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Short Communication

Physical Activity Trackers: Promising Tools to Promote Resilience in Older Surgical Patients

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Abstract

Objectives: Impending surgery presents a high risk for older adults given their vulnerability to adverse outcomes. New approaches to peri-operative care bring together surgeons, geriatricians, and other Multidisciplinary specialties to co-manage the geriatric surgical patient. However, few have incorporated interventions to promote Physical Activity (PA) throughout this period. We describe findings from two Quality Improvement (QI) initiatives that adopted the use of PA trackers to monitor and promote PA during the peri-operative period.

Methods: QI project within Perioperative Optimization of Senior Health (POSH) clinic at two medical centers (Duke and Durham Veterans Healthcare System (VA)) in Durham, North Carolina. Participants included 38 adults, ages 65+. Participants from POSH-at-Duke received PA trackers with one-time bundled advice from the provider team on nutrition, activity, pain management, medications and other relevant education prior to surgery. Participants from POSH-at-VA received the same one-time bundled advice in addition to a visit with an exercise health coach who provided PA guidance followed by weekly PA telephone counseling throughout entire peri-operative period to 4-weeks post-surgery. Primary outcome was daily step counts.

Results: Ninety three percent of participants approached agreed to use PA trackers. POSH-at-Duke had mean daily step counts of 3,951 at baseline, 4,437 two days prior to surgery, and 1,838 at 4-week post-operative visit as opposed to POSH-at-VA with 2,063 steps at baseline, 5,452 two days prior to surgery, and 4,236 at 4-week post-operative visit, p=0.049 for trajectory differences.

Conclusion: PA trackers coupled with appropriate continuous PA counseling has a potential utility in promoting resilience in the geriatric surgical candidate.

Abbreviations

PA	:	Physical Activity
POSH	:	Perioperative Optimization of Senior Health
VA	:	Veterans Affairs
QI	:	Quality Improvement

Introduction

The scientific community is embracing the utility of commercial grade Physical Activity (PA) trackers to measure and promote health, including recovery from surgery. A recent study

reported the use of PA trackers to monitor symptoms, step counts, quality of life, and satisfaction with monitoring in a group of adults undergoing abdominal cancer surgery. They concluded that use of such devices had potential to identify high risk patients needing additional interventions [1]. Although this study fell short of using PA tackers to provide an intervention, the findings contribute to a growing understanding of the value and feasibility of wearable technologies [2]. Geriatric patients presenting for surgery often carry the burden of age-related increases in rates of chronic illness and related declines in function and adaptive capacities that place them at high risk for poor outcomes. There is strong evidence that fitness and PA play a major role in preventing morbidity and attenuating the ill effects of these conditions [3-5]. Yet little has been done to incorporate strategies that promote PA and fitness beyond standard advice to be more active as part of routine peri-operative care [6]. Furthermore, the impact of PA in the recovery capability, i.e. resilience, of geriatric patients, has not been well studied. We propose that the use of commercial grade PA trackers might be a vehicle to assess and promote PA and subsequent resilience. We define physical resilience as an individual's ability to withstand or recover from functional decline following a health stressor [7, 8]. We believe that surgery, as a stressor, is an excellent model in which to study physical resilience trajectories, using step counts, throughout the peri-operative period. We have learned from our own developmental work and the literature that recruiting and retaining geriatric patients into facility-based supervised exercise programs within a narrow preoperative timeframe is difficult [1,9].

There is some literature on the effects of preoperative structured exercise on postoperative outcomes; but the results of these interventions have been mixed, have largely excluded older, physically impaired, frail or unfit adults, and struggled with recruitment and retention of those most needing intervention [10]. There is also a paucity of research examining the impact of overall PA, as opposed to structured exercise, on surgical outcomes [11]. In response to recruitment challenges for supervised exercise and our limited understanding of the impact of simply augmenting overall PA before surgery, we adopted the use of PA trackers coupled with health coaching as an innovative strategy to promote peri-operative health. This brief report describes findings from two related Quality Improvement (QI) approaches to augment PA using PA trackers in older surgical candidates enrolled in an innovative care model developed at two medical centers in Durham, NC. The Perioperative Optimization of Senior Health (POSH) clinic was established at Duke University Medical Center in 2011. In 2015, the POSH program was successfully adapted as a Center of Excellence at the Durham Veterans Affairs (VA) Healthcare System. POSH consists of a multidisciplinary group of providers who evaluate patients preoperatively in the same clinic and jointly formulate synergistic care plans to optimize outcomes among adults 65 years and older undergoing elective surgery. Patients are followed through hospitalization and discharge with findings indicating reduced length of stay and lower readmission rates among clinic patients compared to historical controls [12]. The POSH-at-Duke model has no sustained coaching, whereas POSH-at-VA has a structured sustained coaching protocol throughout the entire peri-operative period. For this brief report, we describe trajectories and findings between each cohort.

