Multidisciplinary prehabilitation management pathway and network platform construction

Research program

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1. Background of the study

Prehabilitation, with its focus on preoperative optimization, is an important component and initiator of ERAS management, a process that enhances the patient's functional reserve prior to surgery so that they are better able to withstand the surgical stresses that follow. For preoperative patients, prehabilitation provides "continuous optimization between the basic diagnosis and the initiation of surgical treatment". Currently advocated multimodal prehabilitation programs generally include moderate to high intensity aerobic and strength exercise, whey protein supplementation-based nutritional support, and psychological support to eliminate anxiety, whose benefits in improving perioperative functional status, shortening hospital stay, and reducing postoperative complications have been demonstrated in cardiac, abdominal, and other surgical fields [1-5]. Multimodal prehabilitation can improve patients' perioperative functional status, and many domestic and international ERAS guidelines, including lung cancer surgery guidelines, have added prehabilitation-related content or raised the level of evidence, recommending or strongly recommending prehabilitation as an important part of ERAS management [6-9].

However, in clinical practice, the implementation rate of prehabilitation is still very low, multidisciplinary collaboration is difficult to put into practice, the scale of previous related studies is relatively small, the degree of intervention standardization is low, these are mainly limited by the relatively fragmented

prehabilitation program, the lack of multidisciplinary co-management platforms and clinical specifications for the management of prehabilitation, and regardless of whether home-based or in-hospital programs are used, a large investment in human resources and time costs are required.

In order to improve the implementation of prehabilitation, we have, on the one hand, streamlined the content of prehabilitation, improved the implementation process, and published a prehabilitation guideline in our previous prehabilitation research; on the other hand, we hope to explore a more feasible management model. Multidisciplinary collaboration is the foundation of prehabilitation. "Internet+medical service" has become a new mode of modern medical management, which can intuitively and vividly deliver information to patients and obtain effective feedback, enhance the efficiency of doctor-patient communication, and improve the enthusiasm of patients to participate in the perioperative management, which is especially suitable for the popularization and application of patient-oriented prehabilitation, and reduces the waste of medical human resources and economic burden. and economic burden. Under the normalization of epidemic prevention and control, the Internet and online diagnosis and treatment will provide a more effective way for preoperative prehabilitation.

"Internet +" perioperative management is in line with the trend of China's medical service innovation and development. The application of the Internet in the field of healthcare is becoming more and more widespread, and has also been strongly supported and advocated by the state. 2016, the CPC Central Committee

and State Council issued the "Healthy China 2030" planning program, in 2017, the General Office of the State Council issued the "China's medium- and long-term plan for the prevention and treatment of chronic diseases (2017-2025)," and The Opinions on Promoting the Development of "Internet+Medical Health" issued by the General Office of the State Council in 20l8, all emphasize the construction of a health information service system, innovation, exploration and improvement of the "Internet+" medical and health service system, the development of telemedicine, health consultation and health management services, and the enhancement of clinical and health care services. consulting, health management services, and strengthen the integration, sharing and application of clinical and scientific research data [10-11].

Prehabilitation is still a hot topic and emerging content in the field of ERAS research at home and abroad, and the application of Internet and wearable technology to prehabilitation is still a gap. We hope to try to establish a multidisciplinary full-process prehabilitation model, explore the main technical medium of "Internet + wearable devices", and build an "Internet +" prehabilitation management model.

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2. Purpose of the study

1) Exploration and development of a smartphone-based online prehabilitation management application for VATS surgery for lung cancer;
2) Conduct perioperative stereoscopic assessment of functional status and quality of life in VATS surgery for lung cancer;
3) Construction of an Internet-based short-term home-based multicomponent prehabilitation model for VATS surgery for lung cancer in combination with wearable exercise devices;
4) Evaluation of the clinical feasibility and clinical significance of Internet + wearable device prehabilitation applied to VATS surgery for lung cancer.

