# Discharge Destination as a Predictor of Postoperative Outcomes and Readmission Following Posterior Lumbar Fusion

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BACKGROUND: **Posterior lumbar fusions are performed to treat various spinal deformities, degenerative diseases, fractures, infections, and tumors. The possibility of episode-based bundled payments for spine surgery necessitates analysis of the factors predicting readmissions and postoperative complications.**

METHODS: **Patients undergoing posterior lumbar fusion in the American College of Surgeons National Surgical Quality Improvement Program were queried via Current Procedural Terminology codes 22630, 22633, and 22612. Patients were grouped based on discharge destination, either to home/home health care or to a facility. Relevant demographics, comorbidities, perioperative statistics, and predischarge and postdischarge complications were compared. Multivariable logistic regression models for severe postdischarge complications and 30-day readmissions were created with the exposure of nonhome discharge.**

RESULTS: **Patients discharged to nonhome destinations were significantly older (68.42 vs. 58.15 years; $P < 0.0001$), sicker (68.11% of patients had American Society of Anesthesiologists Physical Status Classification > 2 vs. 44.25%; $P < 0.0001$), more dependent (5.92% vs. 1.40%; $P < 0.0001$), and had significantly greater body mass indices (10.60% of patients had body mass index > 40 vs. 7.63%; $P < 0.0001$) than patients discharged home. Following discharge, patients in the nonhome discharge group experienced higher mortality (0.28% vs. 0.08%; $P < 0.0001$) and were more likely to experience a severe complication (5.96% vs. 2.85%; $P < 0.0001$), minor complication (4.59% vs. 1.74%; $P < 0.0001$), and readmission (8.92% vs. 4.78%; $P < 0.0001$). Nonhome discharge proved to be a risk factor for both readmission (odds ratio 1.43; 95% confidence interval 1.28—1.60; $P < 0.0001$) and severe postdischarge complication (odds ratio 1.73; 95% confidence interval 1.52—1.97; $P < 0.0001$).**

CONCLUSIONS: **Nonhome discharge patients experienced higher rates of complications and 30-day readmissions.**

## INTRODUCTION

Posterior lumbar fusion (PLF) is a commonly performed, largely elective spine surgery aimed at correcting a plethora of spinal deformities, degenerative diseases, fractures, infections, and tumors.[1] This surgery, along with other fusion-based spinal procedures, accounts for $287 billion of annual U.S. health care spending.[2] An aging population with high rates of spinal disease has contributed to increased utilization of PLF.[3,4] With costs subsequently increasing, and in light of the Triple Aim framework, many have looked to alternative models that redirect financial incentives and optimize patient-centered outcomes.[5,6] Episode-based bundled payment models have been increasingly embraced for a variety of surgeries in an attempt to curtail the fragmented care and escalating costs that can result from a fee-for-service model.[7]

**Key words**
- Bundled payments
- Nonhome discharge
- Outcomes
- Post—acute care facilities
- Posterior lumbar fusion
- Readmissions
- Spine surgery

**Abbreviations and Acronyms**
ASA: American Society of Anesthesiologists
BMI: Body mass index
CI: Confidence interval
IRF: Inpatient rehabilitation facility
NSQIP: National Surgical Quality Improvement Program
OR: Odds ratio
PLF: Posterior lumbar fusion
SNF: Skilled nursing facility
TJA: Total joint arthroplasty

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Implementation of bundled payments in spine surgery requires a comprehensive understanding of the factors that both optimize patient outcomes and streamline health care costs. Although predictors of nonhome discharge have been identified for elective spinal deformity surgery and anterior cervical discectomy and fusion, the effect of discharge destination on patient outcomes remains unclear for an abundance of procedures.[8,9] The literature on total joint arthroplasty (TJA)[10-13] has shown that discharge to an inpatient rehabilitation facility (IRF) or skilled nursing facility (SNF) significantly correlates with increased 30-day and 90-day readmission rates. Furthermore, TJA patients discharged to one of these nonhome destinations (SNF or IRF) experienced significantly higher rates of severe and minor postdischarge adverse events.[14] Despite these findings, there remains a relative paucity of information on how postacute care following PLF relates to patient outcomes and readmissions. Filling this gap represents a meaningful next step towards value-based, patient-centered care.