Methods

These projects occurred as part of QI projects occurring in POSH clinics at Duke Hospital and the Durham VA. Institutional Review Boards at both institutions granted exemption to both programs. In collaboration with POSH providers, program staff, when available, approached participants and asked if they would consider participating in this project. Eligibility criteria, to account for the possibility of engagement in an unsupervised exercise program, included ability to walk without human assistance (assistive devices were acceptable), no requirement of cardiology clearance for surgery, and free of dementia. Patient characteristics, surgical procedures, pain scores assessed preoperatively on a scale of 1-10 with a higher score indicating more pain, length of stay and surgical complications were obtained from the POSH database or from patient electronic medical records.

POSH-at-Duke.

During the initial development of POSH-at-Duke, the POSH preoperative visit for the patient was typically about two weeks prior to surgery. Individuals referred to POSH-at-Duke were oriented on the use of wrist worn PA trackers with no coaching beyond one-time bundled advice by the provider on nutrition, activity, pain management, medications and other relevant education prior to surgery. Each patient was given a handout describing how to use the activity tracker with advanced features deactivated to simplify use and prolong battery life. Individuals with less than one week of time prior to scheduled surgery were not approached.

POSH-at-VA.

We delivered a PA optimization intervention to those with at least two weeks prior to surgery consisting of a one-time baseline visit with an exercise health counselor and weekly telephone follow-up. The orientation to the use of the PA tracker and the handout with instructions for use of the tracker was the same as described above. In addition, patients were encouraged by the health counselor to increase daily step counts, provided instruction on respiratory breathing exercises, and given lower (mobility/chair stands) and upper body strengthening (chair shoulder dips for transfers) exercises that could easily be done in the home. Each person received a handout describing these activities, which included separate sections for each type of exercise, the purpose of the exercise, instructions with diagrams, and specific goals for each activity. The patient also received coaching via weekly telephone calls prior to surgery, a hospital visit if feasible to encourage and support activity, to download data and exchange

devices for a freshly charged battery, and continued weekly coaching calls throughout the peri-operative period. Coaching calls were tailored to baseline step counts, promoting increased step counts, and engagement in recommended exercises. Those with low step counts were encouraged to increase step counts by at least 100 steps or more per day. Those with higher step counts were encouraged to make larger changes over time.

Analysis

Repeated measures models were utilized to evaluate the trajectories of change, first by site among males receiving or not receiving counseling (VA vs Duke) and separately by surgery type (for VA only). Interactions by site or surgery type by assessment time were used to determine whether step count trajectories differed. P-value of 0.05 was used as a threshold for declaring statistical significance. SAS v9.4 was used for all analysis.

Results

Only participants with complete step count data were included in the analysis. Data were lost or incomplete for some of our early recruits primarily due to equipment failures and logistical challenges that were part of the initiation of this novel program. Data collection improved as we refined our methods. A majority of individuals approached for this initiative were receptive to participation and able to use the device with only one training session.

POSH-at-Duke

Thirty-six participants agreed to participate. Of these, we were able to collect complete data on 23 participants who were on average 75.7 ± 6.4 years old (range 67-93), 48% male, had 9.2 ± 3.8 chronic conditions, and a mean Body Mass Index (BMI) of $30.3 \pm 6.7 kg/m^2$.

POSH-at-VA

Twenty-six of 28 consecutive patients approached (93%) agreed to participate. We were able to collect complete data on 14 participants who were all males and on average were 72.1 ± 5.9 years old (range 66-89), had 12.1 ± 4.3 chronic conditions, and a mean BMI of $29.8 \pm 5.5 kg/m^2$. Post-surgical complication rates and mean length of stay for each cohort are presented in (Table 1).