3. Content of the study

3.1 Construction of a user-screen friendly version of the Multi-Link Pre-Rehabilitation online application experience:

1) Introduction to Prehabilitation: A short video is used as the main format, supplemented by pictures and brief text, to introduce the basic contents

and significance of Prehabilitation;

2) Details of the prehabilitation program: details of the purpose of the prehabilitation, the timing of the essential elements and the details of the contents in concise and easy-to-understand language text and pictures;
3) Scheduling: Provide examples of prehabilitation weekly scheduling. In the pre-operative assessment clinic, the doctor conducts a pre-operative assessment of the patient, combining the patient's personal habits and arrangements, and the doctor and patient work together to develop an individualized prehabilitation plan;
4) Demonstration of follow-up exercises: including breathing training follow-up videos, anaerobic exercise follow-up videos, aerobic exercise warm-up follow-up videos, etc., which are suitable for elderly patients with debility, patients with mildly reduced activity tolerance and patients with significantly reduced activity tolerance. It also includes synchronized instruction, so that patients can complete efficient follow-up exercises without leaving home;
5) Three-dimensional assessment of perioperative functional status and quality of life: the application realizes online functional status assessment, including NRS2002 Nutritional Risk Screening, Hospitalization Anxiety and Depression Scale (HADS), Quality of Recovery Rating Scale (QoR-15), and WHO Disability Assessment Scale version 2.0 (WHODAS 2.0), etc., with the patients completing the questionnaires online; and also includes the self-

measurement of the 6-min walking distance (6MWD). At the same time, it includes the self-measurement of 6min walking distance (6MWD), and patients can complete the self-measurement of 6MWD according to the prompts of the application;

6) Implementation and feedback function: It can realize the guidance and adjustment of prehabilitation strategy after reassessment; and set up functions such as daily reminder and prehabilitation activity record.

3.2 To conduct a study on the impact of short-term internet + wearable device-based home-based multilink prehabilitation management on preoperative functional status and prognosis of patients undergoing VATS surgery compared to the traditional model.

A prospective randomized controlled single-blind clinical trial. 64 patients with diagnosed lung occupations intended for VATS surgery were to be included. They were randomized into the "Internet+" group and the traditional prehabilitation control group.

1) Sixty-four adults aged ≤75 years; suspected lung cancer intended for VATS lobectomy/sublobar resection were selected for the study.
2) Prehabilitation intervention: Both groups underwent individualized home-based multimodal prehabilitation strategies, and the timing of the prehabilitation intervention was about 2 weeks from the time the doctor and the patient jointly decided to have the surgery to 1 day before the surgery. The content of prehabilitation included smoking cessation, aerobic training,

anaerobic exercise, nutritional optimization and psychological support. The "Internet+" group used the management mode of online application + wearable devices; the traditional prehabilitation group used the traditional management mode of preoperative preaching + paper records + regular weekly reminders from medical staff.

3) Study endpoints: The follow-up period was from the time when the surgeon and the patient decided to operate to 30 days after the operation. The 6MWD was used as the primary assessment of perioperative functional status and the primary endpoint of the study, and patients were evaluated at enrollment, before surgery, and 30 days after surgery. Secondary endpoints included: length of hospitalization, postoperative complications, and pulmonary function, as well as multiple perioperative functional status scores. The feasibility of "Internet Plus" management and patient implementation were assessed.

4. Sample size and statistical methods

The design of this study was a prospective randomized controlled study, and the sample size of this study was based on the difference in the primary outcome 6-minute walk test distance (6MWD) between the two groups at 30 days postoperatively. It is currently recognized that a difference of 30m in a patient's 6MWD is clinically significant. According to the pre-test of the research team, the standard deviation of the 6MWD was 40 m. The probability of class I error was calculated as 0.05 bilaterally and $\beta=0.2$ to obtain 29 patients in each of the two groups, and 32 patients in each of the two groups were taken to account for the

10% shedding of medical records.