This study aims to characterize the patients who are discharged to home versus those who are discharged to nonhome destinations, and compares the rates of postdischarge adverse events between these groups. The present study also endeavors to determine the risk factors for nonhome discharge following PLF and explore whether, in a controlled multivariate model, nonhome discharge is a predictor of readmission or severe postdischarge adverse events.

## METHODS

Patients were identified from the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) Participant User Files as having undergone PLF from 2012 to 2015, due to the addition of a variable for readmissions in 2012. Patients were queried using the Current Procedural Terminology codes 22612, 22630, and 22633. Any patient whose perioperative data were incomplete or who expired prior to discharge was excluded from the analysis.

Patients were categorized based on their discharge status: to home (which included home health care and self-managed care), an SNF, or an IRF. The SNF and IRF cohorts were further combined to create a nonhome discharge cohort. Comparisons were made between all cohorts to investigate the effect of nonhome discharge on severe, minor, and infectious complications and readmissions, as have been categorized previously.[11] A full explanation of all variables used for analysis can be found in the NSQIP user guide (https://www.facs.org/~/media/files/quality%20programs/nsqip/nsqip_puf_user_guide_2015.ashx).

All statistical analyses were performed on SAS version 9.4 (SAS Institute, Cary, North Carolina, USA) with a 2-tailed $\alpha$ of 0.5. Categorical variables were analyzed using $\chi^2$ and Fisher's exact test, when necessary. Continuous variables were analyzed using a Student's t test. Backwards selection multivariable logistic regression analyses were used to create a model predictive of nonhome discharge, with an inclusion P value of 0.2 to account for nonsignificant confounders. Furthermore, similar models were created to investigate the effect of nonhome discharge on readmissions and postdischarge severe adverse events, with nonhome discharge as the exposure, and several other covariates.

Multivariate analysis included the following risk factors: predischarge severe adverse event(s), age, operative time, sex, dependency status, body mass index > 40, diabetes, pulmonary disease, heart disease, hypertension, stroke, kidney failure, bleeding disorder, total length of stay, and American Society of Anesthesiologists Physical Status Classification (ASA Class) > 2. Past studies have found NSQIP comorbidity and functional status variables to accurately predict postoperative outcomes.[15] Ondeck et al.[16] found just two of these variables, ASA Class and age, to be superior to the modified Charlson Comorbidity and Frailty Indices in predicting adverse events and extended length of stay. Both of these variables, in addition to thirteen others found to be most predictive of patient outcomes, were controlled for when examining nonhome discharge as a risk factor for severe adverse events and readmission.

## RESULTS

A total of 35,973 patients were identified within the NSQIP database as having undergone PLF between 2012 and 2015, with 28,943 patients being discharged home, 3,872 to a SNF, and 3,158 to an IRF (Table 1). Patients within this cohort who were discharged to nonhome destinations were significantly older (68.42 vs. 58.15 years; $P < 0.0001$), sicker (68.11% of patients had ASA class > 2 vs. 44.25%; $P < 0.0001$), more dependent (5.92% vs. 1.40%; $P < 0.0001$), and had significantly greater BMIs (10.60% of patients had BMI > 40 vs. 7.63%; $P < 0.0001$) than did patients discharged home. Those sent to facilities were also more likely to have a history of diabetes (25.99% vs. 15.54%; $P < 0.0001$), pulmonary disease (7.54% vs. 4.12%; $P < 0.0001$), cardiac disease (1.44% vs. 0.50%; $P < 0.0001$), hypertension (71.29% vs. 53.04%; $P < 0.0001$), or renal disease (0.21% vs. 0.03%; $P < 0.0001$) than those discharged home (Table 1).

Those discharged to a nonhome destination were significantly more likely, overall, to have experienced predischarge severe adverse events (6.73% vs. 1.82%; $P < 0.0001$), minor adverse events (3.26% vs. 0.83%; $P < 0.0001$), and infectious complications (1.44% vs. 0.26%; $P < 0.0001$) than those discharged to home (Table 2). The mean total hospital length of stay was also significantly longer for patients discharged to a nonhome destination than for those discharged to their home (5.91 vs. 3.68 days; $P < 0.0001$). A detailed report of individual predischarge complications and their rates among patients discharged to home, SNFs, and IRFs can be found in Table 2.

