Spine
SPINE Volume 42, Number 13, pp 979–983

CLINICAL CASE SERIES

Poor Nutrition Status and Lumbar Spine Fusion Surgery in the Elderly

Readmissions, Complications, and Mortality

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Study Design. Retrospective database review.

Objective. To quantify the medical and surgical risks associated with elective lumbar spine fusion surgery in patients with poor preoperative nutritional status and to assess how nutritional status alters length of stay and readmission rates.

Summary of Background Data. There has been recent interest in quantifying the increased risk of complications caused by frailty, an important consideration in elderly patients that is directly related to comorbidity burden. Preoperative nutritional status is an important contributor to both sarcopenia and frailty and is poorly studied in the elderly spine surgery population.

Methods. The full 100% sample of Medicare data from 2005 to 2012 were utilized to select all patients 65 to 84 years old who underwent elective 1 to 2 level posterior lumbar fusion for degenerative pathology. Patients with diagnoses of poor nutritional status within the 3 months preceding surgery were selected and compared with a control cohort. Outcomes that were assessed included major medical complications, infection, wound dehiscence, and mortality. In addition, readmission rates and length of stay were evaluated.

Results. When adjusting for demographics and comorbidities, malnutrition was determined to result in significantly increased odds of both 90-day major medical complications (adjusted odds ratio, OR: 4.24) and 1-year mortality (adjusted OR: 6.16). Multivariate analysis also demonstrated that malnutrition was a significant predictor of increased infection (adjusted OR: 2.27) and wound dehiscence (adjusted OR: 2.52) risk. Length of stay was higher in malnourished patients, though 30-day readmission rates were similar to controls.

Conclusion. Malnutrition significantly increases complication and mortality rates, whereas also significantly increasing length of stay. Nutritional supplementation before surgery should be considered to optimize postoperative outcomes in malnourished individuals.

Key words: elderly, frailty, lumbar spine, Medicare, morbidity, mortality, nutrition, posterior lumbar fusion, sarcopenia, spine fusion.

Level of Evidence: 3

Spine 2017;42:979–983

In the United States, elective lumbar spine surgery procedural volumes have increased rapidly over recent years, suggesting that improved outcomes and procedure safety have led to greater numbers of patients undergoing these procedures.[1] One particular demographic that is increasingly being treated with elective lumbar spine surgery is the elderly population,[2] a group of patients beset with degenerative spine conditions that often result in unrelenting low back pain. Unfortunately, this patient population is known to have a comorbidity burden that is increased relative to younger patients and can increase complication rates. Common comorbidities, including renal failure,[3,4] diabetes,[5] and smoking history,[6] have all been assessed in previous reports.

There has been recent interest in quantifying the increased risk of complications caused by frailty, an important consideration in elderly patients that is directly related to comorbidity burden. Patients who are "frail" are thought to be less resistant to stressors, such as surgical procedures, predisposing them to poor postoperative outcomes.[7,8] A surrogate measure of frailty is sarcopenia,[9] the loss of skeletal muscle mass that is often age-related. Elderly patients in particular are at risk for developing this

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Acknowledgment date: May 3, 2016. First revision date: September 18, 2016. Second revision date: October 5, 2016. Acceptance date: October 17, 2016.

The manuscript submitted does not contain information about medical device(s)/drug(s).

No funds were received in support of this work.

Relevant financial activities outside the submitted work: grants, consultancy, royalties, patents, and stocks.

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DOI: 10.1097/BRS.0000000000001969

condition, because of the natural loss of muscle mass and increase in fat mass that healthy individuals experience above the age of 35 years.[10,11] Studies have employed morphometric analysis that directly assesses muscle wasting to successfully predict complications after various surgical procedures.[9] One important contributor to sarcopenia is preoperative nutritional status,[12] which can directly influence a patient's frailty and complicate outcomes after major surgery.[13] Unfortunately, little information is available regarding preoperative nutritional status in patients undergoing spine surgery,[14–17] particularly within the elderly population.

The primary goal of this study is to directly quantify the medical risks associated with elective lumbar spine fusion surgery in patients with poor preoperative nutritional status. A secondary goal is to measure how patients with poor nutrition fare from a surgical standpoint. Lastly, we aim to quantify differences in length of stay and 30-day readmission rates directly related to poor preoperative nutritional status.