	Duke Males (n=11)	Duke Females (n=12)	Entire Duke Cohort (n=23)	VA Males (n=14)	P-value*
Baseline Characteristics					
Age, mean ± SD	77.2 ± 6.8	74.4 ± 5.6	75.7 ± 6.4	72.1 ± 5.9	0.06
Body Mass Index, mean ± SD	28.3 ± 4.4	32.1 ± 7.8	30.3 ± 6.7	29.8 ± 5.5	0.46
Race, % Caucasian	81.8	66.7	73.9	71.4	0.55
Types of Surgery					^
Spine, n	8	7	15	5	
Hernia, n	2	1	3	4	
Internal Organ Removal, n	1	3	5	4	
Mastectomy, n	0	1	1	0	
Vascular, n	0	0	0	1	
Chronic Conditions, number, mean ±SD	10.0 ± 4.6	8.4 ± 3.1	9.2 ± 3.8	12.1 ± 4.3	0.25
Pre-Surgical Pain, score (1-10), mean ± SD	3.6 ± 3.5	4.8 ± 3.6	4.2 ± 3.6	3.9 ± 2.9	0.82
Postoperative Outcomes					
Length of Stay, days median (IQR)	2 (1, 2.5)	4 (1.75, 6.25)	2 (1, 5.5)	1.5 (1, 9)	0.56
Post-Surgical Complication, % Yes	0%	33.30%	17.40%	42.90%	0.02
Abbreviations: n = Number, SD = Standard Deviation, IQR = Interquartile Range					
* P-value reflects test between Duke Males and VA Males.					
^ Surgery type could not be properly statistically processed due to sparseness of data					

Table 1: Baseline Characteristics of POSH PA Tracker Participants and Post-Operative Outcomes.

Step Count Trajectories with and without Coaching

Because the VA cohort was exclusively male, and the females had markedly different step counts than the males, step counts are presented by gender. Panel A, depicts step counts between POSH-at-Duke males and POSH-at-VA males as an indicator of trajectories among individuals receiving or not receiving a PA optimization intervention. Step counts were notably different between cohorts at baseline with POSH-at-Duke participants having higher baseline step counts than POSH-at-VA participants (5,241 versus 2,063). In the absence of sustained coaching, participants from POSH-at-Duke had a slightly declining mean daily step count of 4,437 two days prior to surgery, and 3,096 at the 4-week post-operative visit. POSH-at-VA participants had mean daily step counts of 2,063 at baseline, 5,452 two days prior to surgery, and 4,236 at 4-week post-operative visit. Trajectory analyses, using mixed models including a non-linear term, found significant differences between Duke and VA POSH, p=0.049.

Step Counts Among Females

(Figure 1) Panel B depicts the step count trajectories of the females from POSH-at-Duke. Although their baseline step count was higher at baseline than the male cohort from POSH-at-VA (2,768 steps versus 1,866), in the absence of sustained coaching, step count trajectories continued to decline throughout the entire peri-operative period from a baseline of 2,768 steps to 685 steps 4-weeks post discharge.

Figure 1: Step Count Trajectories

A: Step Counts Males With and Without Coaching

	Baseline	Mid-way	2 Days prior	Surgery	Mid-way post	Post-op
Duke Males No Coaching	5241	4948	4437	822	3721	3096
VA Males With Coaching	2063	4268	5452	2238	2424	4236

— — Duke Males No Coaching   —— VA Males With Coaching

B. Step Counts Females with No Coaching

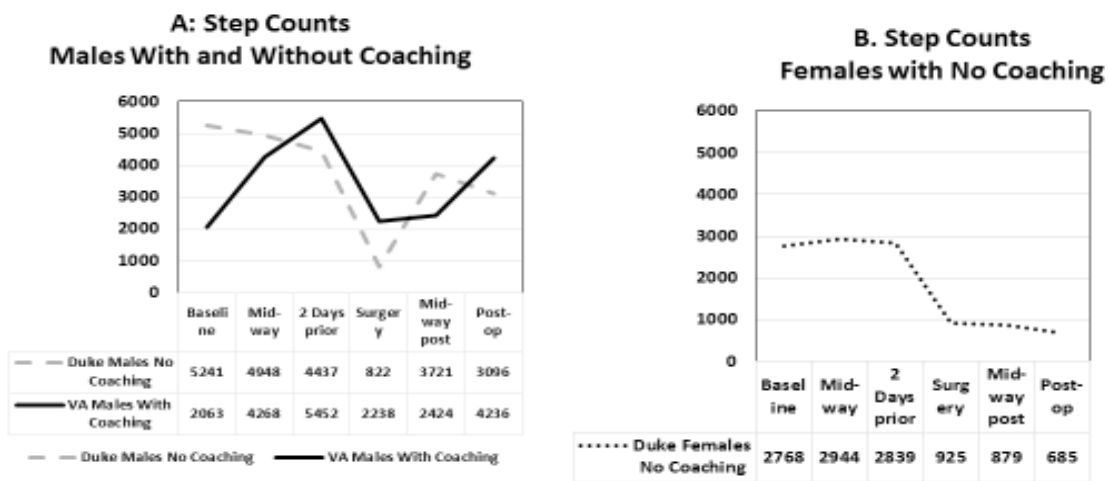|	Baseline	Mid-way	2 Days prior	Surgery	Mid-way post	Post-op
Duke Females No Coaching	2768	2944	2839	925	879	685

