HHS Public Access

Author manuscript

Surg Oncol. Author manuscript; available in PMC 2022 June 01.

Published in final edited form as:

Surg Oncol. 2021 June ; 37: 101525. doi:10.1016/j.suronc.2021.101525.

Potential effectiveness of a surgeon-delivered exercise prescription and an activity tracker on pre-operative exercise adherence and aerobic capacity of lung cancer patients

David J. Finley[a], **Courtney J. Stevens**[b], **Jennifer A. Emond**[c], **John A. Batsis**[d], **Kayla A. Fay**[e], **Christian Darabos**[f], **Olivia A. Sacks**[g], **Summer B. Cook**[h], **Kathleen Doyle Lyons**[i]

[a]Department of Surgery, Section Thoracic Surgery, Dartmouth-Hitchcock Medical Center, 1 Medical Center Drive, Lebanon, NH, USA 03756.

[b]Department of Psychiatry, Dartmouth-Hitchcock Medical Center, Dartmouth Centers for Health & Aging, 46 Centerra Parkway, Lebanon, NH, USA 03756.

[c]Department of Biomedical Data Sciences, Geisel School of Medicine, Dartmouth College, Hanover, NH, USA, 03754;

[d]Department of Medicine, Dartmouth-Hitchcock, The Dartmouth Institute for Health Policy & Clinical Practice, Geisel School of Medicine at Dartmouth, 1 Medical Center Drive, Lebanon, NH 03756. Current Affiliation: University of North Carolina at Chapel Hill, Division of Geriatric Medicine, Chapel Hill, NC 27516,

[e]Department of Surgery, Section of Thoracic Surgery, Dartmouth-Hitchcock Medical Center, 1 Medical Center Dr., Lebanon, NH 03756.

[f]Information, Technology and Consulting, Dartmouth College, 4 Currier Place, Hanover, NH 03748 and Quantitative Biomedical Sciences, Geisel School of Medicine, Dartmouth College, Hanover NH 03748;

[g]Department of Surgery, Boston Medical Center, 1 Boston Medical Center Place, Boston, MA 02118;

[h]Department of Kinesiology, University of New Hampshire, Durham, NH 03824,

[i]Department of Psychiatry Research, Dartmouth-Hitchcock Medical Center, 1 Medical Center Dr., Lebanon, NH, USA 03756.

Abstract

Objectives: Pre-operative exercise may improve functional outcomes for lung cancer patients, but barriers associated with cost, resources, and burden make it challenging to deliver pre-operative exercise programs. The goal of this proof-of-concept study was to determine level of

Corresponding author: David J. Finley, MD, Section of Thoracic Surgery, Department of Surgery, Dartmouth-Hitchcock Medical Center, 1 Medical Center Dr., Lebanon, NH 03756, David.J.Finley@hitchcock.org.

Competing Interests: Dr. Batsis has received honoraria from the Royal College of Physicians of Ireland, Endocrine Society, and Dinse, Knapp, McAndrew LLL legal firm. The other authors have no conflicts of interest to declare.

Trial Registration: The study protocol was registered with ClinicalTrials.gov prior to initiating participant recruitment (NCT03162718).

moderate-vigorous physical activity (MVPA) and change in aerobic capacity after participation in a pre-operative exercise intervention.

Materials and Methods: Eighteen patients scheduled for surgery for suspected stage I-III lung cancer received an exercise prescription from their surgeon and wore a commercially-available device that tracked their daily MVPA throughout the pre-operative period. Descriptive statistics were used to calculate adherence to the exercise prescription. A one-sample t test was used to explore change in aerobic capacity from baseline to the day of surgery.

Results: Participants exhibited a mean of 20.4 (*sd* = 46.2) minutes of MVPA per day during the pre-operative period. On average, the sample met the goal of 30 minutes of MVPA on 16.4% of the days during the pre-operative period. The mean distance achieved at baseline for the six-minute walk test was 456.7 meters (*sd* = 72.9), which increased to 471.1 meters (*sd* = 88.4) on the day of surgery. This equates to a mean improvement of 13.8 meters (*sd*=37.0), but this difference was not statistically different from zero ($p = 0.14$). Eight of the 17 participants (47%) demonstrated a clinically significant improvement of 14 meters or more.