When comparing postdischarge adverse events between nonhome and home discharge groups, those in the former group were found to be significantly more likely to have both a severe (5.96% vs. 2.85%; $P < 0.0001$) and minor (4.59% vs. 1.74%; $P < 0.0001$) adverse event, as well as an infectious complication (3.85% vs. 1.85%; $P < 0.0001$) (Table 3). Patients within the nonhome discharge group were significantly more likely to die (0.28% vs. 0.08%; $P < 0.0001$) and experience an unplanned readmission (8.92% vs. 4.78%; $P < 0.0001$) than those sent to their home (Table 3). A detailed report of individual postdischarge complications and their rates among patients discharged to home, SNFs, and IRFs can be found in Table 3.

Table 4 indicates the factors found to be predictive of nonhome discharge destination. Predictors of nonhome discharge included dependent functional status (odds ratio [OR] 2.45, 95% confidence interval [CI] 2.08–2.90, $P < 0.0001$), heart disease

**Table 1.** Comparison of Posterior Lumbar Fusion Patient Demographic Characteristics by Discharge Destination

| | | | | | *P* Value | | | |
|---|---|---|---|---|---|---|---|---|
| | Home (n = 28,943) | SNF (n = 3872) | IRF (n = 3158) | Nonhome (n = 7030) | Home versus SNF | Home versus IRF | SNF versus IRF | Home versus Nonhome |
| Age (years) | 58.15 (13.02) | 69.39 (10.49) | 67.25 (11.34) | 68.42 (10.93) | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Sex (male) | 13782 (47.62) | 1258 (32.49) | 1212 (38.38) | 2470 (35.14) | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Race | | | | | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| White | 24354 (84.14) | 3326 (85.90) | 2524 (79.92) | 5850 (83.21) | | | | |
| African American | 2092 (7.23) | 294 (7.59) | 364 (11.53) | 658 (9.36) | | | | |
| Asian | 429 (1.48) | 54 (1.39) | 85 (2.69) | 139 (1.98) | | | | |
| Other | 294 (1.02) | 35 (0.9) | 29 (0.92) | 64 (0.91) | | | | |
| Unknown | 1774 (6.13) | 163 (4.21) | 156 (4.94) | 319 (4.54) | | | | |
| Functional status (dependent) | 406 (1.40) | 226 (5.84) | 190 (6.02) | 416 (5.92) | <0.0001 | <0.0001 | 0.75 | <0.0001 |
| BMI >40 kg/m$^2$ | 2208 (7.63) | 400 (10.33) | 345 (10.92) | 745 (10.60) | <0.0001 | <0.0001 | 0.42 | <0.0001 |
| History of smoking | 6512 (22.50) | 477 (12.32) | 441 (13.96) | 918 (13.06) | <0.0001 | <0.0001 | 0.04 | <0.0001 |
| History of diabetes | 4498 (15.54) | 1035 (26.73) | 792 (25.08) | 1827 (25.99) | <0.0001 | <0.0001 | 0.12 | <0.0001 |
| History of pulmonary disease | 1192 (4.12) | 302 (7.80) | 228 (7.22) | 530 (7.54) | <0.0001 | <0.0001 | 0.36 | <0.0001 |
| History of cardiac disease | 145 (0.50) | 57 (1.47) | 44 (1.39) | 101 (1.44) | <0.0001 | <0.0001 | 0.78 | <0.0001 |
| Hypertension | 15351 (53.04) | 2769 (71.51) | 2243 (71.03) | 5012 (71.29) | <0.0001 | <0.0001 | 0.65 | <0.0001 |
| History of stroke | 30 (0.10) | 7 (0.18) | 4 (0.13) | 11 (0.16) | 0.18 | 0.57 | 0.76 | 0.24 |
| History of renal disease | 8 (0.03) | 5 (0.13) | 10 (0.32) | 15 (0.21) | 0.01 | <0.0001 | 0.12 | <0.0001 |
| Steroids for chronic condition | 1037 (3.58) | 247 (6.38) | 210 (6.65) | 457 (6.50) | <0.0001 | <0.0001 | 0.65 | <0.0001 |
| Bleeding-causing disorders | 353 (1.22) | 111 (2.87) | 94 (2.98) | 205 (2.92) | <0.0001 | <0.0001 | 0.79 | <0.0001 |
| ASA class > 2 | 12807 (44.25) | 2593 (66.97) | 2195 (69.51) | 4788 (68.11) | <0.0001 | <0.0001 | 0.02 | <0.0001 |
| Operative time, minutes (mean) | 202.9 (98.51) | 234.6 (116.3) | 257.3 (131.2) | 244.8 (123.7) | <0.0001 | <0.0001 | <0.0001 | <0.0001 |

