
Timed Stair Climbing Is the Single Strongest Predictor of Perioperative Complications in Patients Undergoing Abdominal Surgery



Sushanth Reddy, MD, FACS, Carlo M Contreras, MD, FACS, Brandon Singletary, MPH, T Miller Bradford, Mary G Waldrop, Andrew H Mims, W Andrew Smedley, Jacob A Swords, Thomas N Wang, MD, PhD, FACS, Martin J Heslin, MD, MSHA, FACS

- BACKGROUND:** Current methods to predict patients' perioperative morbidity use complex algorithms with multiple clinical variables focusing primarily on organ-specific compromise. The aim of the current study was to determine the value of a timed stair climb in predicting perioperative complications for patients undergoing abdominal surgery.
- STUDY DESIGN:** From March 2014 to July 2015, three hundred and sixty-two patients attempted stair climbing while being timed before undergoing elective abdominal surgery. Vital signs were measured before and after stair climb. Ninety-day postoperative complications were assessed by the Accordion Severity Grading System. The prognostic value of stair climb was compared with the American College of Surgeons NSQIP risk calculator.
- RESULTS:** A total of 264 (97.4%) patients were able to complete the stair climb. Stair climb time directly correlated to changes in both mean arterial pressure and heart rate as an indicator of stress. An Accordion grade 2 or higher complication occurred in 84 (25%) patients. There were 8 mortalities (2.4%). Patients with slower stair climb times had increased complication rates ($p < 0.0001$). In multivariable analysis, stair climb time was the single strongest predictor of complications (odds ratio = 1.029; $p < 0.0001$), and no other clinical comorbidity reached statistical significance. Receiver operative characteristic curves predicting postoperative morbidity by stair climb time was superior to that of the American College of Surgeons risk calculator (area under the curve = 0.81 vs 0.62; $p < 0.0001$). Additionally, slower patients had greater deviations from predicted length of hospital stay ($p = 0.034$).
- CONCLUSIONS:** Stair climb provides measurable stress, accurately predicts postoperative complications, and is easy to administer in patients undergoing abdominal surgery. Larger patient populations with a diverse group of operations will be needed to validate the use of stair climbing in risk-prediction models. (J Am Coll Surg 2016;222:559–566. © 2016 by the American College of Surgeons. Published by Elsevier Inc. All rights reserved.)
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The decision of whether to operate on a patient depends on the surgeon being able to discern the relative risk to benefit ratio for both the operative intervention and any

nonoperative alternatives. As the adult general population is both aging¹ and developing greater frequency and severity of comorbidities,^{2,3} the ability to predict surgical outcomes becomes increasingly important. In the absence of a reliable tool to assess complications, the onus falls to the surgeon to judge whether a patient is at high risk for adverse postoperative outcomes.

Current methods to predict outcomes focus primarily on the concept of frailty.^{4,5} Frailty has mainly been applied to older adults. Although the relationship between physical debilitation and physiologic age has long been appreciated,^{6,7} chronologic and physiologic age are sometimes divergent. Consequently, a measure of frailty should be used with all patients, not just the elderly. Although

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From the Division of Surgical Oncology, Department of Surgery, University of Alabama at Birmingham, Birmingham, AL.

Correspondence address: Sushanth Reddy, MD, FACS, Division of Surgical Oncology, Department of Surgery, University of Alabama at Birmingham, 1136 Faculty Office Tower, 510 20th Street South, Birmingham, AL 35294. email: sreddy@uabmc.edu

generally accepted as a predictor of surgical risk, the definition of frailty varies widely.^{4,5,8} Many such calculators use both subjective and difficult to determine objective measures to calculate frailty. The American College of Surgeons (ACS) NSQIP Surgical Risk Calculator is also commonly used to assess risk.⁹ This calculator uses a complex algorithm focusing mainly on organ compromise rather than functional status. As a result, neither approach is a practical method for the surgeon in predicting surgical outcomes.