Conclusion: A surgeon-delivered exercise prescription plus an activity tracker may promote clinically significant improvement in aerobic capacity and MVPA engagement among patients with lung cancer during the pre-operative period, but may need to be augmented with more contact with and support from practitioners over time to maximize benefits.

Keywords

telemedicine; rehabilitation; neoplasms; thoracic surgery; exercise; activity tracker

1. Introduction

The evidence for the effectiveness of pre-operative exercise in the context of lung cancer has been steadily growing [1]. Systematic reviews suggest that pre-operative exercise improves aerobic capacity prior to lung surgery [2, 3] and that this improvement could have subsequent, positive effects on post-operative morbidity [1, 4]. Rates of exercise participation tend to decline starting from the time of cancer diagnosis; thus, prescribing exercise to patients pre-operatively may be a strategic prophylactic intervention [5]. The most rigorous evidence for pre-operative exercise among patients with lung cancer has generally been gleaned from studies of supervised, hospital-based, exercise programs [4].

Translating the evidence into clinical practice and supporting pre-operative lung cancer patients in their efforts to exercise at home and in the community is challenging. Reports have called for implementation strategies such as community-based individual or group exercise programs led by rehabilitation practitioners or fitness professionals [6, 7]. Alternatively, other teams have explored telehealth interventions that use mobile applications and/or activity trackers to monitor exercise and deliver remote supervision [8]. These strategies are ideal in that they allow professional direction of exercise behavior, which is seen as a potent proponent of exercise [7, 9]. Unfortunately, such strategies require an investment in specialized professionals or software applications, which pose financial and other practical barriers to implementation.

Another pragmatic approach is to begin with technology and labor options that can be deployed with the least cost or effort (i.e., “low-touch” approaches) and develop triage pathways that identify patients who need more support and guidance to safely exercise (i.e., “high-touch” approaches). In terms of technology, commercially available activity trackers are ubiquitous and are gaining traction in oncology [10, 11]. Activity trackers help to promote increased exercise engagement [12], including among cancer survivor populations [13], and can be set up to relay data back to the surgical team in real time [14], which may help to address some limitations of remotely delivered exercise training. In terms of labor, a clear exercise prescription coming directly from the surgeon during a routine visit is inexpensive, but likely to be particularly potent given the evidence that lung cancer patients want information about and encouragement for exercise directly from their physicians and surgeons [7, 15]. This surgeon-directed approach also has the advantage of encouraging patients to initiate exercise as early as possible, as one challenge of prehabilitation training is the short and variable window of opportunity between diagnosis and treatment [16].

While building towards the development of tailored, high-touch interventions for those who need them, our clinical team explored the potential effectiveness of an exclusively low-touch intervention, which included the following evidence-based intervention components: a) provision of a Garmin Vivoactive HR activity tracker to allow asynchronous, objective monitoring of exercise and b) a verbal and written exercise prescription directly from the surgeon who explained the importance of exercise as a way to maximize the benefits and reduce the risks of lung cancer surgery. The latter component is the standard of care at our facility for surgical candidates with lung cancer; the former component was introduced as a way to obtain objective data regarding the adherence to the exercise prescription.

Consistent with current recommendations for optimizing and systematically developing behavioral interventions to improve health [17, 18], we designed this proof-of-concept study to assess the feasibility and potential effectiveness of the low-touch intervention and identify ways in which it may need to be enhanced to maximize its potency. The feasibility data are reported elsewhere [19]. This paper explores the following research questions: (1) What proportion of participants met the standard expressed in the exercise prescription (adherence)? (2) To what degree did the aerobic capacity change prior to surgery (potential effectiveness)? (3) Is there any indication that people who exercised more had greater improvement in aerobic capacity (mechanism)?

2. Materials and Methods

2.1 Design

This proof-of-concept study used a single arm, pre-post design to explore exercise engagement and change in aerobic capacity resulting from a low-touch pre-operative exercise intervention. Proof-of-concept studies are designed to determine whether the intervention under investigation produces anticipated changes in a behavioral or biomedical risk factor, before investing resources needed to conduct a fully-powered, randomized efficacy trial [17, 18]. Participants enrolled in the study when it was determined that surgery was going to be one of the treatments for their cancer (or presumed cancer prior to biopsy). All study procedures were conducted in accordance with the Declaration of Helsinki and

were prospectively approved by the institutional review boards of Dartmouth College and Dartmouth-Hitchcock Medical Center. The study was registered on ClinicalTrials.gov prior to enrolling the first participant (NCT03162718). All participants signed a document affirming their informed consent to participate.