Values are number (%) except where indicated otherwise.
SNF, skilled nursing facility; IRF, inpatient rehabilitation facility; BMI, body mass index; ASA class, American Society of Anesthesiology Classification.

(OR 1.42, 95% CI 1.05–1.91, P < 0.0001), pulmonary disease (OR 1.33, 95% CI 1.18–1.50, P < 0.0001), ASA class >2 (OR 1.43, 95% CI 1.34–1.52, P < 0.0001), bleeding disorder (OR 1.37, 95% CI 1.12–1.67, P < 0.0001), renal failure (OR 3.29, 95% CI 1.11–9.75, P < 0.0001), diabetes (OR 1.318, 95% CI 1.23–1.42, P < 0.0001), and BMI >40 (OR 1.50, 95% CI 1.35–1.67, P < 0.0001) (Table 4).

Nonhome discharge proved to be a risk factor for both readmission (OR 1.73, 95% CI 1.52–1.97, P < 0.0001) and severe adverse events after discharge (OR 1.43, 95% CI 1.28–1.60, P < 0.0001) when controlling for all other possibly intervening variables in the multivariate model (Table 5).

## DISCUSSION

The results of this study indicate that patients discharged to nonhome destinations suffered a greater number of postdischarge adverse events and were significantly more likely to experience a readmission. The present findings, coupled with the increased cost of postacute care facilities relative to home and home health aid discharges, have important implications for the future utilization of such services. Readmissions and postoperative adverse events are deleterious to a patient's quality of life and compromise important safety goals.

Table 5 illustrates that nonhome discharge destination is a risk factor for both postdischarge adverse events and readmissions; these risks endure even when controlling for a number of factors, including predischarge complications, that might otherwise influence the validity of the comparison. As evidenced by Tables 1 and 4, there are inherent differences in the patient populations discharged to home and nonhome destinations. Indeed, it has been previously shown that patients discharged to postacute care facilities are, on average, older, suffer from a greater number of comorbidities and greater severity of illness, take more medications, and possess more cognitive deficits than do those discharged to their home.[17-20] These preexisting differences between patient populations translate to higher incidences of severe and minor adverse events in patients discharged to a

