

Preoperative Assessment of Functional Capacity

Looking beyond the Ability to Climb Stairs

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Almost any preoperative evaluation—be it by an anesthesiologist, internal medicine physician, or surgeon—involves asking a patient about the ability to climb one to two flights of stairs or walk several blocks on level ground. Patients' responses to these questions provide insights into their usual levels of physical activity and their overall cardiopulmonary fitness, which in turn plausibly help with stratifying risk for postoperative morbidity and mortality. In this issue of *ANESTHESIOLOGY*, Rubin *et al.* present an analysis of the National Health and Nutrition Examination Survey that provides important new data on the validity of patients' self-report as a measure of usual levels of physical activity.¹ Participants in this nationally representative sample of the United States population responded to questions about their usual physical activities (e.g., walking or climbing stairs) and also wore accelerometers to objectively measure their physical activity over a 7-day period. Overall, the authors found that typical interview questions related to physical activity were relatively inaccurate tools for screening out significantly inactive individuals who did not complete at least 2 min of moderate-to-vigorous activity (*i.e.*, walking two blocks at 4 mi/h) over a 7-day period. While the self-reported inability to climb 10 stairs had reasonably good performance (positive likelihood ratio of 3.9) for identifying inactive individuals, the self-reported ability to climb 10 stairs and walk two to three blocks had relatively weak ability to rule out inactivity (negative likelihood ratio of 0.5).

Importantly, the National Health and Nutrition Examination Survey sample analyzed in this study was relatively small (*i.e.*, 522 individuals), drawn from a noncontemporary time period (*i.e.*, 2003 to 2006), and not restricted to surgical patients. The sample therefore differed from



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typical surgical patients in that participants were sicker yet more physically active. For example, coronary artery disease was present in 65% of the National Health and Nutrition Examination Survey sample, compared to 13% of a large, relatively unselected cohort study of patients having major inpatient noncardiac surgery.² About 67% of the National Health and Nutrition Examination Survey sample was sedentary based on measurements by older generation uniaxial accelerometers. By comparison, a recent study of 50 surgical patients in the United Kingdom found that more than 99% were sedentary based on measurements by newer generation triaxial accelerometers over a 3-day period preceding surgery.³

This study by Rubin *et al.* adds to a growing body of literature pointing to the important limitations of the usual clinical approach of subjectively assessing preoperative functional capacity based on responses to a few simple unstructured questions. The relatively poor performance of simple questions at screening out unfit patients is consistent with the findings of the Measurement of Exercise Tolerance before Surgery study.⁴ In this multicenter prospective cohort study, anesthesiologists' subjective rating of poor fitness (defined as being unable to attain four metabolic equivalents of activity) had a positive likelihood ratio of 3.8 and negative likelihood ratio of 0.85 for identifying patients with poor performance on objective exercise testing. Importantly, in the Measurement of Exercise Tolerance before Surgery study, cardiopulmonary fitness was objectively measured by formal exercise testing, while in the National Health and Nutrition Examination Survey sample, usual levels of physical activity were objectively measured by accelerometers. Cardiopulmonary fitness and usual

Image: J. P. Rathmell.

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physical activity levels are related, but different, constructs. Indeed, preoperative activity levels measured by accelerometers are only moderately correlated with exercise testing performance (*i.e.*, correlation coefficients ranging from 0.55 to 0.6) in surgical patients.³ Thus, an individual may conceivably exhibit a higher level of cardiopulmonary fitness on strenuous exercise testing than would be evident during usual daily physical activities. Conversely, usual physical activity levels might be limited by factors other than fitness (*e.g.*, musculoskeletal disease). Cardiopulmonary fitness and usual physical activity levels may also have different prognostic relevance. In the surgical setting, maximal exercise ability on formal objective testing is predictive of moderate or severe postoperative complications, but not cardiac events such as myocardial infarction or myocardial injury.⁴ The prognostic relevance of preoperative activity levels remains unclear but could plausibly be superior to objectively measured fitness for some outcomes. Consistent with this possibility, self-reported activity as measured by the standardized 12-item Duke Activity Status Index questionnaire has been shown to predict postoperative cardiovascular complications.^{4–6} Thus, future studies should assess the ability of activity levels as objectively measured by accelerometers to predict important postoperative complications.

Moving forward, how might clinicians assess preoperative functional capacity in a more valid and prognostically accurate manner? It is increasingly clear that the current clinical approach of unstructured questions is simply inadequate. There are some promising alternatives, but all require further study before mainstream clinical implementation. Rubin *et al.* have highlighted the potential for the application of accelerometers and other similar wearable healthcare technology. If these devices are to be used to inform preoperative risk stratification, future research must specifically evaluate the prognostic relevance of preoperative accelerometer measurements. Such studies are especially needed since accelerometer measurements have similar correlation to objectively measured exercise capacity as the much simpler Duke Activity Status Index questionnaire.³ Importantly, there are potential roles for accelerometers and other similar wearable healthcare technology in the perioperative setting beyond estimating preoperative activity levels. Indeed, these devices may be best suited to the postoperative setting, where they can facilitate early identification of patients at risk for poor postsurgical recovery.⁷ As with many emerging perioperative care technologies—such as minimally invasive cardiac output monitors, remote postoperative physiological monitors, and wearable technology—the onus lies with anesthesiologists and perioperative physicians to identify the most cost-effective opportunities to apply new technology to improve clinical care and outcomes.

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Competing Interests

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References

1. Rubin DS, Huisinigh-Scheetz M, Hung A, Ward RP, Nagele P, Arena R, Hedeker D: Accuracy of physical function questions to predict moderate-vigorous physical activity as measured by hip accelerometry. *ANESTHESIOLOGY* 2019; 131:992–1003
2. Writing Committee for the VISION Study Investigators: Association of postoperative high-sensitivity troponin levels with myocardial injury and 30-day mortality among patients undergoing noncardiac surgery. *JAMA* 2017; 317:1642–51
3. Cui HW, Kirby GS, Surmacz K, Hargrove C, Griffiths J, Turney BW: The association of pre-operative home accelerometry with cardiopulmonary exercise variables. *Anaesthesia* 2018; 73:738–45
4. Wijeyesundera DN, Pearse RM, Shulman MA, Abbott TEF, Torres E, Ambosta A, Croal BL, Granton JT, Thorpe KE, Grocott MPW, Farrington C, Myles PS, Cuthbertson BH; METS Study Investigators: Assessment of functional capacity before major non-cardiac surgery: An international, prospective cohort study. *Lancet* 2018; 391:2631–40
5. Hlatky MA, Boineau RE, Higginbotham MB, Lee KL, Mark DB, Califf RM, Cobb FR, Pryor DB: A brief self-administered questionnaire to determine functional capacity (the Duke Activity Status Index). *Am J Cardiol* 1989; 64:651–4
6. Kaw R, Nagarajan V, Jaikumar L, Halkar M, Mohananey D, Hernandez AV, Ramakrishna H, Wijeyesundera D: Predictive value of stress testing, Revised Cardiac Risk Index, and functional status in patients undergoing noncardiac surgery. *J Cardiothorac Vasc Anesth* 2019; 33:927–32
7. Daskivich TJ, Houman J, Lopez M, Luu M, Fleshner P, Zaghiyan K, Cunneen S, Burch M, Walsh C, Paiement G, Kremen T, Soukiasian H, Spitzer A, Jackson T, Kim HL, Li A, Spiegel B: Association of wearable activity monitors with assessment of daily ambulation and length of stay among patients undergoing major surgery. *JAMA Netw Open* 2019; 2:e187673