2.2 Participants

Participants were recruited by a project coordinator after the surgeon had established the plan of care for surgery and provided the exercise prescription. Participants were eligible for the study if they a) were over the age of 18 and scheduled for surgery for suspected or biopsy-proven lung cancer, clinical stage I, II or III; b) were able to tolerate surgery (i.e., segmentectomy, lobectomy or bilobectomy) as indicated by standard clinical pre-op evaluation, including pulmonary function tests and cardiac evaluation (if indicated); c) had access to either Wi-Fi or cellular service and permission/ability to download the wearable fitness device app on an iOS or Android device or computer; d) were able to provide voluntary, written consent.

Participants were excluded from the study if they a) had a life expectancy of < 12 months or were receiving hospice services; b) had a psychiatric diagnosis that would require significant study modification to meet their needs such as uncontrolled severe mental illness, substance abuse, or active suicidal ideation; c) exhibited American College of Sports Medicine contraindications to exercise which include a resting heart rate of >120bpm, blood pressure >180/100mmHg or unstable angina [20]; d) were unable to walk or to complete the 6-minute walk test [21].

2.3 Intervention

Participants received the following exercise prescription: “Do any moderately-intense, aerobic physical activity (e.g., walking, jogging, stairclimbing, upper body ergometer, stationary bicycle) for 30 minutes a day and for 5 days each week. While doing the activity, you should be working hard enough that it is difficult to speak more than a few words at a time (i.e., it would be uncomfortable and impractical to carry on a conversation with another person). You may need to start slowly (e.g., 5–10 minutes at a time), but as you get stronger you can increase your activity so that you exercise for 30 minutes at a time.” The prescription was orally conveyed by the surgeon and the project coordinator provided a written copy of the prescription on enrollment. The targets of 30 minutes a day [22] and 150 minutes a week [23, 24] are supported by guidelines in exercise oncology. The prescription included the recommended elements of frequency, duration, type of exercise, and degree of intensity [22].

The project coordinator gave participants a wrist-worn Garmin Vivoactive HR fitness device. Using a commercially-available device, as opposed to a research-grade device, reflected our intent to study a low-cost and ubiquitous tool that could be deployed in any clinical setting. Participants were assigned an email address and password to use within the Garmin Connect Mobile Application. In almost all cases, the project coordinator downloaded the application onto the participant’s cellular phone and activated the fitness device during enrollment. The project coordinator showed participants how to synchronize and charge the device.

Participants were asked to wear the device at all times, including showering and sleeping, and to synchronize and charge the device daily.

2.4 Data Collection Schedule

Participants underwent an assessment battery upon four occasions: (1) enrollment, (2) on the morning of surgery, (3) two weeks post-surgery and (4) 16 weeks post-surgery. However, this analysis focuses only on the primary outcomes of the study: exercise engagement and change in aerobic capacity during the pre-operative period.

2.5 Measures

2.5.1 Clinical characteristics.—Participants provided a self-report of the following variables: marital status, education level and employment status. A project coordinator manually extracted the following variables from the electronic medical record: age, race, ethnicity, clinical cancer stage and pulmonary function (i.e., forced expiratory volume in one second; forced vital capacity; defusing capacity of the lung for carbon monoxide).

2.5.2 Garmin Vivoactive HR device data.—The Garmin Vivoactive HR device records a number of sensor-based data points at regular intervals, as well as daily aggregates. We extracted the following data from the Garmin Vivoactive HR device: heart rate time series every 15 seconds, number of steps, floors climbed, minutes spent in moderate to vigorous activity and “active” minutes [25]. Raw data from the device is sent to Garmin Connect (Cloud Service) via the participant’s cell phone or tablet, which is synced with the device. Using the Garmin REpresentational State Transfer Application Programming Interface (REST API), the patient data is then collected, processed, stored anonymously in near-real-time on a dedicated server database. Dartmouth’s Research Informatics team performed thorough filtering, data reformatting, and data integration checks before exporting the time series for analysis by the biostatistician.