**Table 2.** Comparison of Predischarge Adverse Events in Patients With Posterior Lumbar Fusion by Discharge Destination

| | | | | | *P* Value | | | |
|---|---|---|---|---|---|---|---|---|
| | Home (n = 28,943) | SNF (n = 3872) | IRF (n = 3158) | Nonhome (n = 7030) | Home versus SNF | Home versus IRF | SNF versus IRF | Home versus Nonhome |
| Severe adverse event | 526 (1.82) | 246 (6.35) | 227 (7.19) | 473 (6.73) | <0.0001 | <0.0001 | 0.16 | <0.0001 |
| Deep wound infection | 18 (0.06) | 8 (0.21) | 13 (0.41) | 21 (0.30) | 0.003 | <0.0001 | 0.12 | <0.0001 |
| Organ/space infection | 9 (0.03) | 12 (0.31) | 6 (0.19) | 18 (0.26) | <0.0001 | <0.0001 | 0.32 | <0.0001 |
| Wound dehiscence | 12 (0.04) | 4 (0.10) | 2 (0.06) | 6 (0.09) | 0.11 | 0.64 | 0.7 | 0.14 |
| Unplanned intubation | 28 (0.10) | 19 (0.49) | 29 (0.92) | 48 (0.68) | <0.0001 | <0.0001 | 0.03 | <0.0001 |
| Deep vein thrombosis | 53 (0.18) | 25 (0.65) | 39 (1.23) | 64 (0.91) | <0.0001 | <0.0001 | 0.01 | <0.0001 |
| Pulmonary embolism | 60 (0.21) | 21 (0.54) | 26 (0.82) | 47 (0.67) | <0.0001 | <0.0001 | 0.15 | <0.0001 |
| Ventilator >48 hours | 13 (0.04) | 28 (0.72) | 20 (0.63) | 48 (0.68) | <0.0001 | <0.0001 | 0.64 | <0.0001 |
| Renal insufficiency | 16 (0.06) | 16 (0.41) | 9 (0.28) | 25 (0.36) | <0.0001 | <0.0001 | 0.37 | <0.0001 |
| Renal failure | 11 (0.04) | 7 (0.18) | 10 (0.32) | 17 (0.24) | 0.0004 | <0.0001 | 0.25 | <0.0001 |
| Stroke/cerebrovascular accident | 6 (0.02) | 13 (0.34) | 14 (0.44) | 27 (0.38) | <0.0001 | <0.0001 | 0.47 | <0.0001 |
| Cardiac arrest requiring CPR | 8 (0.03) | 7 (0.18) | 5 (0.16) | 12 (0.17) | <0.0001 | 0.006 | 1 | <0.0001 |
| Myocardial infarction | 42 (0.15) | 25 (0.65) | 19 (0.60) | 44 (0.63) | <0.0001 | <0.0001 | 0.82 | <0.0001 |
| Sepsis | 37 (0.13) | 33 (0.85) | 18 (0.57) | 51 (0.73) | <0.0001 | <0.0001 | 0.17 | <0.0001 |
| Septic shock | 6 (0.02) | 11 (0.28) | 6 (0.19) | 17 (0.24) | <0.0001 | <0.0001 | 0.42 | <0.0001 |
| Return to operating room | 291 (1.01) | 104 (2.69) | 90 (2.85) | 194 (2.76) | <0.0001 | <0.0001 | 0.68 | <0.0001 |
| Death | 0 | 0 | 0 | 0 | — | — | — | — |
| Minor adverse event | 239 (0.83) | 137 (3.54) | 92 (2.91) | 229 (3.26) | <0.0001 | <0.0001 | 0.14 | <0.0001 |
| Superficial infection | 13 (0.04) | 7 (0.18) | 5 (0.16) | 12 (0.17) | 0.001 | 0.03 | 0.82 | 0.0003 |
| Pneumonia | 101 (0.35) | 51 (1.32) | 32 (1.01) | 83 (1.18) | <0.0001 | <0.0001 | 0.24 | <0.0001 |
| Urinary tract infection | 131 (0.45) | 81 (2.09) | 55 (1.74) | 136 (1.93) | <0.0001 | <0.0001 | 0.29 | <0.0001 |
| Infectious complication | 76 (0.26) | 60 (1.55) | 41 (1.30) | 101 (1.44) | <0.0001 | <0.0001 | 0.38 | <0.0001 |
| Total length of stay, days (mean) | 3.37 (3.68) | 5.97 (5.76) | 6.12 (6.08) | 6.04 (5.91) | <0.0001 | <0.0001 | 0.32 | <0.0001 |

Values are number (%) except where indicated otherwise.
SNF, skilled nursing facility; IRF, inpatient rehabilitation facility; CPR, cardiopulmonary resuscitation.

nonhome destination (Tables 2 and 3). However, the multivariable logistic regression analyses shown in Table 5 account for the effects of these potentially confounding preexisting differences. Further studies are needed to elucidate the source of these differences in outcomes, which are beyond the scope of the present analysis.

Extant literature has shown that elevated ASA class, dependent functional status, and advanced age are positively correlated with readmission and complication rates for PLF and spine surgeries in general.[21-28] As evidenced by the present results, ASA class also predicts nonhome discharge and postdischarge adverse events accurately through the 30-day follow-up period, even when controlling for confounding factors (Tables 4 and 5). These conclusions further attest to the strength of ASA class as a conglomerate, easy measure of preoperative comorbidity burden and a predictor of subsequent clinical outcomes.