The statistical software for this study was in R language (R Foundation for Statistical Computing, Vienna, Austria; version 3.5.2). Measurements were expressed as mean ± standard deviation or quartiles, depending on the distribution, and counts were expressed as frequencies. In this study, for the primary outcome 6MWD, as well as for the WHODAS 2.0, and the HADS psychological scores, repeated measurements were taken at different time points in the same patient. Considering the correlation between multiple measurements, a linear mixed-effects model was developed in this study to analyze the effect of the intervention. Intervention factors, time points as categorical variables, and interactions between intervention factors and time as fixed effects were included in the model. When there was no evidence in the model suggesting an interaction between the intervention and time, it was removed from the model to estimate the effect of the intervention on the primary outcome at all time points and the effect of time on the primary outcome. Also, given the potential bias of patients missing visits, we will perform sensitivity analyses of the worst measurements for all patients with missing 6MWD data and determine whether missing data have an impact on the analysis of the primary outcome. For other single-measure secondary outcomes, group comparisons were performed using the paired t test for measures that satisfied normality and the nonparametric Mann-Whitney U test for measures that did not satisfy normality. Count data were expressed as frequencies, and intergroup comparisons were performed using the $\chi 2$ test. The test level was $\alpha=0.05$. A statistically significant difference was defined as a two-sided $P<0.05$.

5. Patient inclusion and exclusion criteria

5.1 Inclusion

1) Age: 18-75 years;

2) 64 adults with suspected lung cancer proposed for VATS lobectomy/sublobar resection.

5.2 exclusion:

1) Patient refusal;

2) ASA classification III or higher;

3) Pre-neoadjuvant chemotherapy;

4) Inability to cooperate (psychiatric abnormalities, impaired consciousness, mental retardation);

5) Comorbidities cannot tolerate home rehabilitation or functional motor examination;

6) Inability to use a smartphone or read Chinese;

7) Average weekly moderate-intensity/high-intensity exercise of >90min/>60min.

6. Research process

1) Patients were assessed for enrollment criteria at the time of their initial outpatient visit and decision to proceed with surgery. After obtaining informed consent from the patients, basic information (basic, past medical history, metabolic equivalents, etc.), smoking status, ASA classification, metabolic equivalents, 6MWD, lung function, grip strength, NRS 2002 nutritional risk screening, HADS and WHODAS 2.0 scores were collected

2) Both groups were given routine preoperative anesthesia clinic visits and

guidance, and a short-term home multimodal prehabilitation intervention strategy of about 2 weeks, including smoking cessation, aerobic exercise, impedance training, respiratory exercise, nutritional guidance, whey protein powder supplementation and psychological support. Elastic bands, whey protein powder and respiratory trainers were distributed to patients in both groups.

The "Internet+" team trained patients on the online application of the "Preoperative Family Prehabilitation Program". The patients used the online application for prehabilitation, followed the exercises, and used the sports bracelet as a wearable device to adjust the exercise intensity and record the exercise time.

Patients in the traditional group were issued a portable finger oxygenator to assist in the completion of exercises, as well as a Pre-Rehabilitation Manual and Completion Record Form, which patients were instructed to fill out daily, and patients were followed up twice a week.

Comprehensive reference to previous studies and prior research by the group, combined with patient execution, to propose a concise and easy-to-follow exercise program:

i) Tobacco and alcohol cessation

ii) Aerobic exercise

Aerobic exercise is the core of exercise training in a way that consists of two steps, the first step being a 5-minute warm-up process. The second

step is a 25-minute aerobic exercise in the form of simple popular methods such as brisk walking, jogging, stair climbing, swimming, aerobics or cycling, depending on the patient. The frequency of exercise is at least 3 times a week.

Exercise intensity was evaluated by both rating of perceived exertion (RPE), i.e., Borg score (see table below), and target heart rate. The target heart rate was calculated based on the patient's age, i.e., target heart rate = (220 - age - base heart rate) × 70% + base heart rate, which could be recorded by finger oxygenator or exercise bracelet. The exercise intensity setting of aerobic exercise should be controlled between 13-16 points of modified Borg score, i.e., subjective exertion is felt as a little bit hard or forceful, and the exercise intensity is appropriately increased if it is felt that the exercise can be easily accomplished, and the intensity of the exercise can be lowered when the self-perception of fatigue is heavy or slightly severe dyspnea is felt, and overly strenuous exercise is not recommended.