2.5.3 Aerobic capacity.—Participants completed the six-minute walk test [21], a surrogate for submaximal exercise capacity, which measures how far a person can walk (in meters) within six minutes. Participants walked down a straight hallway circling around cones placed 30 meters apart. A physical therapist trained the project coordinator to administer the testing procedure, which includes a standardized script for instruction and supervision of participant during the walking trial. Studies suggest that an improvement of 14 meters is the minimal threshold for clinically significant improvement in aerobic capacity [26].

2.6 Analytic Strategy

2.6.1 Demographics—Descriptive statistics were used to summarize age, race, ethnicity, marital status, education level, employment status, clinical cancer stage, and pulmonary function.

2.6.2 Adherence—Because of the variability in the number of days prior to surgery for each participant, we evaluated adherence by analyzing our data in a number of different ways. First, we summarized the entire pre-operative period in two ways. We calculated

descriptive statistics on the number of minutes of moderate to vigorous physical activity (MVPA) per day for the sample and on the number of days each participant met the goal of 30 minutes of MVPA during the pre-operative period.

We then looked at each of the three weeks before surgery, because those were the points in time when, theoretically, participants had built up their endurance to exhibit maximal exercise behavior. We summarized the data by calculating descriptive statistics on a) the number of minutes of MVPA per day, b) the number of minutes of MVPA per week, c) the number of days in which each participant met the goal of 30 minutes per day, and d) the proportion of people who were adherent to the prescription (i.e., 150 minutes of exercise) during each of the three weeks before surgery. Finally, we determined each individual's weekly level of adherence as the proportion of days pre-surgery in which he or she exercised for at least 30 minutes. Because participants were instructed to exercise at least 5 of the 7 days each week, a proportion score of 71% (i.e., 5 days out of 7 days) or higher would suggest perfect adherence to the prescription. We then averaged the proportion scores.

2.6.3 Potential Effectiveness—We performed a one sample *t* test comparing the change in six-minute walk test scores at enrollment and on the day of surgery. We also calculated the proportion of the sample who had a clinically significant improvement in aerobic capacity (i.e., a ≥ 14-meter increase in six-minute walk test score [26]).

2.6.4 Mechanism—We computed a Pearson's correlation between total minutes of MVPA per day in the pre-operative period and six-minute walk test change scores to explore the degree to which exercise engagement may be associated with aerobic capacity improvements. We also explored the adjusted association between the change in six-minute walk test scores and minutes of MVPA per day over the pre-operative period in a multivariable linear regression model, adjusted for baseline six-minute walk test score, age, gender, and stage of disease. Adjusted logistic regression was also used to fit the likelihood of improving by 14 meters or more on the six-minute walk test on minutes of MVPA per day over the pre-operative period, adjusted for the same covariates.

We also ran a series of secondary analyses to assess if the number of days enrolled in the intervention pre-surgery related to a change in MVPA or performance on the six-minute walk test. Specifically, we used mixed-effects linear regression to examine the trend in daily minutes of MVPA over the pre-surgery period, including a random effect at the participant level to account for the repeated measures. We also used simple linear and logistic regression to examine if the change on the six-minute walk test, or if improving by 14 meters or more on the six-minute walk test, respectively, was associated with the number of days enrolled in the intervention during the pre-surgery period. All analyses were completed with the R language and environment for statistical computing (version 3.6.2).

3. Results

3.1 Participants

Thirty people enrolled in the study, however, only 18 participants had data associated with their device. Loss of data occurred due to participant attrition and technology malfunction

and those data are detailed in another manuscript [19]. Table 1 contains data regarding the clinical characteristics of the sample in two strata: the full sample of 30 participants who enrolled in the study and the 18 participants from whom we were able to collect device data. There were no significant differences between the full sample and the subsample with device data in terms on any of the clinical or demographic characteristics ($p > 0.20$ for all bivariate comparisons). It is this analytic sample of 18 participants who will be referred to throughout the remainder of the manuscript.