Although discharge disposition has previously been implicated in readmission rates for a variety of procedures, there has heretofore been a lack of consensus on the role that discharge disposition plays in readmissions following spine surgery specifically. Two current reports present differing conclusions on whether nonhome discharge destination is associated with higher rates of readmission, with Akamnonu et al.[29] presenting results suggesting a significant association and Vasquez et al.[30] suggesting the contrary. However, the relatively small readmission sample size (n = 65) presented by Vasquez et al. may have precluded the authors from finding a statistically significant difference in outcomes for the two discharge

**Table 3.** Comparison of Postdischarge Adverse Events in Patients With Posterior Lumbar Fusion by Discharge Destination

| | Home (n = 28,943), n (%) | SNF (n = 3872), n (%) | IRF (n = 3158), n (%) | Nonhome (n = 7030), n (%) | *P* Value | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Home versus SNF | Home versus IRF | SNF versus IRF | Home versus Nonhome |
| Severe adverse event | 826 (2.85) | 225 (5.81) | 194 (6.14) | 419 (5.96) | <0.0001 | <0.0001 | 0.56 | <0.0001 |
| Deep wound infection | 177 (0.61) | 45 (1.16) | 35 (1.11) | 80 (1.14) | <0.0001 | 0.001 | 0.83 | <0.0001 |
| Organ/space infection | 56 (0.19) | 23 (0.59) | 14 (0.44) | 37 (0.53) | <0.0001 | 0.004 | 0.39 | <0.0001 |
| Wound dehiscence | 54 (0.19) | 22 (0.57) | 15 (0.47) | 37 (0.53) | <0.0001 | 0.0009 | 0.59 | <0.0001 |
| Unplanned intubation | 19 (0.07) | 7 (0.18) | 4 (0.13) | 11 (0.16) | 0.02 | 0.28 | 0.57 | 0.02 |
| Deep vein thrombosis | 101 (0.35) | 33 (0.85) | 44 (1.39) | 77 (1.10) | <0.0001 | <0.0001 | 0.03 | <0.0001 |
| Pulmonary embolism | 58 (0.20) | 20 (0.52) | 22 (0.70) | 42 (0.60) | 0.0001 | <0.0001 | 0.33 | <0.0001 |
| Ventilator >48 hours | 10 (0.03) | 3 (0.08) | 1 (0.03) | 4 (0.06) | 0.19 | 1 | 0.63 | 0.5 |
| Renal insufficiency | 10 (0.03) | 9 (0.23) | 5 (0.16) | 14 (0.20) | <0.0001 | 0.01 | 0.6 | <0.0001 |
| Renal failure | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0 | — | — | — | — |
| Stroke/cerebrovascular accident | 8 (0.03) | 3 (0.08) | 4 (0.13) | 7 (0.10) | 0.13 | 0.02 | 0.52 | 0.008 |
| Cardiac arrest requiring cardiopulmonary resuscitation | 6 (0.02) | 4 (0.10) | 1 (0.03) | 5 (0.07) | 0.02 | 0.52 | 0.39 | 0.05 |
| Myocardial infarction | 21 (0.07) | 7 (0.18) | 4 (0.13) | 11 (0.16) | 0.03 | 0.3 | 0.76 | 0.03 |
| Sepsis | 110 (0.38) | 37 (0.96) | 29 (0.92) | 66 (0.94) | <0.0001 | <0.0001 | 0.9 | <0.0001 |
| Septic shock | 23 (0.08) | 16 (0.41) | 5 (0.16) | 21 (0.30) | <0.0001 | 0.19 | 0.08 | <0.0001 |
| Return to operating room | 562 (1.94) | 124 (3.20) | 105 (3.32) | 229 (3.26) | <0.0001 | <0.0001 | 0.77 | <0.0001 |
| Death | 22 (0.08) | 14 (0.36) | 6 (0.19) | 20 (0.28) | <0.0001 | 0.04 | 0.18 | <0.0001 |
| Minor adverse event | 504 (1.74) | 178 (4.60) | 145 (4.59) | 323 (4.59) | <0.0001 | <0.0001 | 0.99 | <0.0001 |
| Superficial infection | 262 (0.91) | 85 (2.20) | 33 (1.04) | 118 (1.68) | <0.0001 | 0.43 | 0.0002 | <0.0001 |
| Pneumonia | 51 (0.18) | 22 (0.57) | 14 (0.44) | 36 (0.51) | <0.0001 | 0.002 | 0.47 | <0.0001 |
| Urinary tract infection | 203 (0.70) | 80 (2.07) | 102 (3.23) | 182 (2.59) | <0.0001 | <0.0001 | 0.002 | <0.0001 |
| Infectious complication | 534 (1.85) | 173 (4.47) | 98 (3.10) | 271 (3.85) | <0.0001 | <0.0001 | 0.003 | <0.0001 |
| Unplanned readmission | 1384 (4.78) | 335 (8.65) | 292 (9.25) | 627 (8.92) | <0.0001 | <0.0001 | 0.38 | <0.0001 |