Improved Borg Scoring Indicator

Brog score	Self-perceived level of exertion
6-8	Very, very light.
9-10	very light
11-12	light
13-14	A little hard

15-16	hard
17-18	Very hard
19-20	Very, very hard

iii) Anaerobic exercise

Muscle strength training includes all muscle groups needed in daily life (biceps, triceps, deltoids, pectoralis major, latissimus dorsi, obliques, lumbar, abdominal, gluteal, quadriceps, etc.), and the exercises are performed with self-weighted training or resistance bands. Movements can be selected according to the patient's own situation. Resistance bands with appropriate weights are individualized according to the patient's condition. Strength training was done in 3 sets of 10-12 repetitions for each movement. Again the intensity of exercise was evaluated on Borg scale. The duration of anaerobic exercise i.e. strength training was about 10-15 minutes to prevent muscle soreness and affect compliance. The frequency of training was 2 times a week, alternating with aerobic exercise.

iv) Breathing exercise

The prehabilitation program for patients undergoing lung surgery requires emphasis on breathing exercises in addition to exercise workouts. The latter helps to improve lung function, facilitates sputum expulsion, increases lung capacity, and prevents the occurrence of perioperative pulmonary atelectasis. Respiratory function training is recommended to be

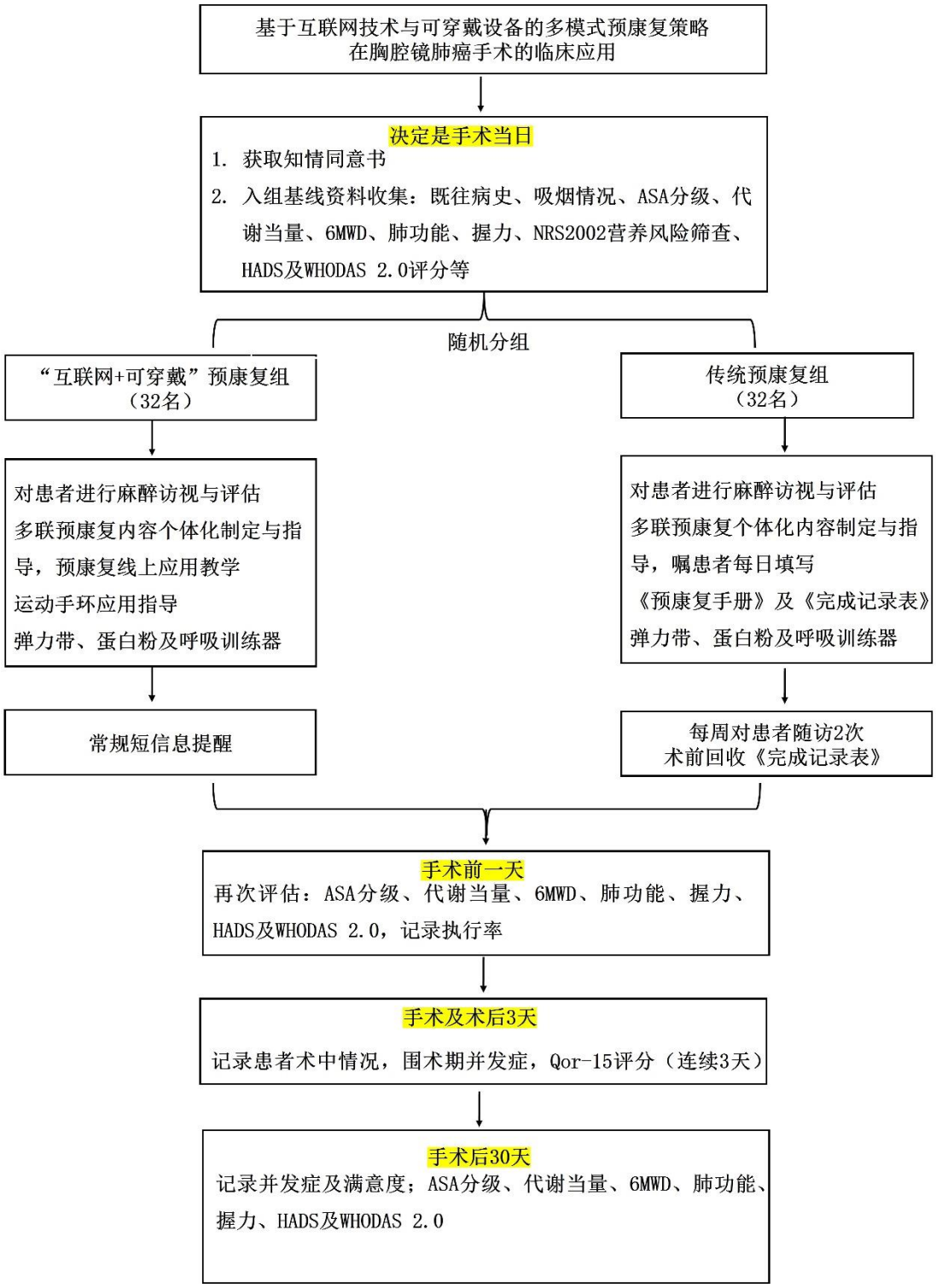
performed twice a day for 10 minutes each time, and respiratory exercises include balloon blowing, three-ball instrument, respiratory trainer, and active cycle breathing techniques. Individualized protocols are developed based on the patient's underlying respiratory function and tolerance.