The analytic sample had a mean age of 68 years (*sd* = 5.4; range 61–78 years) and were primarily female (56%), married (67%), and retired (50%). Most participants (*n*=15; 83%) enrolled 34 days or less prior to their surgery (range 10 to 129 days); three participants (17%) enrolled more than 60 days prior to their surgery. The median time between the baseline visit and surgery among participants was 18.5 (interquartile range: 16.0, 26.8) days.

3.2 Adherence

3.2.1 Adherence in the entire pre-operative period

Average minutes of pre-operative exercise per day.: Participants exhibited a mean of 20.4 (*sd* = 46.2) minutes of MVPA per day in the pre-operative period. That average was influenced by one outlier participant who exercised a great amount; when that participant's data was removed, the mean number of minutes of MVPA per day was 10.3 (*sd* = 17.4).

Average number of days meeting 30 minutes of MVPA during the entire pre-operative period.: On average, participants met the goal of 30 minutes of MVPA on 2.9 (*sd*=5.5) days (16.4% of the days) during the pre-operative period. That number dropped to 2.2 (*sd*=4.6) days (12.1%) of all pre-surgery days when the outlier was removed from the sample.

3.2.2. Adherence in the last three weeks before surgery—Table 2 contains the adherence data for each of the three weeks prior to surgery. Average minutes of MVPA per day decreased each week from 24.0, to 17.0, to 14.4 in the final week before surgery. However, when the outlier was removed, the average minutes of MVPA per day was somewhat steady at 10.8, 12.3, and 12.6 minutes, respectively. Average minutes of MVPA per week followed a similar pattern, coming closest to the target of 150 minutes in the third week prior to surgery with an average of 136.9 minutes and reducing from there to 116.2 minutes and 86.9 minutes, respectively for the second and last week before surgery. However, when the outlier was removed, the average minutes increased from 42.7 minutes in the third week before surgery to 82.7 minutes in the second week before surgery, before dropping to 73.4 minutes in the last week before surgery.

The average number of days when a participant achieved at least 30 minutes of MVPA was uniformly low; the highest value was 1.3 days in the second week before surgery (see Table 2). The proportion scores were also the highest in the second week before surgery, where participants achieved 30 minutes or more of MVPA on 18.6% of the days in that week; as a reference, a proportion score of 71.4% would reflect perfect adherence to the prescription to exercise at least 5 of the 7 days in a week.

The number of participants who achieved at least 150 minutes of exercise grew by one each week: 3 in the third week before surgery, 4 in the second week before surgery, and 5 in the last week before surgery. This pattern held true when the outlier was removed with 2, 3, and 4, participants meeting the goal in each respective week. Therefore, when looking at the degree of adherence in terms of meeting the recommended 150 minutes a week, about one quarter of the analytic sample was adherent in the last week before surgery (28% if including the outlier and 22% if excluding the outlier).

3.3 Potential Effectiveness

Seventeen of the 18 participants in the analytic sample completed the six-minute walk test at baseline and on the day of surgery. The mean distance walked at baseline was 456.7 meters (*sd* = 72.9) which increased to 471.1 meters (*sd* = 88.4) on the day of surgery. This equates to a mean improvement of 13.8 meters (*sd*=33.0), but the difference was not statistically different from zero ($p = 0.14$). Eight of the 17 participants (47%) demonstrated a clinically significant improvement of 14 meters or more.

3.4 Mechanism

There was no association between minutes of MVPA per day during the pre-surgery period and change in six-minute walk test in the unadjusted analysis ($r = -0.05$, $p = 0.84$). Similarly, there was no significant association between minutes of MVPA per day and change in the six-minute walk test in the adjusted linear regression model; on average, performance on the 6-minute walk test changed by −0.1 meters (95% CI: −0.6, 0.4; p=0.70) per each 1 minute more of MVPA per day. Minutes of MVPA per day pre-surgery remained unrelated to achieving a clinically significant improvement of 14 meters or more on the six-minute walk test in an adjusted logistic regression model; the odds ratio for achieving an increase of 14 meters or more was 1.00 (95% CI: 0.97, 1.02; p=0.87) per each 1 minute more of MVPA per day pre-surgery.