MATERIALS AND METHODS

Data utilized for this study were acquired through the PearlDiver Patient Records Database (www.pearldiverinc.com; PearlDiver Inc., Fort Wayne, IN). The PearlDiver database system is a for-fee database containing all Medicare patient records from 2005 through 2012, organized by ICD-9 diagnosis and procedure and Current Procedural Technology (CPT) codes. As all patient data was previously acquired and de-identified, an institutional review board approval waiver was acquired for this study.

All elderly patients (65–84 yrs) who were treated with posterior lumbar spinal fusion surgery from 2005 to 2012 were identified with ICD-9-CM procedural codes 81.07 and 81.08. Only 1–2 level fusions were selected for further analysis. Patients coded with same-day procedures pertaining to cervical (ICD-9-CM: 81.01–81.03), thoracic (ICD-9-CM: 81.04–81.05), or revision spine fusion surgery (ICD-9-CM: 81.30–81.39) were excluded. Further surgical exclusion criteria included patients who had anterior lumbar fusion surgery within 3 months of the index procedure, to exclude any staged fusion surgeries. To select for an elective surgery population, any patients with spine infection or spine trauma preceding the index procedure were excluded. In addition, any patients with a diagnosis of malignant cancer; congestive heart failure; or end stage renal disease (ICD-9-CM: 585.4, 585.5, V45.11, 588.0, including dialysis dependence and renal osteodystrophy),[4] all common reasons for poor nutritional status in the elderly population,[18] were excluded, as these syndromes are associated with greater morbidity risk. Lastly, only patients with a surgery-day diagnosis for common lumbar degenerative pathologies were selected for further analysis. Specific surgical indications that were chosen included lumbosacral spondylosis (ICD-9-CM: 721.3, 721.42), lumbar degenerative disc disease (ICD-9-CM: 722.10, 722.52, 722.73), or acquired spondylolisthesis (ICD-9-CM: 738.4). In total, this resulted in a total population of 154,972 patients. Of these, 960 patients were noted to be diagnosed with poor nutritional status (kwashiorkor, nutritional marasmus, or other protein-calorie malnutrition; ICD-9-CM: 260, 261, 262, 263.0x) that was coded either on the day of or within the 3 month period before the index procedure, forming the study cohort, henceforth referred to as the "malnutrition cohort." When specifically selecting this study group, those patients who had a diagnosis code for malnutrition during their hospital stay after the index procedure, but not before or on the day of surgery, were not included in the "malnutrition cohort." For demographic and comorbidity comparisons, a control cohort of patients who never were diagnosed with one of the aforementioned malnutrition ICD-9-CM diagnosis codes was also selected from the full patient population ($n = 147{,}278$). The remaining 6734 patients who had a diagnosis of malnutrition before the 3 months preceding surgery, but were not coded as having malnutrition during the 3 months leading up to surgery or on the day of surgery, were excluded from analysis.

Both malnutrition and control cohorts were then queried for demographics (age, sex) and comorbidities (smoking history, obesity, diabetes, chronic kidney disease, and chronic pulmonary disease).[19] All comorbidities were assessed within a standard 1-year "look back" period to combat poor ICD-9 coding practices that may limit accurate capture of patients' full comorbidity burdens.

Outcomes that were assessed included major medical complications within ninety days and revision surgeries, infections, wound dehiscence, and mortality within 1 year. Major medical complications included cerebrovascular accident, pulmonary embolism, pneumonia, myocardial infarction, and acute renal failure.

Statistical Analysis

Pearson χ^2 analysis was used to compare the demographic make-up of the malnutrition and control cohorts and differences in complication and readmission rates. Student *t* test was utilized to compare average Medicare reimbursement. Multivariate logistic regression analysis was used to quantify the independent effect of malnutrition on all clinical outcomes and 30-day readmission rates. Multivariate linear regression analysis was used to assess how malnutrition affects length of stay. The model was adjusted for age (dichotomized as either 65–74 yrs or 75–84 yrs), sex, and all aforementioned comorbidities. For all analyses, significance was set at $P < 0.001$.