v) Dietary and psychological adjustments

The European Society of Clinical Nutrition and Metabolism recommends a daily protein intake of 1.2g/kg-1.5g/kg (ideal weight for obese patients) for surgical patients. Patients are advised to change unhealthy dietary habits, especially high-calorie and high-fat diets, and increase the intake of vegetables, fruits and high-quality proteins (fish, chicken breast and other lean meats, milk, eggs, soybeans) as appropriate. In addition, patients are advised to supplement high-quality protein, such as whey protein powder, one hour before exercise every day to better promote muscle synthesis according to their individual conditions. Encourage patients to perform self-psychological adjustment and listen to relaxing music to sleep before bedtime every day.

The 6MWD at 30 days postoperatively was used as the primary assessment of functional status and the primary endpoint of the study (enrollment, preoperative and 30 d postoperative); secondary endpoints included pulmonary function, length of hospital stay, ICU stay, postoperative complications, and hospitalization costs, and the HADS assessed perioperative psychosocial, the QoR-15 scale assessed

near-term prognosis, and the WHODAS-2.0 scale assessed mid-term prognosis.



7. Research quality control

1) All 6-minute walk tests were measured by a unified person, conducted in accordance with international standard procedures and equipped with first-aid

medicines, so that patients could be dealt with in a timely manner if they felt unwell or needed to take a rest;

2) The whey protein powder provided free of charge to the patients was selected from "Nerishi" isolate whey protein powder through the Nutrition Department of the hospital, taking into consideration the purity, purification method, safety, taste and other issues;

3) For patients in the traditional prehabilitation group who have no wearable devices, patients are provided with free finger oxygen meters to facilitate patients to record their heart rate during aerobic exercise, adjust the intensity of exercise, and ensure the safety and effectiveness of exercise;

4) provide patients with free three-ball instrument respiratory trainer, resistance respiratory trainer and elastic band exercise equipment without safety problems. The three-ball instrument respiratory trainer and our hospital unified sale for the same manufacturer and supplier products;

5) Full-process supervision of patients' prehabilitation implementation, including daily short message reminders and study log-in records for patients in the Internet + wearable device group, and 2 weekly SMS/WeChat or telephone follow-up visits for patients in the traditional group to ensure their implementation;

6) Data are entered by two persons, and data consistency test is conducted to clean and screen the data to avoid entry errors.