There was no trend for the change in daily minutes of MVPA over the pre-surgery period in that model (beta for change in daily minutes of MVPA for each one day increment until survey: −0.03; 95% CI: −0.20, 0.13; p=0.70). We further examined scatterplots of daily MVPA for the pre-surgery time period for the sample overall and for each participant, which confirmed there were no consistent linear or non-linear trends in MVPA over that pre-surgery time period. The length of the pre-surgery period (days) was not related to the mean change in the six-minute walk test (beta: 0.33; 95% CI: −0.15, 0.81; p=0.20), nor the odds of improving 14 meters or more (OR: 1.02; 95% CI: 0.98, 1.06; p=0.28).

4.1 Discussion

This study explored the potential effectiveness of a surgeon-delivered exercise prescription and an activity tracker on pre-operative exercise prescription adherence and change in aerobic capacity. Over the pre-operative period, participants met the goal of 30 minutes of MVPA on 16.4% of the days. The average number of minutes of MVPA per day ranged from approximately 10 to 20 minutes, depending on whether we included one outlier with high exercise engagement. During the last week before surgery, about one quarter of the sample was meeting the recommended minutes of exercise per week. It is hard to assess how

these adherence rates match other studies. Most studies of prehabilitation for lung cancer patients involve supervised exercise programs and do not report exercise engagement with this level of detail [1]. A recent systematic review of home-based, unsupervised exercise programs for patients with lung cancer [27] only included one study that focused on the pre-operative period. That study reported better than 100% adherence to the exercise prescription of 30 minutes per session for 3–5 times a week [28]. However, adherence was based upon self-report as opposed to objective monitoring and the intervention included supportive phone calls designed to maximize exercise engagement. Our results add to the literature by beginning to explore the level of adherence seen when exercise is enthusiastically prescribed by a surgeon.

While many participants were unable to adhere to the pre-operative exercise prescription, they still engaged in some MVPA. Over the entire pre-operative period, the mean number of minutes of MVPA per day was 20.4. This is encouraging as many studies indicate that initiating exercise before surgery is challenging or impractical for most people [29]. The exact dose of exercise needed to improve aerobic capacity and surgical outcomes is not yet clear in the literature [23, 24, 30], so it is uncertain how important it is to insist upon strict adherence to the recommended target of 30 minutes per day or 150 minutes per week for the purpose of prehabilitation for patients with lung cancer. Should future dose-response studies suggest strict adherence to this or another prescription be required, it will likely be important to supplement the low touch intervention components with additional more “high touch” intervention components such as coaching or rehabilitation.

There was a high degree of variability in the minutes of exercise seen in the sample. In order to make sure resources are dispersed to those patients who most need them, and used economically among patients who more readily adhere to the pre-operative exercise prescription independently, it may be important to develop a triage system to assess factors such as patients’ exercise history, confidence in their ability to exercise safely independently, and social supports for exercise, in addition to their relevant medical history (e.g., physical limitations). Patients with certain risk factors (e.g., history of injuries, low confidence for exercise, etc.) may be referred for additional high touch services, which could be modulated in intensity or frequency based on the patients’ demonstrated needs [32]. To the extent that patients’ MVPA could be monitored by the study team remotely (using the fitness device) in real time, indicators of patients’ progress could be used to make decisions about contacting patients to deploy additional high touch supports.

The average improvement in aerobic capacity (13.8m) was close to the threshold for clinically meaningful improvement of 14m [26], and almost half of the sample met or exceeded that threshold. It is not surprising that the improvement was not statistically significant, as the sample for this proof-of-concept study was small and likely underpowered to detect the change [33]. This average improvement is more than was seen in the usual care condition of a home-based prehabilitation clinical trial (increase of 3.8m in the pre-operative period) but less than what was seen in the group that participated in multimodal, home-based prehabilitation involving aerobic and resistance exercise, nutritional supplements, and psychosocial support (increase of 45.1m in the pre-operative period) [34].

What is somewhat surprising is the lack of association between minutes of MVPA and change in aerobic capacity. In light of this, it is difficult to determine if there is another, unmeasured, pathway by which aerobic capacity may improve. Given the impossibility of blinding patients and study coordinator to time point and study purpose, it is possible that either social desirability or level of fatigue influenced the results of the six-minute walk test. This is not the first study to see an improvement in one outcome thought to be associated with exercise, in the absence of statistically significant improvement in exercise engagement [35], conveying the need for additional research in this area.