RESULTS

Patient Demographics and Comorbidities

Characteristics of both the malnutrition and control cohorts are provided in Table 1. Patients who had malnutrition diagnosis codes were more likely to be older females. There were no significant differences in obesity or smoking rates within the two populations. However, patients who were diagnosed with malnutrition were more likely to have diabetes mellitus, chronic pulmonary disease, or chronic kidney disease ($P < 0.001$).

TABLE 1. Population Characteristics

		Malnutrition		Control		
		n	%	n	%	
Total number		960		147,278		*P*
Age	65–69	274	28.5	59,617	40.5	*
	70–74	277	28.9	44,587	30.3	0.34
	75–79	252	26.3	29,819	20.2	*
	80–84	157	16.4	13,255	9.0	*
Male sex		273	28.4	51,948	35.3	*
Smoking		174	18.1	28,839	19.6	0.26
Obesity (BMI $\geq$ 30)		127	13.2	17,338	11.8	0.16
Diabetes mellitus		299	31.1	36,755	25.0	*
Chronic pulmonary disease		250	26.0	28,147	19.1	*
Chronic kidney disease		92	9.6	5790	3.9	*

*If $P < 0.001$.

Ninety-Day Medical Complication Rates and 1-Year Mortality

Within the malnutrition cohort, major medical complications were noted in 238 patients (24.8%) within 90 days after posterior lumbar spine fusion. Sixteen (1.7%) patients died within 1 year. Analogous major medical complication and mortality rates within the control cohort were 6.1% and 0.2%, respectively ($P < 0.001$ for both comparisons). When adjusting for demographics and comorbidities, a diagnosis of malnutrition was determined to result in significantly increased odds of both 90-day major medical complications (adjusted odds ratio, OR: 4.24, 95% CI: 3.64–4.94, $P < 0.001$) and 1-year mortality (adjusted OR: 6.16, 95% CI: 3.70–10.25, $P < 0.001$).

One-Year Wound Complication and Revision Surgery Rates

Postoperative infections were observed in 49 (5.1%) of patients in the malnutrition cohort, as compared to 1.9% in the control cohort ($P < 0.001$). Wound dehiscence was observed in 22 (2.3%) of patients in the malnutrition cohort, as compared with 0.7% in the control cohort ($P < 0.001$). Multivariate analysis revealed that a diagnosis of malnutrition was a significant predictor of increased infection (adjusted OR: 2.27, 95% CI: 1.70–3.04, $P < 0.001$) and wound dehiscence (adjusted OR: 2.52, 95% CI: 1.64–3.88, $P < 0.001$) risk. Revision surgeries were performed in 37 (3.9%) of patients within the malnutrition cohort, but a malnutrition diagnosis was not observed to be significant in predisposing patients to this particular outcome when adjusting for other variables ($P = 0.004$).

Length of Stay and Readmission Rates

Multivariate linear regression analysis revealed that malnutrition increased length of stay by 3.1 days, adjusted for demographics and comorbidities ($P < 0.001$). Twenty-nine (3.0%) malnourished patients were readmitted within 30 days, which was not significantly increased relative to the control cohort ($P = 0.13$). Furthermore, a diagnosis of poor nutrition status was not noted to be a significant predictor of increased 30-day readmissions when considering the multivariate logistic regression model ($P = 0.56$).

DISCUSSION

Preoperative health status is an extremely important consideration when considering whether or not it is safe to proceed with elective surgery. In elderly patients, nutritional status is an important concern that has not been assessed widely in the literature with regards to spine surgery outcomes. In the current study, we found that patients who were diagnosed with malnourishment before elective 1–2 level lumbar spine fusion surgery were significantly more likely to experience major medical complications, infections, and mortality postoperatively. Notably, malnutrition diagnosis was associated with over six times increased odds of mortality, over four times increased odds of major medical complications, and over two times increased odds of postoperative infection and wound dehiscence. Lastly, a diagnosis of malnutrition was significantly associated with increased length of stay, but not 30-day readmission rates.