Figure 1: Panel A depicts the mean step counts by counseling status for males, Duke and VA cohorts. Trajectories of females and males at Duke were different, thus comparisons between POSH at Duke and POSH at VA were limited to males only. Panel B depicts trajectories for the females from Duke who did not receive sustained coaching.

Step Counts by Surgery Type

Among the POSH-at-VA participants, step counts trajectories were similar for all surgery types, p=0.32, using analysis of variance (Figure 2).
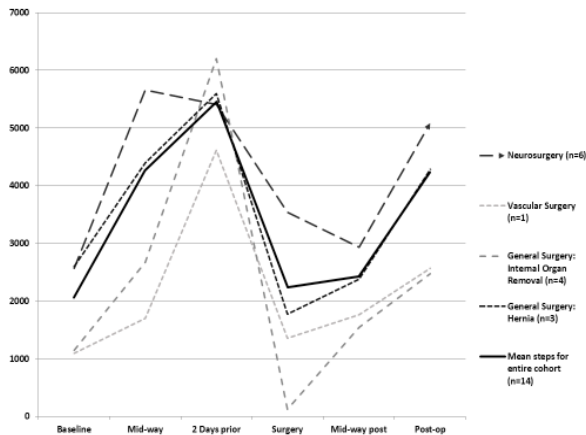
Figure 2: Figure 2 depicts the trajectories of step counts by type of surgery for individuals receiving sustained coaching.

Discussion

We present a proof of concept description of an ongoing effort to improve outcomes among older surgical candidates. We believe that pending surgery represents a teachable moment that can be used to introduce health promoting coaching that enhances PA and mobility throughout the peri-operative continuum [13]. While there is evidence that preoperative exercise interventions among older adults have high potential, [14-17] we used PA trackers with coaching as a way to overcome many of the barriers, such as time and transportation that have limited uptake of promising interventions [9]. Our data suggest that PA trackers coupled with appropriate continuous PA coaching increases PA with potential utility in promoting resilience in the geriatric surgical candidate. Preliminary work leading to this effort laid the groundwork for establishing the feasibility of the use of PA trackers among older adults [18]. Focus groups helped us identify trackers that adults found easiest to use and we learned that disabling some of the advanced features of the watch, extended battery life and made it easier for our participants to use the trackers to simply monitor step counts [18].

Most individuals approached for this initiative were receptive to the notion that increased PA might augment recovery, consistent with the strong desire to remain and regain independence rapidly following surgery. The literature suggests that even modest amounts of preconditioning has potential benefit [19]. Our coaching with PA trackers appeared to encourage increased walking as we found that individuals increased their step counts preoperatively and were quick to resume walking following discharge to the home. We acknowledge that interpretation of these data are limited by differences between Duke and VA patient characteristics and health care delivery. The females at Duke, who did not receive coaching had poor trajectories following surgery and experienced high rates of postoperative complications. The Veterans had higher baseline comorbidities and lower baseline step counts than the Duke cohorts. Even though they experienced high rates of postoperative complications, they readily adopted the coaching program and continued to increase their step counts following discharge. In addition, we had a high preponderance of neurological surgeries at Duke, which may confound our findings.

Conclusion

We believe there is utility in determining whether PA trackers can identify at-risk populations, i.e. low baseline step count, where PA optimization can provide the most benefit as an intervention prior to and following surgery. Step counts also might serve as an indicator of resilience, where high baseline step counts, increased step counts during the preoperative period or early mobilization might indicate rapid recovery from surgery or conversely, low step counts might indicate poor resiliency.

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Author Contributions

All authors contributed to the interpretation of the data and the preparation of manuscript. MCM contributed to the study concept and design. KM, YG, SM, MH, KPS, NL, SDL contributed to acquisition of subjects and data. RS contributed to analysis of data.

Sponsor's Role

None.

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