnaire. The DASH is a self-reported questionnaire on upper limb function. ³
Emotional functioning	
Pain catastrophising	Pain Catastrophising Scale (PCS). The PCS is a self-reported questionnaire measuring catastrophic thinking related to pain. ⁵⁴
Depression, anxiety and stress	Depression Anxiety Stress scales 21 (DASS-21). The DASS-21 is a self-reported questionnaire that measures the three related states of depression, anxiety and stress. ⁵⁵
Health-related quality of life	McGill Quality of Life questionnaire. ⁵⁶
Social functioning	
Return to work rate	Self-reported questionnaire on return to work, employment status, work adjustments.

Continued

Table 3 Continued

Outcome	Assessment method
QuickScan	Questionnaire on health status and return-to-work obstacles in order to assess potential predictive factors for long-term absenteeism.
Patients perceived ability to work	19-item Return-to-work self-efficacy questionnaire (RTWSE-19). The RTWSE-19 is a self-reported questionnaire on the patients' perceived ability to work. ⁵⁷

*Testing is performed bilaterally, except preoperatively because of feasibility reasons.
CPM, Conditioned Pain Modulation.

PDI.^{39 40} and calculated to detect with 80% power a difference of 20% in PDI after 1 year. Assuming a coefficient of variation (CV) equal to 0.5, 87 participants per group are needed based on a two-sample pooled t-test of a mean ratio with lognormal data and setting alpha equal to 0.05. The assumed CV is a conservative estimate, derived from the observed CV of 0.30 in a sample of normative data for women with chronic pain. To anticipate a drop-out rate of approximately 5%, 184 participants in total will be recruited. The drop-out rate is based on previous similar trials at our institution.^{24 25 29} To handle the potential missing measurements after 1 year, the comparison of the PDI will be based on a multivariate normal model for longitudinal measurements fitted on all repeated measures over time (preoperative, postoperative, 4, 6, 8, 12 and 18 months). A log-transformation will be applied if necessary to handle the right-skewed distribution of the PDI.

Data analysis

Statistical analysis will be intention to treat and will comply with the Consolidated Standards of Reporting Trials (CONSORT) guidelines. Analysis will be conducted in a blinded way. The continuous data will be summarised using mean, SD, median and range values. The primary outcome will be analysed using multilevel linear regression models for repeated (longitudinal) measures, using an unstructured covariance matrix. The mean change from baseline (ie, preoperative assessment) to 4, 6, 8, 12 and 18 months (with correction for the postoperative assessment) will be estimated using contrast statements for each of the treatment arms. The difference in mean changes and their 95% CIs between interventions will be plotted graphically so that change can be assessed over the course of the study. Continuous secondary outcomes will be assessed in a similar way to the primary outcome. Categorical data will be analysed using logistic models. For non-repeated continuous and binary measurements, ordinary linear regression and logistic models will be used, respectively.

Data security and management

Participant data are stored on a secure database in accordance with the General Data Protection Regulations (2018). Data are de-identified and a unique trial identification number used on all participant communication. Clinical and patient forms are being checked for completeness and congruity before data entry onto the

database. Data will undergo additional checks to ensure consistency between data submitted and original paper forms. Trial documentation and data will be archived for at least 10 years after completion of the trial.

Trial monitoring

The steering committee of the research team will oversee all aspects of design, delivery, quality assurance and data analysis. The steering committee will monitor the trial at least once per year.

ETHICS AND DISSEMINATION

The EduCan Trial applies the principles established in the Declaration of Helsinki. Participants provide written informed consent before data collection. Only de-identified coded and interpreted data will be shared between the members of the research team.

Dissemination of results

The research team are committed to full disclosure of the results of the trial. Findings will be reported in accordance with CONSORT guidelines and we aim to publish in high impact journals. Given the multitude of outcome parameters, results will be divided over several papers. Our patient representatives and representative of the National Health Service will assist with dissemination of study results. The funder will take no role in the analysis or interpretation of trial results.

Author affiliations

¹Department of Rehabilitation Sciences, KU Leuven – University of Leuven, Leuven, Belgium

²Department of Physical Medicine and Rehabilitation, University Hospitals Leuven, Leuven, Belgium

³Department of Vascular Surgery, University Hospitals Leuven, Leuven, Belgium

⁴Department of Rehabilitation Sciences and Physiotherapy, Faculty of Medicine and Health Sciences, University of Antwerp, Antwerp, Belgium

⁵The Leuven Centre for Algology and Pain Management, University Hospitals Leuven, Leuven, Belgium

⁶Centre for Environment and Health of KU Leuven, Leuven, Belgium

⁷IDEWE, External Service for Prevention and Protection at Work, Leuven, Belgium

⁸Department of Cardiovascular Sciences, Section Anaesthesiology and Algology, KU Leuven – University of Leuven, Leuven, Belgium

⁹Faculty of Medicine and Health Sciences, Macquarie University, Sydney, New South Wales, Australia

¹⁰Thrive Physiotherapy, Guernsey, UK

¹¹Department of Surgical Oncology, University Hospitals Leuven, Leuven, Belgium

¹²Pain in Motion research group (www.paininmotion.be)

¹³Department of Physiotherapy, Human Physiology and Anatomy, Faculty of Physical Education and Physiotherapy, Vrije Universiteit Brussel, Brussels, Belgium

¹⁴Transcare, Transdisciplinary Pain Management Centre, Groningen, The Netherlands

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