4.2 Limitations

Our results should be interpreted with caution in light of the small, heterogeneous, and unblinded convenience sample used in this single arm study. However, these design choices are appropriate for early-phase intervention development studies where demonstrating proof-of-concept, rather than intervention efficacy, is the goal [17, 18]. While we asked the participants to wear the Garmin device daily, not everyone did and thus it is possible that we underestimated MVPA by failing to capture any exercise that occurred when they were not wearing the device. We also did not obtain an objective measure of pre-intervention MVPA by which to compare MVPA levels during the intervention. Therefore, the effect of participants' past behavior on their intervention performance is unknown for this sample. The collection of those data will be important in future iterations of this work when the intervention is tested for efficacy.

Another limitation of the current study is that the Garmin Vivoactive HR device used for this study has not yet been rigorously validated for MVPA assessment (a Garmin proprietary algorithm), in ecologically valid (non-laboratory based) contexts, among the general population or among pre-operative cancer patient populations. While there are numerous appealing characteristics of commercially available devices for investigators pursuing "low-touch" options to support exercise prehab intervention development, there is consensus in the literature that commercially available devices are less accurate than other gold-standard methods of measuring variables such as heart rate, energy expenditure, and thus the calculation of time spent engaged in MVPA [36, 37]. Researchers conducting this work should consider the function of the activity tracker as part of the intervention; if precise measurement of MVPA or other activity metrics is the goal, data obtained from commercially available devices should be interpreted with caution [37]. By contrast, if the device is intended to serve as a self-monitoring tool for participants and/or if clinically relevant estimation of MVPA is the goal, commercially available devices may be a justifiable and scalable option.

5. Conclusion

This study explored the potential effectiveness of the standard of care at our facility: a surgeon-delivered exercise prescription, augmented by an activity tracker to objectively measure exercise engagement. This proof-of-concept study was the first step in a line of research to determine how to optimize our clinical practice. There are few studies in the literature regarding unsupervised exercise for patients scheduled for lung cancer surgery and

none that we are aware of that do not include at least one “high-touch” resource such as motivational or supervisory telephone calls. Thus, our study makes a contribution by being one of the first to describe and assess an exclusively low-touch intervention for this patient population. This work helps us strategize how to refine and optimize the intervention prior to rigorous efficacy testing.

In the present study, proof-of-concept was indicated by the finding that nearly half of the study sample achieved the minimal clinically meaningful improvement in aerobic capacity prior to surgery as a result of participation in the intervention. However, given that half of the sample did not achieve this benchmark for improved aerobic capacity, average MVPA engagement fluctuated during the preoperative period, and the majority of participants fell short of achieving the prescribed weekly MVPA goal, our results suggest additional intervention refinement efforts are needed before the intervention is tested for efficacy. Specifically, this low touch intervention will likely need to be augmented for patients who less readily adhere to the exercise prescription and/or who may need additional resources (e.g., coaching, rehabilitation) to maximize exercise engagement. This future work might involve developing a triage system to identify patients who can successfully adhere to the pre-operative exercise prescription with only “low-touch” support and those who could benefit from additional resources and high-touch forms of support.

Funding:

This study was funded by a Population Sciences Developmental Pilot Fund award from the Norris Cotton Cancer Center, Lebanon, NH. Dr. Batsis’ was supported, in part by the National Institute On Aging (NIA) under Award Number K23AG051681, The Dartmouth Clinical and Translational Science Institute, under award number UL1TR001086 from the National Center for Advancing Translational Sciences (NCATS). Drs. Lyons and Batsis were supported in part by the Dartmouth Health Promotion and Disease Prevention Research Center (Cooperative Agreement Number U48DP005018) from the Centers for Disease Control and Prevention. Dr. Stevens was supported by the National Institute of Mental Health under Award Number T32MH073553. The funding sources had no role in study design, data collection, analysis, or interpretation.

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Table 1.