Others have advocated a measure of physiologic compromise in the form of the timed up-and-go (TUG).¹⁰ Although useful in predicting outcomes, TUG is best used in combination with other models. In this study, we introduce the concept of inducing a moderately stressful physical activity of climbing a flight of stairs as a method of predicting surgical outcomes. The purpose of this analysis was to determine the physiologic stress provided by stair climbing, the ability of stair climbing to forecast operative outcomes, and the use of stair climbing to predict hospital length of stay.

METHODS

A prospective cohort study was conducted of patients undergoing planned elective abdominal operative surgery at a single institution from March 5, 2014 to July 22, 2015. Inclusion criteria were the use of general anesthesia, age 19 years or older, and entry into the peritoneal cavity. Patients were included in the study only after they were deemed to be appropriate operative candidates by their surgeon. The study was approved by the IRB and informed consent was obtained from all participants.

All subjects were asked to walk down and then up one single flight of stairs (7 steps each way) while being timed. Vital signs were collected before beginning and immediately after completing the task. Surgeons were blinded to the results of the subjects' performance. Clinical variables were collected prospectively. The presence of hypertension, diabetes mellitus, coronary artery disease, congestive heart failure, tobacco use, hypercholesterolemia, and alcohol abuse were defined as described previously.⁹ These variables are all included in the ACS NSQIP Surgical Risk Calculator. Low serum albumin has been shown to be associated with poor surgical outcomes.¹¹⁻¹³ A cutoff of albumin <3.4 g/dL was used, as this considered abnormal in our hospital laboratory. Ninety-day complications were graded using the Accordion Severity Grading System.¹⁴ Grade 2 or higher complications were included in the analysis. Patients who cancelled surgery, underwent a nonabdominal operation, or underwent an emergent operation were excluded

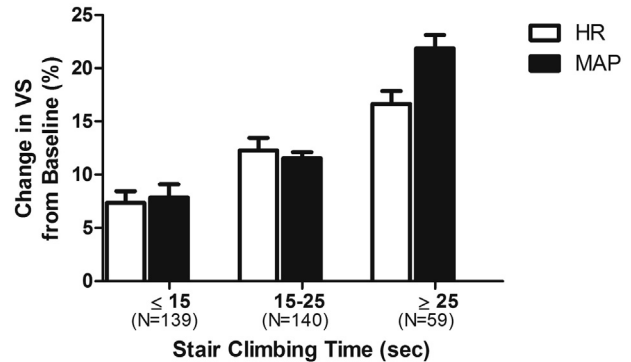


Figure 1. Stair climbing and changes in vital signs (VS). Changes in patients' heart rate (HR) and mean arterial pressure (MAP) were calculated as a function of the stair climbing time. Patients who were slower climbing stairs had a greater deviation in their vital signs (Wilcoxon rank sum test, $p < 0.0001$).

from the complication analysis, but their data were included in assessing vital signs after stair climbing.

Outcomes were compared with the ACS NSQIP Surgical Risk Calculator.⁹ Length of stay was calculated from the date of surgery to the date of discharge, inclusive of both dates. Univariable differences in population characteristics by postoperative complication status were assessed using t -test and 2-sided Fisher's exact test statistics. Differences across stair climbing performance time groups for patient vital signs, postoperative complications, and increased length of stay were assessed using Wilcoxon rank sum analyses. Univariable and multivariable logistic regression models were created to assess for significant predictors of complications. To test the ability of the stair climbing task to predict surgical outcomes, we constructed receiver operator characteristic curves. All statistical analyses were performed using STATA SE 13.0 (StataCorp) and GraphPad Prism 5 (GraphPad Software Inc) software. The statistical threshold for significance was set at $\alpha = 0.05$ for all tests.

RESULTS

Stair walking and stress

A total of 362 patients were enrolled in the study. Twenty of these patients were later excluded from complication analysis: 12 patients elected to cancel surgery, 7 underwent operations where the peritoneum was not entered, and 1 underwent an emergent operation before his planned elective procedure. Twenty-four patients were unable to perform the task (including 20 patients who were included in the complication analysis and 4 who were excluded). For the 338 patients who were able to complete the task, the mean time was 18.0 seconds, with a median time of 16 seconds (range 6 to 108 seconds). Changes in both heart rate and mean arterial pressure were calculated

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