Using Wearable Devices to Track Post-operative Recovery Trajectories in TKA Patients

Robert Hall, Alexander P Hamel, Pamela Chan, Hua Zheng, Shao-Hsien Liu, David Christopher Ayers

INTRODUCTION:

Wearable devices enable remote monitoring of patients following total knee arthroplasty (TKA), but little is known about variability in recovery trajectories. This study aimed to determine whether a patient's anticipated recovery can be predicted preoperatively based on demographics, comorbidities, and baseline activity levels. We also evaluated whether wearable devices can track recovery and identify patients not meeting expected activity benchmarks.

METHODS:

Sixty-three patients undergoing primary TKA were prospectively enrolled under a protocol approved by the Institutional Review Board (IRB). Daily step counts were recorded using a smartwatch for at least three days preoperatively and for 90 days postoperatively. Participants were stratified into tertiles based on average preoperative daily steps: least active, moderately active, and most active. One-way analysis of variance (ANOVA) assessed differences in step counts among groups ($p < 0.05$), and recovery trajectories were compared using 95% confidence intervals.

RESULTS:

Mean age was 68.4 years (standard deviation [SD] = 7.2); 53.5% were women. Mean body mass index (BMI) was 33.5 kg/m² (SD = 5.3) in the least active group, 30.8 kg/m² (SD = 5.6) in the moderately active group, and 29.9 kg/m² (SD = 3.5) in the most active group. Demographic data are reported in Table 1. Preoperative daily steps averaged 1,133, 2,092, and 6,498, respectively. At two weeks, mean daily steps were 1,478 (SD = 897), 3,106 (SD = 1,630), and 3,337 (SD = 2,336) ($p < 0.001$). At 12 weeks, steps increased to 4,583 (SD = 3,368), 6,252 (SD = 3,247), and 6,236 (SD = 2,731) ($p = 0.32$) (Table 2). The least and moderately active groups exceeded preoperative levels by two weeks, while the most active group did not return to baseline by 12 weeks (Figure 1).

DISCUSSION AND CONCLUSION:

Remote monitoring offers a novel method for evaluating TKA recovery. Preoperative activity levels predict recovery trajectories, and wearable devices support patient engagement while enabling early detection of those deviating from expected recovery.

Figure 1: Mean Post-Operative Steps by Tertile

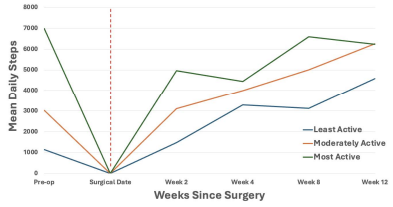

Table 1. Baseline socio-demographic and clinical characteristics among patients receiving total knee replacement surgery by tertile of pre-operative step counts (n=63).

Characteristics	Least active (n=21)	Moderately (n=21)	Most active (n=21)	All (n=63)
Age, mean (SD), years	68.6 (8.7)	69.1 (6.1)	67.6 (6.8)	68.4 (7.2)
Women (%)	42.1	57.9	40.0	53.5
Race/ethnicity (%)				
White	89.5	95.0	95.0	93.2
Black or African American	5.3	0	0	3.4
Other	5.3	5.0	5.0	3.4
Married (%)	79.0	85.0	68.4	77.6
Education (%)				
<high school	5.6	5.3	0	3.9
High School/Some College	72.2	57.9	73.3	67.3
≥College graduate	11.1	36.8	26.7	25.0
Other	11.1	0	0	3.9
Insurance status (%)				
Medicaid	0	0	5.3	1.8
Medicare	36.8	58.8	36.8	43.6
Other	21.1	29.4	36.8	29.1
Private	42.1	11.8	21.1	25.5
Body mass index, mean (SD), kg/m²	33.5 (5.3)	30.8 (5.6)	29.9 (3.5)	31.3 (5.1)
Charlson Comorbidity Index Score (%)				
0	47.4	45.0	60.0	50.9
1	31.6	45.0	40.0	39.0
≥2	21.1	10.0	0	10.2
Oswestry Disability Index low back pain (%)				
None	42.1	45.0	55.0	47.5
Mild	36.8	25.0	15.0	25.4
Moderate	21.1	20.0	25.0	22.0
Severe	0	10.0	5.0	5.1

Table 2. Post-operative mean step counts by tertile of pre-operative step counts (n=63).

	Least active (n=21)		Moderately (n=21)		Most active (n=21)		All (n=63)		P-value
Steps counts	Mean (SD)	Median	Mean (SD)	Median	Mean (SD)	Median	Mean (SD)	Median	
Pre-op	1,137 (505)	1,133	3,018 (592)	2,092	6,977 (2,263)	6,469	3,710 (2,805)	2,902	<0.001
Week 2	1,478 (897)	1,296	3,106 (1,630)	3,062	4,962 (2,536)	5,429	3,337 (2,336)	2,905	<0.001
Week 4	3,290 (2,373)	2,900	3,996 (2,162)	4,030	4,446 (2,448)	5,052	3,958 (2,326)	3,486	0.36
Week 8	3,124 (1,888)	2,481	4,999 (2,867)	4,783	6,597 (3,399)	6,397	5,117 (3,137)	4,193	0.01
Week 12	4,583 (3,368)	3,813	6,252 (3,247)	5,724	6,236 (2,731)	6,323	5,797 (3,088)	5,369	0.32