JOURNAL OF SURGICAL RESEARCH 199 (2015) 51–55

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.JournalofSurgicalResearch.com

Association for Academic Surgery

One-year postoperative resource utilization in sarcopenic patients

Peter S. Kirk, BA, Jeffrey F. Friedman, BS, MS, David C. Cron, BS, Michael N. Terjimanian, BS, MS, Stewart C. Wang, MD, PhD, Darrell A. Campbell, MD, Michael J. Englesbe, MD, and Nicole L. Werner, MD, MS*

Department of Surgery, Taubman Center, University of Michigan Health System, Ann Arbor, Michigan

ARTICLE INFO

Article history:
Received 3 January 2015
Received in revised form
12 April 2015
Accepted 21 April 2015
Available online 30 April 2015

Keywords:
Sarcopenia
Morphomics
Cost
Discharge disposition
Readmissions
Health care utilization

ABSTRACT

Background: It is well established that sarcopenic patients are at higher risk of postoperative complications and short-term health care utilization. Less well understood is how these patients fare over the long term after surviving the immediate postoperative period. We explored costs over the first postoperative year among sarcopenic patients.

Methods: We identified 1279 patients in the Michigan Surgical Quality Collaborative database who underwent inpatient elective surgery at a single institution from 2006–2011. Sarcopenia, defined by gender-stratified tertiles of lean psoas area, was determined from preoperative computed tomography scans using validated analytic morphomics. Data were analyzed to assess sarcopenia's relationship to costs, readmissions, discharge location, intensive care unit admissions, hospital length of stay, and mortality. Multivariate models were adjusted for patient demographics and surgical risk factors.

Results: Sarcopenia was independently associated with increased adjusted costs at 30, 90, and 180 but not 365 d. The difference in adjusted postsurgical costs between sarcopenic and nonsarcopenic patients was $16,455 at 30 d and $14,093 at 1 y. Sarcopenic patients were more likely to be discharged somewhere other than home ($P < 0.001$). Sarcopenia was not an independent predictor of increased readmission rates in the postsurgical year.

Conclusions: The effects of sarcopenia on health care costs are concentrated in the immediate postoperative period. It may be appropriate to allocate additional resources to sarcopenic patients in the perioperative setting to reduce the incidence of negative postoperative outcomes.

1. Introduction

Sarcopenia, the age-related degeneration of skeletal muscle mass and function, is increasingly recognized as a burgeoning public health problem. It is associated with increased short-term morbidity and mortality across a wide range of procedures [1,2]. Although rates of sarcopenia increase in tandem with age, sarcopenia is more predictive of postoperative mortality and length of stay than chronologic age alone [3,4]. There is also evidence that sarcopenia can occur rapidly after

* *Corresponding author.* Department of Surgery, Taubman Center, University of Michigan Health System, 3328 Medical Science Building 1, 1150 W. Medical Center Drive, Ann Arbor, MI 48109 5677. Tel.: +1 734 764 7879; fax: +1 734 764 7173.

E-mail address: pkirk@med.umich.edu (P.S. Kirk).

0022-4804/$ – see front matter

http://dx.doi.org/10.1016/j.jss.2015.04.074

acute illness and that rate of skeletal muscle mass change is itself predictive of poorer outcomes [5,6]. Furthermore, it has long been known that the surgical event is itself a stressor that can strongly negatively impact body composition and that this effect can prolong recovery time [7].

Protein depletion is a defining trait among sarcopenic patients and is a key factor contributing to their morbidity. These patients have increased incidence of major complications, including pneumonia and decreased wound healing [8–10]. The protein depletion increases the metabolic stress and impairs the immune system, limiting its capacity to respond to insults [11–13]. Based on these findings, it is intuitive that perioperative interventions have been considered for sarcopenic patients. Intensive nutrition interventions have been investigated in this context and produced mixed results [14,15]. Testosterone and growth hormone replacement aimed at increasing muscle volume and quality have not shown advantage and were associated with adverse effects [16]. However, relatively simple resistance training and walking exercises have shown efficacy [16–18]. Importantly, exercise addresses the decreased respiratory capacity that is common among sarcopenic patients [19,20]. Recent perioperative optimization programs emphasizing these activities demonstrate promising results [21–23]. It is important that these programs be considered in the context of cost. More specifically, understanding the cost drivers of care for these at-risk patients will inform targeted and effective clinical interventions [24,25].