SNF, skilled nursing facility; IRF, inpatient rehabilitation facility.

dispositions. The literature also suggests substantial variation in complication rates following PLF. Overall PLF complication rates range from 3.8% to 33.3%,[31,32] indicating that the complication rates in the present study remain within those previously reported. The present findings, in conjunction with the previous literature from TJA, indicate that nonhome discharge is likely associated with higher rates of postdischarge adverse events and readmissions.

Although the present study found nonhome discharge to be predictive of adverse patient outcomes, effective preventive measures may be taken at several points along the care continuum. Prolonged length of stay is a predictor of adverse patient outcomes (Table 5),[33] and early ambulation has been shown to decrease both the average length of stay and postoperative complications.[34] Discerning health care teams should seek to mobilize patients with spinal fusion early and increasingly utilize home or home health care discharges. Future studies should seek to balance the risks associated with a prolonged length of stay with those of readmitting a prematurely discharged patient. The identification of patients at high risk for nonhome discharge disposition, as well as the treatment of potentially modifiable risk factors, may improve overall patient outcomes and postacute expenditures.[11]

The finding that nonhome discharge predicts adverse events and readmissions in PLF may, at first glance, challenge the prevailing notion that increased care and surveillance result in better outcomes. However, the mere usage of postacute facilities does not ensure the quality of care. Hospitals that remain vigilant about the quality of the postacute care facilities to which they discharge their patients may reap the financial rewards that accompany

**Table 4.** Risk Factors for Nonhome Discharge Destination

| Outcome/Risk Factor | Odds Ratio (95% Confidence Interval) | *P* Value |
|---|---|---|
| Age | 1.08 (1.07–1.08) | <0.0001 |
| Operative time | 1.00 (1.00–1.00) | <0.0001 |
| Male sex | 0.57 (0.54–0.61) | <0.0001 |
| Dependent functional status | 2.45 (2.08–2.90) | <0.0001 |
| Body mass index >40 kg/m$^2$ | 1.50 (1.35–1.67) | <0.0001 |
| Diabetes | 1.32 (1.23–1.42) | <0.0001 |
| History of pulmonary disease | 1.33 (1.18–1.50) | <0.0001 |
| History of heart disease | 1.42 (1.05–1.91) | 0.0211 |
| Hypertension | 1.05 (0.98–1.12) | 0.1692 |
| History of stroke | 0.51 (0.23–1.11) | 0.0876 |
| Renal failure | 3.29 (1.11–9.75) | 0.0315 |
| Bleeding disorder | 1.37 (1.12–1.67) | 0.0024 |
| Total length of stay | 1.18 (1.17–1.19) | <0.0001 |
| ASA class >2 | 1.43 (1.34–1.52) | <0.0001 |
| *c* statistic = 0.82 | | |

