

## EDITORIALS

## Mobility Sensors for Hospitalized Patients: Quo Vadis?

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Functional impairment, such as difficulty with activities of daily living or limited mobility,<sup>1</sup> is common among hospitalized patients and correlated with important outcomes: approximately 50% of hospitalized Medicare seniors have some level of impairment that correlates with higher rates of readmission,<sup>2</sup> long-term care placement,<sup>3</sup> and even death.<sup>4</sup>

Lack of consistent, accurate, and reliable data on functional mobility during hospitalization poses an important barrier for programs seeking to improve functional outcomes in hospitalized patients.<sup>5,6</sup> More accurate mobility data could improve current hospital practices to diagnose mobility problems, target mobility interventions, and measure interventions' effectiveness. Although wearable mobility sensors (small, wireless accelerometers placed on patients' wrists, ankles, or waists) hold promise in overcoming these barriers and improving current practice, existing data are from small samples of focused populations and have not integrated sensor data into patient care.<sup>7,8</sup>

In this issue of the *Journal of Hospital Medicine*, Sallis and colleagues used mobility sensors to study 777 hospitalized patients.<sup>9</sup> This article has several strengths that make it unique among the handful of articles in this area: it is the largest to date, the first to consider patients on both medical and surgical units, and the first to correlate sensor data with clinical assessments of mobility by providers (nurses). The authors found that, regardless of length of stay, patients averaged 1100 steps during the final 24 hours of their hospitalization. Older patients had slightly fewer steps on average (982 per 24 hours), but, taken collectively, these findings led the authors to postulate that 1000 steps per day might be a good "normative" value for discharge readiness in terms of patient mobility.

This idea of a normative value for steps taken by inpatients prior to discharge raises several interesting questions. First, could numbers of steps become a value that hospital providers routinely use to optimize care of hospitalized patients similar to other values

such as blood pressure or blood sugar? Such a threshold could be used to define strategies that target "tight" mobility control for patients at high risk for decline, and others might be managed with a more traditional "ad lib" approach. Alternatively, perhaps physicians should focus more on improvement in mobility regardless of a population-defined threshold. In this case, the measure would be progress toward a patient-centered or patient-defined goal. Second, it is important to note that Sallis and colleagues found that patients whose nurses documented their estimated mobility more frequently in the medical record also had substantially higher sensor step counts. This raises the question of whether more data from sensors can assist front-line inpatient providers to more effectively engage patients in mobilizing to avoid functional deconditioning during hospitalization. Often we tell our patients to "try to get out of bed today...go for a walk around the unit," but we are rarely specific about how far they should walk, and patients do not get feedback on their daily progress toward a specific mobility goal. Perhaps data on the number of steps from mobility sensors could be shown to both patients and providers so as to encourage patients to reach their goal, whether that is the normative 1000 steps per day or slightly more or less.

This article also has limitations, which raise important questions for future research. First, patients in this study were ambulatory and relatively healthy (85% had Charlson scores 0 or 1) at the time of admission, making it difficult to determine whether the approach used or threshold defined are valid in higher-risk populations, such as those with preexisting functional limitations. Second, lack of clinical outcomes data is another important limitation in this study, which is shared by many, but not all, inpatient sensor studies. For example, a recent study correlated discharge location (skilled nursing facility vs home) to levels of step mobility; however, the authors were unable to determine the degree to which their step measures were simply mirroring clinical decision making.<sup>10</sup> Another recent study demonstrated that decreased inpatient step counts are associated with early mortality; however, more proximal outcomes such as postdischarge function were not measured.<sup>11</sup> Moreover, future studies will need to assess whether mobility sensors can reliably predict postdischarge function, and even be used to improve mobility or reduce functional impairment in hospital populations that include sicker patients.

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Ultimately, the results by Sallis et al. are a useful step in the right direction, but much more work is needed to determine the clinical utility of mobility sensors as part of larger efforts to harness the potential of mobile health (mHealth) efforts to improve care for hospitalized patients.<sup>12</sup> The future of mobility sensors in healthcare is likely about how well patients and providers can use them to successfully guide and support behavior change. This will require a strong health-adopter focus in coaching patients to use mobility sensors and their mobile, patient-facing applications.<sup>13</sup> Ultimately, the goal must be to embed these mHealth approaches into larger behavior management and health system redesign so that clinical goals such as improved function after hospital discharge are met.<sup>14</sup>

Disclosures: Nothing to report.

## References

- Covinsky KE, Pierluissi E, Johnston CB. Hospitalization-associated disability: "She was probably able to ambulate, but I'm not sure." *JAMA*. 2011;306(16):1782–1793.
- Greysen SR, Stijacic-Cenzer I, Auerbach AD, Covinsky KE. Functional impairment and readmissions in Medicare seniors [published online ahead of print February 2, 2015]. *JAMA Intern Med*. doi:10.1001/jamainternmed.2014.7756.
- Covinsky KE, Palmer RM, Fortinsky RH, et al. Loss of independence in activities of daily living in older adults hospitalized with medical illnesses: increased vulnerability with age. *J Am Geriatr Soc*. 2003;51(4):451–458.
- Barnes DE, Mehta KM, Boscardin WJ, et al. Prediction of recovery, dependence or death in elders who become disabled during hospitalization. *J Gen Intern Med*. 2013;28(2):261–268.
- Greysen SR, Covinsky KE. Functional status—an important but overlooked variable in the readmissions equation. *J Hosp Med*. 2014;9(5):330–331.
- Hoyer EH, Needham DM, Atanelov L, Knox B, Friedman M, Brotman DJ. Association of impaired functional status at hospital discharge and subsequent rehospitalization. *J Hosp Med*. 2014;9(5):277–282.
- Brown CJ, Redden DT, Flood KL, Allman RM. The under-recognized epidemic of low mobility during hospitalization of older adults. *J Am Geriatr Soc*. 2009;57(9):1660–1665.
- Pedersen MM, Bodilsen AC, Petersen J, et al. Twenty-four-hour mobility during acute hospitalization in older medical patients. *J Gerontol A Biol Sci Med Sci*. 2013;68(3):331–337.
- Sallis R, Stern Y, Chijioke E, et al. Stepping towards discharge: level of ambulation in hospitalized patients. *J Hosp Med*. 2015;10(6):358–363.
- Cook DJ, Thompson JE, Prinsen SK, Dearani JA, Deschamps C. Functional recovery in the elderly after major surgery: assessment of mobility recovery using wireless technology. *Ann Thorac Surg*. 2013;96(3):1057–1061.
- Ostir GV, Berges IM, Kuo YF, et al. Mobility activity and its value as a prognostic indicator of survival in hospitalized older adults. *J Am Geriatr Soc*. 2013;61(4):551–557.
- Herz JC. Wearables are totally failing the people who need them most. *Wired*. Available at: <http://www.wired.com/2014/11/where-fitness-trackers-fail>. Published November 6, 2014. Accessed January 21, 2015.
- Patel MS, Asch DA, Volpp KG. Wearable devices as facilitators, not drivers, of health behavior change. *JAMA*. 2015;313(5):459–460.
- Topol EJ, Steinhubl SR, Torkamani A. Digital medical tools and sensors. *JAMA*. 2015;313(4):353–354.