Malnutrition is an essential contributor to comorbidity in elderly patients, predisposing this particular demographic to developing sarcopenia[20] and associated decreased resistance to physical stressors.[7,8] Much research has been conducted concerning the effects of poor preoperative nutrition status on outcomes after various surgical procedures,[13,21] though, unfortunately, malnutrition is poorly studied in the literature with regards to spine surgery outcomes. Recent studies have established that poor preoperative nutritional status is an independent risk factor for increased length of stay and wound complications,[14,15] findings that are similar to what was observed within the current study. Wound complications are predictable given the essential pathophysiology associated with poor nutritional status, as protein and vitamin deficiencies can cause decreased wound tensile strength and hinder the normal healing process.[22,23]

Though these previous studies on spine surgery outcomes related to poor health status are instructive in establishing increased risks associated with malnutrition, they were essentially limited by not focusing completely on the elderly population, which is particularly at risk for developing nutrition-related sarcopenia and frailty. This consideration is particularly important when examining the medical complication and mortality rates that were observed in the elderly, malnourished population in the current study. Serious major medical events within ninety days after surgery occurred at a rate that was four times that which was observed in the control cohort. Similarly, mortality was increased almost six-fold at 1 year. Interestingly, we were unable to establish a significant increase in revision surgery rates within the malnutrition cohort, despite increases in dehiscence and infection rates. This may be because of patients within this cohort having poor health status and not being able to be medically cleared for revision surgery. We similarly did not observe increased 30-day readmission rates within the malnourished cohort, which disagrees with previous studies.[14,15] However, this finding may be a reflection of the high baseline readmission rate observed within the elderly population.[24,25]

The significant risks associated with a diagnosis of poor nutrition in the elderly population may suggest the importance of interventions to improve nutritional status before surgery. Nutritional management before surgery may be a cost-effective method of reversing malnutrition and its undesired effects on physiological systems.[26–28] This type of intervention may reduce complication rates and decrease length of stay, thus decreasing two essential drivers of increased healthcare costs. Unfortunately, we cannot demonstrate that nutritional supplementation would in fact improve outcomes in patients with poor nutritional states, as our study is cross-sectional and not capable of identifying how changes in nutritional status over time impact patient outcomes and costs. Well-controlled, prospective trials are needed to fully assess the impact of nutritional supplementation in malnourished elderly individuals.

The current study has several advantages. By using the full sample of Medicare data from 2005 to 2012, we were able to select a large population of elderly, elective spine fusion surgery patients to assess malnutrition in a previously poorly studied demographic. This study characteristic is important, given that elderly patients are known to be particularly susceptible to age-related decreases in muscle mass that can negatively affect outcomes. In addition, we were able to follow patients beyond 30 days, which is a notable limitation of prior database studies. However, there are several limitations that must be considered and may limit our conclusions. First, our study was retrospective, which challenges interpretation of causality. Second, as we used an administrative database, coding errors, particularly with comorbidities, must be considered. Unfortunately, to the author's best knowledge, rates of malnutrition miscoding have not been reported in the literature. Beyond miscoding, however, there is another source of bias that likely skewed the presented data. By selecting only those patients with a discrete ICD-9 diagnosis code for various malnutrition disorders, we likely selected only those patients who had a sufficiently "worse" nutrition status to merit coding by a physician. As such, our study cohort may contain only those patients who are at the lowest percentiles of nutrition, without comprehensively capturing the full set of elderly patients who fulfill the criteria of poor nutrition. The end result of this selection bias would be overestimated complication and mortality rates, an inherent limitation to this manuscript. This would have been improved upon if we were able to code for quantitative preoperative albumin levels, which as a marker of poor nutrition, may have strengthened our study and added credibility to the relationship that was observed.

CONCLUSION

Nutritional status is an important aspect of preoperative health survey in the elderly population. Malnutrition diagnosis significantly increases complication and mortality rates, whereas also significantly increasing length of stay. In elderly patients with poor nutritional status, options such as nutritional supplementation before surgery should be studied as an effective means to optimize postoperative outcomes.

➢ Key Points

- ❑ Preoperative nutritional status is an important contributor to both sarcopenia and frailty.
- ❑ Malnutrition significantly increases odds of both 90-day major medical complications (adjusted OR: 4.24) and 1-year mortality (adjusted OR: 6.16).
- ❑ Malnutrition is a significant predictor of increased infection (adjusted OR: 2.27) and wound dehiscence (adjusted OR: 2.52) risk.

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