**Table 5.** Risk Factors for Severe Adverse Event After Discharge and Readmission

| Outcome/Risk Factor | Odds Ratio (95% Confidence Interval) | *P* Value |
|---|---|---|
| Severe adverse event after discharge | | |
| Nonhome discharge | 1.73 (1.52–1.97) | <0.0001 |
| Severe predischarge adverse event | 1.93 (1.52–2.45) | <0.0001 |
| Operative time | 1.00 (1.00–1.00) | 0.0002 |
| Male sex | 1.09 (0.97–1.23) | 0.13 |
| Dependent functional status | 1.35 (1.01–1.81) | 0.045 |
| Body mass index >40 kg/m$^2$ | 1.61 (1.36–1.91) | <0.0001 |
| Diabetes | 1.10 (0.96–1.27) | 0.18 |
| History of heart disease | 1.43 (0.86–2.36) | 0.17 |
| Hypertension | 1.23 (1.08–1.39) | 0.002 |
| ASA class >2 | 1.35 (1.18–1.53) | <0.0001 |
| Readmission | | |
| Nonhome discharge | 1.43 (1.28–1.60) | <0.0001 |
| Severe predischarge adverse event | 1.45 (1.17–1.81) | 0.0009 |
| Age | 1.01 (1.003–1.01) | 0.0003 |
| Operative time | 1.00 (1.00–1.00) | <0.0001 |
| Dependent functional status | 1.44 (1.14–1.82) | 0.002 |
| Body mass index >40 kg/m$^2$ | 1.26 (1.08–1.46) | 0.003 |
| Diabetes | 1.15 (1.03–1.29) | 0.02 |
| History of chronic obstructive pulmonary disease | 1.27 (1.06–1.52) | 0.009 |
| Hypertension | 1.11 (0.99–1.23) | 0.07 |
| Length of stay | 1.01 (1.00–1.02) | 0.005 |
| ASA class >2 | 1.39 (1.25–1.55) | <0.0001 |

lower readmissions. Communication barriers, both between hospitals and facilities and within facilities themselves, limited resources and training, and staffing patterns (e.g., nurse retention, level of physician engagement, and continuity of care) may all contribute to the curative clout of a postacute care facility.[35] Schoenfeld et al. found that strengthened linkage between the facility and referring hospital reduced the likelihood of readmission for patients undergoing numerous major surgeries, lumbar spine surgery included.[36] Furthermore, the threshold for readmission may vary widely depending on the patient's condition and preferences, facility capabilities, and the influence of local, state, and national policies, thus creating potential discrepancies from facility to facility.[35]

Beyond improving the quality of the facilities themselves, hospitals may reduce postacute care spending by shifting their discharge disposition strategy. A 2013 report from the Institute of Medicine indicated that postacute care is the most significant contributor to overall geographic variation in Medicare spending.[37] Postacute care accounted for $62 billion of Medicare spending in 2012 alone. These payments have increased more rapidly than most other categories of spending, with SNFs accounting for approximately half of these expenditures.[38] In spine surgery specifically, Schoenfeld et al.[39] found postacute care and readmission costs to be the major drivers of cost variation within diagnosis-related groups, even when controlling for regional wage differences, type of surgery, indication, and use of fusion-based procedures. In contrast, the marginal cost of the last day of hospitalization was found to constitute a mere 2.4% of the average total cost per admission, which is substantially lower than the cost of an SNF or IRF admission.[38,40] Reducing this variation in payments for similar procedures remains an untapped opportunity to reduce overall costs.[39] As shown by the present study, limiting the utilization of postacute care facilities stands to improve PLF patient outcomes and holds tremendous potential to decrease health care expenditures.

The present study is not without its limitations. Data were limited to complications and readmissions up to 30, but not 90 days after discharge, and therefore do not cover the full period analyzed in some episode-based bundled payment models, and also likely underestimate some patient-level complications and readmissions. Moreover, the NSQIP database groups both home health care and independent home self-managed care into one category of discharge disposition, thereby preventing the detection of differences between these patients. NSQIP data are extracted from hospitals in which PLF was first performed, and thus do not account for complications or readmissions at a separate facility.[11]

Lastly, data collected are limited to those found in the NSQIP database, automatically preventing the present study from controlling for specific spinal measures of procedural complexity or physician characteristics that may contribute to nonhome discharge, adverse events, or readmission rates.[41,42] This limitation may also contribute to an overall underestimation of total readmission and complication rates.

The present results indicate a potential opportunity to improve patient outcomes and reduce ineffective postacute health care spending. To realize these mutual benefits, hospitals may need to limit the utilization of postacute care facilities or improve the transition through increased communication and continuity of care. A more comprehensive analysis of the SNF and IRF qualities most significantly affecting PLF patient outcomes is warranted.

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