Within this context, the purpose of this study was to explore the relationship between sarcopenia and postoperative inhospital costs through and beyond the immediate postoperative hospital stay. To provide further insight into these costs, we also assessed several outcomes known to drive higher costs such as: length of stay, intensive care unit (ICU) admissions, discharge location, and readmissions. We hypothesized that sarcopenic patients accumulate higher inhospital costs than their nonsarcopenic counterparts through a variety of related mechanisms. We expected this difference to be visible and significant by the end of the index hospital stay and for this difference to persist throughout the first year after surgery.

2. Methods

2.1. Patient population and outcomes

We used data from the Michigan surgical quality collaborative (MSQC) clinical registry to identify patients undergoing general surgery at a single institution between 2006 and 2011 [26,27]. MSQC is a prospectively maintained surgical quality improvement database funded by Blue Cross and Blue Shield of Michigan. This database uses standard data definitions and collection protocols of the American College of Surgeons National Surgical Quality Improvement Programs. All patients identified underwent elective inpatient operations that required at least a 23-h inpatient observation period. Clinical variables were downloaded from the MSQC database and were supplemented with readmission and discharge disposition data by a review of electronic medical records at the study institution. Clinical data points collected included patient demographic information, preoperative comorbidities, and postoperative morbidity and mortality. Surgical procedures were classified by primary organ of interest and diagnosis into the following categories: appendix, biliary, colorectal and/or large bowel, endocrine, gastric, hepatic, hernia, pancreas, small bowel, vascular, and other. An internal cost-accounting database at the study institution was used to determine inpatient and outpatient financial data, which were collected from the day of operation to 365 d postoperatively. Financial data were limited to those fees incurred within the institution's system and were adjusted to account for inflation. Cumulative inhospital costs were evaluated at 30, 90, 180, and 365 d postoperatively. There were 8605 unique patients in our database between 2006 and 2011. Of these patients, 6648 had preoperative computed tomography (CT) scans, and 3469 of those were within 90 d of their operative date. A total of 2179 of these patients were excluded because they were either outpatient or emergent procedures. During review of the CT scans, an additional 11 patients were excluded for poor image quality in the lumbar region, yielding a final cohort of 1279 patients. Cost data were available for all these patients.

2.2. Analytic morphomics

Analytic morphomic measurements were performed in a semiautomated manner on collected CT scans using proprietary algorithms programmed in MATLABv13.0 (MathWorks, Natick, MA) according to established methods [28]. Briefly, the spinal column vertebral levels were mapped and then cross-sectional area of the left and right psoas muscles at the inferior aspect of the fourth lumbar vertebrae were summed to give the total psoas area. This was then adjusted for fatty infiltration of the muscle using density, measured in Hounsfield units, to yield lean psoas area (LPA) [29].

2.3. Statistical analysis

Descriptive statistics were computed for clinical variables, continuous variables were summarized by mean and standard deviation, and categorical variables were summarized by frequency of observation. Tests of significance were performed using Student *t*-tests or Wilcoxon rank-sum tests for continuous variables and Fisher exact tests and chi-squared tests for categorical variables, where appropriate. LPA measurements were made categorical, and patients were grouped into gender-standardized tertiles of LPA as follows: sarcopenic (small), average (medium), and nonsarcopenic (large). Multivariate analysis was used to assess the risk-adjusted impact of sarcopenia on inhospital costs and outcomes by controlling for clinical and operative characteristics. Operative time and work relative value units were used to control for operative complexity and case-mix disparity among tertiles. First, univariate logistic and linear regression was performed to identify variables appropriate for input into multivariate models. Selected variables were entered into the multivariate models in a stepwise-backward fashion. To account for the nonnormal distribution of cost outcomes, these variables were log-transformed before regression analysis. In one case when log transformation was inadequate to achieve normality, a Box–Cox transformation was used instead. Patients who were deceased before a given cost evaluation time point were not