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Joshuel A. Pahang

David B. Auyong

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# Validation of Consumer Activity Monitors in Postoperative Total Arthroplasty Patients

Joshuel A. Pahang, David B. Auyong  
Washington State University – Elson S. Floyd College of Medicine

## Background

Mobilization and rehabilitation are essential components of a successful functional recovery following total knee arthroplasty. Currently, we have no objective measure of a patient's mobility after surgery. Rising popularity and recent technological advances in personal activity monitors, such as Fitbit, might provide medical providers and patients the opportunity to more objectively monitor their postoperative mobility and recovery course. However, these consumer activity monitors have yet to be validated in terms of their accuracy and utility for monitoring mobility in the immediate postoperative setting in arthroplasty patients.

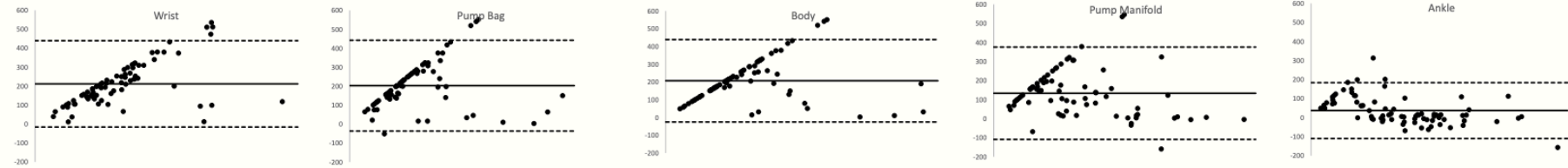
## Methods

We collected data on a total of 76 subjects, all of whom had a total knee arthroplasty surgery. The study activity monitors were attached to patients immediately prior to PT sessions. Five separate activity monitors were attached to each patient at the following sites:

- Wrist – contralateral to side of surgery
- Body – either to waist belt or patient gown
- OnQ pump manifold – site of nerve catheter insertion site
- OnQ pump bag
- Ankle – contralateral to side of surgery

Patients then progressed through PT sessions as usual with activity monitors attached. One of the study personnel acted as the objective observer and counted the number of steps using a tally counter, duration of mobilization during the PT session, and distance ambulated. A step was to be counted if there is forward progress of the foot past the midpoint of the contralateral foot. This was to prevent observer counts of in-place steps or steps not resulting in forward motion. Distance was recorded using a measuring wheel rolled over the distance the patient has ambulated.

## Results



Our specific aim was to validate one of the most popular consumer activity monitors, Fitbit, in the postoperative total joint arthroplasty patient population. Fitbit monitors have already been validated in non-hospital settings but their accuracy and the best location to place them for the most accurate measurements in the post-arthroplasty population was previously unknown. Our primary outcome was to determine the accuracy of the step counts obtained from these monitors on five different locations on the body by comparing them to a "gold standard" step count, distance ambulated, and duration of ambulation obtained by an observer watching the patient during a monitored physical therapy (PT) session. We observed 76 different patient PT sessions and compared device results stratified by body location in each patient. Bland-Altman analysis was conducted to produce the figures above, with x-axis being number of "true steps" and the y-axis being the difference between the true steps and the steps counted on the Fitbit device. This analysis determined that the ankle was most accurate of the five evaluated locations of the monitor, with the narrowest limits of agreement (dotted lines), regardless of true steps taken.

## Discussion

Early mobilization following total knee arthroplasty surgeries is important in decreasing the risk of complications such as deep venous thrombosis, pulmonary embolus, pneumonia, and urinary retention. It is also generally accepted that early mobilization may help prevent late complications such as joint stiffness or arthrofibrosis. Aside from these complications, patient satisfaction and length of hospital stay both seem to be correlated with early mobilization with poor mobility negatively impacting both outcomes. Therefore, it is important for clinicians to ensure that patients are adequately mobilizing in the immediate postoperative period to promote a successful recovery after total knee arthroplasty. The advent of enhanced recovery pathways in post-arthroplasty care has resulted in decreased length of hospitalization. In addition, there is growing interest in same-day discharge after total knee arthroplasty. These factors have made it more challenging to closely monitor patient mobility in the immediate postoperative period and it may become more important for clinicians to be able to accurately monitor their patients' mobility in the outpatient setting as well. The increasing popularity of consumer activity monitors used to monitor step counts, such as those manufactured by Fitbit, may present clinicians with the opportunity to better monitor their patients in the outpatient setting. There are many devices on the market ranging from very simple and cheap devices to increasingly complex ones that can track several other physiologic parameters. In the midst of all this variation, companies employ a consistent algorithm to record the number of steps. It is currently unknown how accurately these devices measure activity in the post-arthroplasty setting.

Consumer activity monitors are generally manufactured to be used in a relatively healthy, ambulatory population. Their accuracy has been validated in multiple studies in healthy subjects in a variety of controlled settings. Several studies have also looked at accuracy of certain models in elderly populations or in inpatient rehabilitation settings. Based on these validity studies, some of these consumer activity monitors have worse accuracy in certain situations, such as slower-paced walking or in people using assistive devices for ambulation, such as canes and walkers. The limitations of these devices in these settings could be problematic for monitoring post-arthroplasty patients all of these patients ambulate slowly, with an altered gait, and with a walker. Our study also demonstrated this limitation with the devices, however, this seemed to be overcome with placing on the contralateral ankle, as this foot maintains adequate motion to be counted as an accurate step. Thus, we can begin to plan for further advancement of these monitors with the knowledge that the contralateral ankle is the best placement in the post-arthroplasty setting.

## Conclusion and Next Steps

Our goal for this study is to validate and to determine the best location for placement of the Fitbit in the postoperative total knee arthroplasty patient population. Accuracy of step counts is important in order to establish how and where activity monitors can be used to track patient progress in the outpatient setting. If we can accurately use this device as a surrogate for in-person observation in order to detect those patients most at risk for readmission and complications, this will aid in efficiency of distribution of valuable resources. Another important topic of investigation regarding use of consumer activity monitors for home observation is the potential ability to aid in postoperative complication risk stratification. Ultimately, the long-term goal is to potentially determine whether activity monitors can help clinicians detect potential problems in postoperative patients earlier and therefore allocate resources to intervene prior to the development of complications in those at highest risk.