Participant Sample Baseline Clinical Characteristics

	Enrolled Sample (n=30)	Analytic Sample (n=18)
Demographics		
Age at enrollment, mean (*sd*)	67.5 (10.6)	68.2 (5.4)
Male, n (%)	13 (43.3%)	8 (44.4%)
Female, n (%)	17 (56.7%)	10 (55.6%)
Ethnicity, n (%)		
Non-Hispanic	28 (93.3%)	16 (88.9%)
Did not answer	2 (6.7%)	2 (11.1%)
Race, n (%)		
White	30 (100%)	18 (100%)
Marital status, n (%)		
Married	17 (56.7%)	12 (66.7%)
Single, divorced or widowed	13 (43.3%)	6 (33.3%)
Highest education completed, n (%)		
High school graduate or equivalent	8 (26.7%)	5 (27.8%)
Some college or technical school	9 (30.0%)	6 (33.3%)
Bachelor's degree	2 (6.7%)	2 (11.1%)
Graduate degree	9 (30.0%)	5 (27.8%)
Missing	2 (6.6)	0 (0)
Current employment status, n (%)		
Full time	7 (23.3%)	5 (27.8%)
Part time	4 (13.3%)	3 (16.7%)
Retired	15 (50.0%)	9 (50.0%)
Disability	2 (6.7%)	1 (5.6%)
Missing	0 (6.7%)	0 (0)
Clinical Characteristics		
Lung cancer stage, n (%) *		
I	22 (73.3%)	13 (72.2%)
II	3 (10.0%)	2 (11.1%)
III	5 (16.7%)	3 (16.7%)
Pulmonary function, mean (*sd*)		
FEV 1 (liters)	1.9 (0.6)	2.0 (0.6)
FEV 1 %	74.2 (18.2)	75.4 (18.6)
FVC (liters)	3.0 (0.7)	3.1 (0.7)
FVC %	86.1 (11.7)	87.7 (11.5)
DLCO (ml/min/mmhg)	78.7 (17.6)	77.9 (17.1)
6-minute walk test (meters)	450.3 (71.6)	456.7 (72.9)

Note.

*Denotes that the staging system changed in January 2018 from AJCC7 to AJCC8. For the purposes of categorization, we combined AJCC7 to AJCC8 diagnoses into one classification system based on number (i.e., stage I, II, or III) not letter. FEV 1 = Forced expiratory volume in one second; FEV 1% = percent predicted for FEV1; FVC = Forced vital capacity; FVC % = percent predicted for FVC; DLCO = defusing capacity of the lung for carbon monoxide; *sd* = standard deviation.

Table 2.

Summary of Adherence Data for Each of the Three Weeks Prior to Surgery

		Daily Estimates			Weekly Estimates	
	Days device worn	Minutes of MVPA per day	Days with ≥30 minutes MVPA		Total minutes MVPA per week	≥150 minutes MVPA per week
			Number	%		
Timepoint*	Mean (SD)	Mean (SD)	Mean (SD)		Mean (SD)	N (%)
Third week prior to surgery (i.e., day −21 to −15)						
All participants who wore the device (n=14)	4.3 (2.0)	24.0 (52.6)	0.9 (1.7)	14.9%	136.9 (360.2)	3 (21.4%)
Excluding one outlier participant (n=13)**	4.1 (1.9)	10.8 (19.0)	0.5 (0.8)	13.2%	42.7 (67.1)	2 (14.3%)
Second week prior to surgery (i.e., day −14 to −8)						
All participants who wore the device (n=16)	6.1 (1.4)	17.0 (27.9)	1.3 (2.3)	18.6%	116.2 (195.1)	4 (25.0%)
Excluding one outlier participant (n=15)**	6.1 (1.4)	12.3 (21.1)	1.1 (2.3)	16.0%	82.7 (146.7)	3 (18.8%)
One week prior to surgery (i.e., day −7 to −1)						
All participants who wore the device (n=17)	6.4 (1.5)	14.4 (18.8)	1.0 (1.7)	18.3%	86.9 (126.2)	5 (29.4%)
Excluding one outlier participant (n=16)**	6.4 (1.5)	12.6 (17.8)	0.9 (1.7)	13.1%	73.4 (117.1)	4 (25.0%)

Note.

*Denotes reported values are limited to participants who wore the device for at least one day during each one-week time period: n=14 participants for three weeks prior to surgery, n=16 participants for two weeks prior to surgery, and n=17 participants for one week prior to surgery;

**Excludes one outlier participant with extreme values for MVPA.

MVPA = Moderate to vigorous physical activity; SD = standard deviation.